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PRATT FOUNDATION

Commercial Protected Cropping Production Methodologies and Systems Applicable to Vegetable Growers in Southern Victoria

Tony Bundock
The Pratt Foundation/ISS Institute Overseas Fellowship

Fellowship supported by The Pratt Foundation

ISS Institute Inc.
MARCH 2010

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Published by International Specialised Skills Institute, Melbourne.

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AUSTRALIA

March 2010

Also extract published on www.issinstitute.org.au

Executive Summary

The main focus of the Fellowship was to look at concepts involving hydroponic growing systems. Hydroponics is the production of crops in isolation from the soil, either with or without a medium, with their total water and nutrient requirements supplied by the system. Production takes place either in a greenhouse or outdoors, and systems can recirculate or allow nutrients to 'free drain' for reuse on to other crops, such as trees, and for pasture improvement. The generic industry is highly efficient in its use of all inputs including water, fertilisers, labour, land and energy. Growers can expect to produce crops that will exhibit faster growth rates with significantly higher yields and improved quality due to a well maintained growing environment.

Utilisation of hydroponic systems in conjunction with controlled environment glasshouses means that:

- Growers can grow crops out of traditional seasons and native areas. This gives growers a higher premium for their product at times of high demand offering higher returns for farmers' efforts
- Closed irrigation systems used in hydroponic growing can deliver major energy and water efficiencies, with near zero waste water resulting from production methods.

The protected cropping industry has clearly identified that it is looking for its future management to have the skills that are needed to monitor and manage both the growing structures and the environment within them, in order to achieve maximum output from intensive systems. The industry is currently looking to either employ overseas practitioners who have these skills, or send staff members overseas to gain these skills.

The common theme running though the protected cropping industry was a lack of training and skills development options for all levels of participants. A 2005 review of the industry performed by the Australian Hydroponic and Glasshouse Association (AHGA) explored market failures and constraints to industry development with the main industry representatives in all Australian states. This review resulted in identification of around 19 issues that urgently required attention, with the number one common issue identified as a lack of skills training opportunities. The identified skills and knowledge deficiencies utilised in the Fellowship comprised of a list of subject areas identified by the industry. The skills have been identified by the AHGA as being pivotal to training within the industry.

The Fellow travelled to Belgium, Netherlands and the United Kingdom to visit a range of training establishments, commercial growers and ancillary suppliers of technology.

During this period the Fellow was able to experience first hand the latest technology, growing methods and processes associated with commercial hydroponic systems currently utilised in Europe.

Since his return, the Fellow has been actively involved in the development of a controlled environment horticulture training facility to allow for the delivery of training to fill the identified skills deficiency.

This has led to the development of a design and technical specification that will see the establishment of the most advanced controlled environment horticulture facility in Australia.

Executive Summary

The training centre itself will see an initial construction of a 1,000 square metre commercial glasshouse with a height of six metres. A further expansion of an additional 1,000 square metres of glass is proposed within a two-year time frame. In order to ensure within both facilities that current 'best practice' and growing techniques are adopted in any future developments, the Fellow has been working closely with a consortium of three commercial companies (Faber Glasshouse, Greenworks, and Powerplants) to achieve this aim.

Contained within this structure will be the latest technology in environmental management, staff management, and crop production. The facility will also contain specialised computer-based and practical teaching resources that will allow students to adopt a hands-on, 'learning by doing' approach to their training.

As part of this development, the Fellow will be actively involved in the initial project management of the glasshouse complex, and will then be involved in developing new and emerging training opportunities. Part of this program will see the Fellow having the ability to impart the knowledge that he gained overseas in to both the facility development process, and the resultant training opportunities.

Table of Contents

Abbreviations and Acronyms

AHGA	Australian Hydroponic Growers Association
AQTF	Australian Quality Training Framework
AYR	All year round
BASIS	British Agrochemical Standards Inspection Scheme
BCP Certis	Biological Crop Protection Certis Pty Ltd
BER	Blossom end rot
CEH	Controlled Environment Horticulture
CF	Conductivity Factor
CFA	Country Fire Authority
CHP	Combined heat and power
CO_2	Carbon Dioxide
CPD	Continuing professional development
EC	Electro Conductivity
ha	Hectares
HFF	Hydroponic Farmers Federation
IPM	Integrated Pest Management
ISS Institute	International Specialised Skills Institute
IT	Information Technology
kW	Kilowatt
LED	Light emitting Diode
Lux	A unit of illumination equal to 1 lumen per square mete
MDS	Management development services
MW	Megawatt
NFT	Nutrient Film technique
NROSO	National Register of Sprayer Operators
OHS	Occupational health and safety

Abbreviations and Acronyms

OTFE	Office of Training and Further Education
P band	Proportional band
pH	Hydrogen Ion concentration
PPE	Personal protective equipment
PPM	Parts per million
PTC+	Practical Training Centre +
RFID	Radio frequency identification device
RIRDC	Rural Industries Research and Development Corporation
SWOT	Strengths, weaknesses, opportunities, threats
TAFE	Technical and Further Education
USA	United States of America
UV	Ultra Violet

Definitions

Design	Design is problem setting and problem solving. Design is a fundamental economic and business tool. It is embedded in every aspect of commerce and industry and adds high value to any service or product - in business, government, education and training and the community in general. *Reference: 'Sustainable Policies for a Dynamic Future', Carolynne Bourne AM, ISS Institute 2007.*
Skills deficiency	A skill deficiency is where a demand for labour has not been recognised and where accredited courses are not available through Australian higher education institutions. This demand is met where skills and knowledge are acquired on-the-job, gleaned from published material, or from working and/or study overseas. There may be individuals or individual firms that have these capabilities. However, individuals in the main do not share their capabilities, but rather keep the IP to themselves; and over time they retire and pass away. Firms likewise come and go. *Reference: 'Directory of Opportunities. Specialised Courses with Italy. Part 1: Veneto Region', ISS Institute, 1991*.
Sustainability	The ISS Institute follows the United Nations NGO on Sustainability, *"Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* *Reference: http://www.unngosustainability.org/CSD_Definitions%20SD*.htm

Acknowledgements

Tony Bundock would like to thank the following individuals and organisations who gave generously of their time and their expertise to assist, advise and guide him throughout the Fellowship programme.

Awarding Body – International Specialised Skills Institute (ISS Institute)

The International Specialised Skills Institute Inc is an independent, national organisation that for over two decades has worked with Australian governments, industry and education institutions to enable individuals to gain enhanced skills and experience in traditional trades, professions and leading-edge technologies.

At the heart of the Institute are our Fellows. Under the **Overseas Applied Research Fellowship Programme** the Fellows travel overseas. Upon their return, they pass on what they have learnt by:

1. Preparing detailed reports to government departments, industry and education institutions.
2. Recommending improvements to accredited educational courses.
3. Offering training activities including workshops, conferences and forums.

Over 180 Australians have received Fellowships, across many industry sectors.

Recognised experts from overseas also conduct training activities and events. To date, 22 leaders in their field have shared their expertise in Australia.

According to Skills Australia's 'Australian Workforce Futures: A National Workforce Development Strategy 2010':

> Australia requires a highly skilled population to maintain and improve our economic position in the face of increasing global competition, and to have the skills to adapt to the introduction of new technology and rapid change.
>
> International and Australian research indicates we need a deeper level of skills than currently exists in the Australian labour market to lift productivity. We need a workforce in which more people have skills, but also multiple and higher level skills and qualifications. Deepening skills across all occupations is crucial to achieving long-term productivity growth. It also reflects the recent trend for jobs to become more complex and the consequent increased demand for higher level skills. This trend is projected to continue regardless of whether we experience strong or weak economic growth in the future. Future environmental challenges will also create demand for more sustainability related skills across a range of industries and occupations.[1]

In this context, the Institute works with Fellows, industry and government to identify specific skills in Australia that require enhancing, where accredited courses are not available through Australian higher education institutions or other Registered Training Organisations. The Fellows' overseas experience sees them broadening and deepening their own professional practice, which they then share with their peers, industry and government upon their return. This is the focus of the Institute's work.

For further information on our Fellows and our work see www.issinstitute.org.au.

[1] Skills Australia's 'Australian Workforce Futures: A National Workforce Development Strategy 2010', pp. 1-2 http://www.skillsaustralia.gov.au/PDFs_RTFs/WWF_strategy.pdf

Acknowledgements

Fellowship Supporter

The Pratt Foundation was established in 1978 by Richard and Jeanne Pratt with the shared vision of supporting charitable enterprises and adding value to philanthropy. The Foundation is now one of the largest private sources of philanthropy in Australia. In the words of its mission statement, it aims *"to enrich the lives of our community"* and, in the words of Jeremiah, it works to fulfil this aim in a spirit of *"kindness, justice and equity"*. Bundock would like to thank them for providing funding support for this Fellowship.

Supporters

Special thanks are extended to Karen Bundock for her understanding and patience, and to Chisholm Institute of TAFE staff member Mary-Anne Hall for her role as report writing mentor.

Special thanks to Carolynne Bourne, AM of the International Specialised Skills (ISS) Institute for her guidance and support, and Paul Sumner and Ken Greenhill for their assistance and encouragement in preparing the original submission and guidance with report writing.

Those Involved in the Development of the Overseas Programme

- Nigel Bartle – Cornerways Nursery, Norfolk, UK
- Simon Hart – Senior Lecturer, Writtle College/University of Essex
- Mark Knight – Technical Manager, Tangmere Nursery, Sussex, Kent
- Michael Powell – Account Manager Export, Priva UK, Sussex, UK
- Christien Sauviller – Proefcentrum, Hoogstraten, Belgium
- Mariska Schellevis – Rijk Zwaan, De Lier, Netherlands
- Graeme Smith – Chairman, Australian Hydroponic and Glasshouse Association, Australia
- Peet Van Adrichem – Proprietor, Metazet Demo Nursery, Honselersdijk, Netherlands
- Ben Van Den Brink – Senior Lecturer, PTC+, Netherlands
- Carl Van Loon – Director, Powerplants, Australia
- Gert van Straalen – Thanet Earth, Kent, UK
- Judy Whittaker – Thanet Earth, Kent, UK
- Tom Zwinkels – Thanet Earth, Kent, UK

Those Involved in the Fellowship Submission

Thanks are extended to the Chief Executive Officer of Chisholm Institute of TAFE, Virginia Simmons, for endorsing the Fellowship submission.

Thanks are also made to:

- Chisholm Institute of TAFE Director, Malcolm McPherson and Unit Manager, Peter Curson, for their support and encouragement in preparing the Fellowship submission.
- President of the AHGA, Graeme Smith for assisting with the technical content relating to the Fellowship submission.

Acknowledgements

Letters of Support were Received from the Following Organisations and Individuals

- AgriFood Skills Australia – Arthur Blewitt – Chief Executive Officer
- Australian Hydroponic and Glasshouse Association – Graeme Smith – President
- Primary Skills Victoria – Greg Hallihan – Chief Executive Officer
- Rural Skills Australia – Gordon Griffin – Education and Training Advisor
- Victorian Technical and Further Education (TAFE) Teachers Network – Tony Thake – Chairman

Australian Organisations Impacted by the Fellowship

Government

- AgriFood Skills Australia
- Department of Primary Industry

Industry

- Australian Hydroponic and Glasshouse Association
- Hydroponic Farmers Federation
- Nursery Industry Association

Professional Associations

- Rural Skills Australia
- Primary Skills Victoria

Education and Training

- Primary Industry Curriculum Maintenance Manager
- Victorian TAFE Teachers Network
- Chisholm Institute of TAFE

About the Fellow

Qualifications

- National Diploma in Commercial Horticultur, Writtle Agricultural College (now Writtle College), UK, 1979
- Certificate IV Workplace Trainer and Assessor, Chisholm Institute of TAFE, 1992
- Diploma of Teaching, Technical & Further Education, University of Melbourne, 1994
- Overseas Travelling Scholarship recipient, Office of Training and Further Education (OTFE), July 1998
- Graduate Certificate Educational Management, Victorian University, 2002
- Leadership Development for Education and Training Managers, Victorian University/ Chair Academy, USA, 2002
- Currently studying for a Masters of Education through research at Monash University

Memberships

- State-wide teaching advisory network to the Horticultural Industry
- Australian Hydroponic and Glasshouse Association
- Hydroponic Farmers Federation
- Nursery and Garden Industry Association Victoria

Bundock was born in the United Kingdom and began his horticultural career whilst at school at the age of fourteen with a part-time job in a garden centre. At the age of eighteen, he undertook his formal training at Writtle Agricultural College, UK, via a four-year Diploma course specialising in commercial crops. He then worked in the protected cut flower industry in the Lea Valley. In 1990 Bundock immigrated to Australia and directed his career towards education. He originally began teaching with Frankston College of TAFE (now Chisholm Institute of TAFE). Bundock is now a senior teaching staff member with Chisholm Institute of TAFE, and has a strong interest in crop production and, in particular, glasshouse environmental management and protected cropping. Bundock has a strong passion for education, and is keen to impart his knowledge and experience on to future generations of Horticulturalists via his teaching.

Tony Bundock is currently employed at Chisholm Institute of Technical and Further Education (TAFE), Cranbourne Campus, in the Horticulture and Conservation Land Management unit. He is a member of a team responsible for the development, implementation, review and evaluation of all full-time, part-time, and traineeship/new apprenticeship programs, Vocational Education and Training (VET) in schools, and 'fee for service' horticultural courses conducted at the Cranbourne campus. Bundock also undertakes work at industry worksites in skills recognition programs for existing workers.

Bundock is directly responsible for coordinating the development of a variety of projects in relation to campus functions and teaching facility development, as well as the management of the institute's commercial nursery and vegetable growing areas.

When he is not teaching, Bundock enjoys fishing, boating, and general family life. Bundock is also a volunteer fire fighter with Country Fire Authority (CFA) with the Narre Warren Fire Brigade, and has been actively involved with CFA for the past nineteen years. He holds officer rank and attended numerous emergency response calls in assisting the community via attendance at fires, road traffic accidents and other incidents, as well as participating in community education programs.

Aims of the Fellowship Programme

The aim of the Fellowship programme was to identify commercial protected cropping production methodologies and systems that can be translated to working solutions for vegetable growers in southern Victoria.

1. Identify the range of emerging technologies and their application in the protected cropping sector.
2. Establish a fundamental understanding of the latest developments in vegetable crop growing production methods.
3. Enhance skills levels to enable the Fellow to be able to develop and deliver training programs that will assist local growers in embracing new technology and production methods.

The Fellowship outcomes will directly benefit the Australian Hydroponic Industry in filling the current and clearly defined skills deficiency that has been identified by industry practitioners. The Fellowship will produce wide ranging outcomes for a large number of diverse industry participants, and also has the ability to be able to set the foundations of a long-term training process for the Australian horticultural community.

The Australian Context

The Australian hydroponic and greenhouse Industry is the fastest growing food producing sector in Australia, valued at around $1.8 billion per annum at the farm gate. This is equivalent to 20 per cent of the value of total vegetable and cut flower production in Australia. *(Rural Industries Research and Development Corporation [RIRDC] report HSA-9)*.

"It is estimated that more than 10,000 people are employed directly in glasshouse horticulture throughout Australia, with the industry expanding at between four to six per cent per annum." (AHGA – Overview of the Hydroponic Industry)

Hydroponics is the production of crops in isolation from the soil, either with or without a medium, with their total water and nutrient requirements supplied by the system. Production takes place either in a greenhouse or outdoors and systems can recirculate or allow nutrients to 'free drain' for reuse on to other crops, such as trees and for pasture improvement. The industry is highly efficient in its use of all inputs including water, fertilisers, labour, land and energy.

Hydroponics and greenhouse technology have emerged as a commercial alternative to soil-based production. Significant crops include tomatoes, cucumbers, capsicum, lettuce, strawberries, Mediterranean and Asian herbs, Asian greens, Asiatic and Oriental lilies and cut flowers such as roses, gerberas, carnations, lisianthus and chrysanthemums.

Successful commercial production is undertaken by families producing for boutique markets, families as part of a larger growing and marketing cooperatives and by corporate bodies with investors who are not active in day-to-day management.

"The industry is capital intensive, and capital costs vary between $100 and over $300 per square metre, depending on the sophistication of the greenhouse and the level of equipment. Viable production units are a minimum of 1,500 square metres. The estimated return on investment by utilising this type of crop production system offers up to 20–25 per cent return on investment, as opposed to three to five per cent on investment with traditional production methods." (AHGA – Overview of the Hydroponic Industry presentation)

Growers can expect to produce crops that will exhibit faster growth rates with significantly higher yields with improved quality due to a well maintained growing environment.

Crops can be grown out of traditional seasons and native areas. This gives growers a higher premium for their product at times of high demand, offering higher returns for farmers' efforts. Closed systems can deliver major energy and water efficiencies, with near zero waste water resulting from production methods.

The ability to be located on a small area also enables growers to produce local foods close to urban environments, thus keeping 'food kilometres' low for transport to markets.

Current field-based growers are limited to either growing out to the limitations of their land, or seeking new methods of production to give increased crop production on a vastly diminished footprint of land under protected cropping.

How the Need for Additional Skills was Identified

The identified skills and knowledge deficiencies are comprised of a list of subject areas identified by the industry groups. The skills have been identified by the AHGA as being pivotal to training within the industry. At a higher level (AQTF levels 5–6), no competencies currently exist to evaluate training in this area.

The Australian Context

The common theme running though the protected cropping industry was a lack of training and 'skilling' options for all levels of participants. The 2005 review of the industry, performed by the AHGA, explored market failures and constraints to industry development with the main industry representatives in all Australian states. This review resulted in identification of around 19 issues that urgently required attention, with the number one common issue identified as a lack of skills training opportunities.

There are currently no 'schools to industry' pathways (to encourage horticultural students to pursue careers in the hydroponic industry), industry career pathways or specific hydroponic production modules (units & competencies) within the national curriculum framework. Some limited sub-modules within other horticultural production modules do exist. Whilst the industry has received some support in the past for important industry issues (such as Integrated Pest Management and Minor Use Registration), there has never been any support for grower 'skilling' that has the capacity to lift the entire industry.

The AHGA's Pathways to Production project consulted industry participants via a series of national workshops to perform a training needs analysis and then develop the program, research and produce the training units and competencies. A compelling argument for adoption of this project was that without basic skills training in specialised horticultural subjects such as plant physiology or environmental management, then no amount of new or existing technology, chemical or fertiliser regimes, integrated pest management strategies or new varieties or cultivars, will change or enhance the grower's productivity or viability. Skills training at all levels is seen as necessary to underpin industry development and growth.

Currently growers are required to travel to overseas training institutions (most notably in the Netherlands) to receive tuition in this specialised area, and at significant cost. Additionally, growers operate in a global economy with fierce competition from exporting nations that have access to full training programs at all levels.

The Pathways to Production project identified a total of 63 base units and competencies covering Australian Qualifying Training Framework (AQTF) Certificate II to VI.

These new units are being aligned with the AQTF to facilitate a national recognition that would create a new discipline within a Production Horticulture Training Package to be known as Controlled Environment Horticulture (CEH).

Additionally, a further 12 supplementary units identified by industry during the project are to be developed. These units are not necessarily required within the base qualifications and could be delivered as short-course modules to meet specific enterprise needs or 'skills sets'.

A demonstrated need for a pre-employment program to introduce intending new industry participants to a comprehensive overview and heightened awareness of CEH was also identified.

An additional output from this project was the strong potential for development of a National Training Centre for Controlled Environment Horticulture, based on a Dutch model that delivers both theoretical and practical training in a purpose-built glasshouse facility.

Such a national greenhouse training centre would:

- Have the capacity to lift the entire industry through targeted education and research
- Assist in overcoming grower reluctance to invest in unfamiliar (yet proven) technology
- Set industry standards and targets (in both quality and production)
- Demonstrate 'best practice' growing techniques for Australian greenhouse crops
- Be a centre for Asia–Pacific education and training in greenhouse crops and technologies (targeting Malaysian, Indonesian, Chinese, New Zealand and other regional growers).

Chisholm Institute of TAFE is one of two Registered Training Organisations (RTOs) in robust discussions with the AHGA to further develop this proposal; Goulbourn Ovens TAFE is the other.[2]

It is recognised that current practitioners in the field grown vegetable industry have a strong knowledge of plant physiology and crop production methodology. However, additional skills are needed to monitor and manage both the growing structures and the environment within them, in order for growers to achieve maximum output from such intensive systems.

These generic skills include:

- Managing controlled environments
- Crop production techniques
- Identification of emerging technology and production methods.

As previously mentioned in this report, the gaining of these skills will greatly enhance the ability of the Fellow to undertake a high level of professional development, and become recognised as a 'master craftsman' in this field. This will subsequently assist in delivering training to industry participants. The threat of not obtaining these skills is that the hydroponic industry will not have the opportunity to enhance its skill base, and will run the risk of falling behind overseas competitors in terms of identifying 'cutting edge' technology, and its application in commercial crop production.

SWOT Analysis

Strengths

- Project is based on current industry identified training needs
- Industry is dynamic and seeking active training solutions to allow it to develop
- Protected cropping industry represents the future of horticulture in reduced water usage and smaller land based footprints
- Project will allow immediate reflection to industry on current solutions to Australian problems

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[2] Leigh Taig Manager, Horticulture, Goulburn Ovens TAFE, was awarded a '06 ISS Institute/TAFE Fellowship, sponsored by OTTE, Victorian Government. Taig travelled to Holland, United Kingdom, France to:

- Collect and record data for crop registration of a variety of crops
- Adentify Physiology and manipulation of the growing plant and its relationship to number, size and quality of fruit and other products
- Understand techniques and technologies and the ability to evaluate and adapt to Australian growing environments
- Investigate the role of nutrients and their effect on number, size and quality of fruit and other products.

A copy of Taig's report can be obtained by contacting ISS Institute Inc.

The Australian Context

- Establishment of purpose-built training facility at Chisholm Institute of TAFE will see implementation of specialised training within a six-month time frame
- Fellow conducting the study is well respected and known within the industry and industry associations
- Strong Industry networks both within Australia and overseas will enable facilitation of worksite visits

Weaknesses

- Some industry practitioners may be resistant to change and will not adopt recommendations of the Fellowship's findings

Opportunities

- To assist in development of training needs for the protected cropping industry and further progress Australia-wide industry development
- Elevate generic industry knowledge and facilitate personal professional development to others
- Broaden and strengthen existing networks and linkages between industry partners
- Forge new partnerships with industry-based companies and training organisations
- Investigate reciprocal student exchanges with overseas training establishments

Threats

- Delay in establishing new practical industry training resource to facilitate training

Identifying the Skills Deficiencies

The identified skills and knowledge deficiencies listed below are comprised of a list of subject areas identified by the industry groups. These skills have been identified by the AHGA as being pivotal to training within the industry. No competencies currently exist to evaluate training in this area.

Identified Skills Deficiencies – What the National Industry Lacks

The protected cropping industry has clearly identified that it is looking for its future management to have the skills that are needed to monitor and manage both the growing structures and the environment within them, in order to achieve maximum output from intensive systems. The industry is currently looking to either employ overseas practitioners who have these skills, or send staff members overseas to gain these skills.

1. **Manage Controlled Environments via Complex Computer-based Technology to Enhance Plant Growth Rates**

- Manipulate controlled environment temperatures to enhance plant growth rates via the use of computer-based control and monitoring equipment.
- Adjust climate control systems to provide optimum growing conditions based on data from aspirated screens and external weather stations
- Effectively control of ventilation systems via computer-based controllers so as to be able to set specific ventilation temperatures, and allow for the graded operation of such systems via Proportional band (P band) allocations
- Monitor Carbon Dioxide (CO_2) Levels in the controlled environment in parts per million (PPM) to gain an advantage in crop production rates for plant growth. (Protected cropping systems utilise the introduction of CO_2 gas into the growing environment to increase crop photosynthetic rates, and hence production levels)
- Implement the management of air flow systems to encourage an 'active' environment for plant growth.

Aim: To become skilled in the interpretation of data that can be translated to practical applications via computer-based technology to enhance plant growth rates.

2. **Crop Production Techniques**

- Further development of knowledge relating to the various mediums that are commercially available for crop production
- Design and implement high-level maintenance programs to combat and control disease issues
- Operate and program irrigation systems within controlled environments to deliver irrigation based on accumulated sunlight levels. Devise predetermined trigger points for irrigation, and link crop irrigation with appropriate light values
- Carry out accurate and intensive monitoring of both the plant, substrate, and fertilising solutions in relation to Nutrient, Hydrogen Ion concentration (pH) and Conductivity Factor (CF) levels.

Aim: To become skilled in determining the most appropriate growing mediums, suitable irrigation, fertigation and pest and disease control programs for specific crops (Identification of emerging technology and production methods).

Identifying the Skills Deficiencies

3. Identification of Emerging Technology and Production Methods

- Advanced Information Technology (IT)—use of climate control software and associated applications. Undertake training in the use of the latest software and its integration in the physical operation of the glasshouse environment and associated control gear
- Design specific operating and maintenance procedures for plant handling systems within controlled environments such as gantry, monorail, and mobile benching systems.

  Aim: To determine current 'best practice' techniques' in the use of both IT and plant handling systems associated with commercial horticulture (production and farm planning).

4. Production Planning and 'Whole Farm' Planning

- Operate software package Priva, to allow for the complete tracking process of staffing and production operations. Development of the capacity to plan future crops and generic facility planning.

  Aim: To become skilled in the use of software-based packages to undertake 'whole farm' planning and monitoring.

Why the Skills Deficiencies Need to be Addressed

The Australian Hydroponic Growing Industry is a dynamic sector of horticulture/agriculture that takes its development and training needs seriously.

The Hydroponic Industry is highly efficient in its use of water, and offers high production outputs from a small footprint. These factors make the industry a leader in embracing efficient growing methods whilst facing the ongoing challenge of reduced water availability due to current climatic conditions.

The skills deficiency that has been identified highlights that the industry is acutely aware of the direction that it is heading, and the skill base that it requires to achieve its goals.

It is vital that the skills deficiency is met so that the industry can continue to develop and expand in a seamless way, and to continue to provide up-to-date and relevant training to current and future participants.

Addressing the current skills deficiency will also ensure that training in this specialised area will allow Australian growers to access training locally rather than having to go overseas to gain the level of expertise that they require, and to continue to allow the industry to raise its level of productivity.

The International Experience

Writtle College

Destination – Writtle College – Chelmsford, UK, in partnership with the University of Essex

Objective

The objective was to visit a well established training provider to gain an understanding of current training programs and facilities suited to CEH.

Outcomes

The visit to Writtle College enabled the Fellow to gain a basic understanding of the range of courses that are being offered to new entrants and existing industry practitioners. The Fellow gained knowledge of the current issues facing UK-based training providers relating to both higher and further education. He was able to observe current training facilities that Writtle College has established in order to prepare students for entry in to the controlled environment industry.

Findings

Writtle College has been offering training via land-based courses since 1893, and is set in its own 220 hectare estate with landscaped gardens, working animal units, construction areas, workshops and retail, business and leisure operations.

Writtle College main building

The International Experience

The college now operates in a partnership arrangement with the University of Essex, responsible for validating their degree courses.

The majority of students spend a large proportion of their course time using the diversity of the natural and built environments on campus for case study work, practical learning and hands-on work experience, and business training.

Writtle College offers a wide range of degrees from a range of subject disciplines, including a continually growing postgraduate community specialising in Horticulture, Equine Studies and Business Management. However, at the time of visiting, further education programs were being reduced due to funding issues.

Originally Writtle College had a large commercial glasshouse complex that was built in the late 1960s and produced a range of commercial crops. Over time this facility had fallen in to disrepair, and a more sustainable solution was sought.

The college has just invested in a new, smaller, purpose-built glasshouse complex for the training of students in commercial controlled environment cropping. The facility covers approximately 800 square metres.

Writtle College glasshouse training facility

Senior Lecturer, Simon Hart, provided a tour of the facility and gave an explanation of the issues that had been faced with the facility's development.

The glasshouse is designed to cater for a range of students' practical training needs for crop production, as well as provide a location for research into certain facets of crop production.

The International Experience

Within the facility are a number of cropping systems that provide students with the opportunity to gain practical experience in the use of different commercial production methods for a variety of crops.

Tomato and pepper crops in rockwool medium

Ebb and flood benching systems for pot plant production

The facility also has the capacity for heating of the glasshouse area via a 'hydronic system', thus giving it an operational capacity of 365 days of the year. Energy saving screens also add to the efficiency of the facility, and 'black out' screens are also installed for the reduction of 'day length' of flowering crops. CO_2 is also drawn off of the boiler system for atmosphere enrichment to promote photosynthesis of the cropping plants.

Students also had the opportunity to operate both inputs and controls relating to the climate control system.

Whilst the facility provides a sound basis for practical experience, there is still an underlying concern in the training process.

According to Hart, the training that Writtle College is currently providing for the commercial controlled environment industry, is still lacking in terms of extensive industry-based experience. Previous Diploma-based courses included a two-year industry practical component that allowed students to develop their skills at a recognised industry location, and campus-based training provided by Writtle College was seen as a further step to the knowledge deepening process.

However, the industry still actively seeks Writtle College graduates to undertake supervisory and middle management roles on commercial enterprises.

Cornerways Nursery

Destination – Cornerways Nursery – British Sugar, Norfolk, UK

Objectives

The objectives were to visit a commercial production nursery utilising hydroponic growing techniques, and to observe the production methods and technologies utilised with controlled environment production of tomatoes.

Outcomes

The visit to Cornerways Nursery enabled the Fellow to gain a high level of insight into the process of managing controlled environments, crop production techniques and emerging technologies associated with tomato production in a controlled environment. This allowed the Fellow to address identified skills deficiencies 1, 2 and 3.

With this understanding, the Fellow was able to observe current 'best practice' in both crop growing facilities and husbandry practices.

Findings

Cornerways Nursery is a major grower of quality tomatoes located in rural East Anglia about ten miles south of King's Lynn. Cornerways Nursery places strong emphasis on quality and excellence in all areas of their production.

The current site has been operating for eight years and is one of the largest tomato producing glasshouses in the UK. It covers eleven hectares in area, and produces over 30 Million tomatoes annually.

Cornerways Nursery

The International Experience

Cornerways Nursery has a working partnership with British Sugar. The most tangible benefit for Cornerways' is its location near British Sugar's Wissington sugar beet factory, giving access to their waste heat and gasses. More than two hundred and twenty-five miles of piping carries hot water from the factory's Combined Heat and Power (CHP) plant to the glasshouse, to maintain the temperatures that suit tomato plants. This hot water would otherwise be destined for cooling towers, so the scheme ensures that the heat is used productively.

Another benefit is the productive use of waste CO_2 from the sugar beet factory, which the tomatoes use during photosynthesis. CO_2 (a by-product from the CHP boiler) is pumped into the glasshouse to be absorbed by the plants rather than vented into the atmosphere as waste emissions.

British Sugar Wissington factory

Water used primarily to wash incoming sugar beet carries vital nutrients from the soil and is re-used to irrigate the tomato plants. All the produce is packed on-site in a modern 'packhouse', minimising handling and transport and allowing produce to be despatched for supermarket shelves often less than 12 hours after being picked. Product has to adhere to the British Farm Standard, which means that tomatoes are produced to stringent standards and are independently inspected.

Harvesting Manager, Brendan Henry, provided a tour of the facility and provided an explanation of the issues associated with running the facility.

The International Experience

Crop production area

All crop production was undertaken via a hanging gutter system with rockwool being the major substrate utilised for plant growth. The gutter system was seen to give efficiency with crop harvesting and general maintenance work, and also gave a reduction in the incidents of the disease, Botrytis. Better airflow around the gutters was also seen as a factor that helped reduce disease. Crop training is via a bobbin system, with 30 metre string lengths being utilised. Metal hot water pipes provide the heating process, and these pipes double as rails for the electric crop trolleys. The rails are monitored for level and stability by workers on a weekly basis to avoid trolleys becoming unstable and falling over.

Hanging gutter system and heating pipe/rails

Thermal screens are utilised for screening and shading. A large central screen that runs down the length of the production facility provides shade during the day to protect harvested product.

To enable more light to fall on to developing fruit, the crop is de-leafed to one truss above the fruiting truss showing colour as a rule of thumb. The cut off leaves are left on the floor under the main crop. This practice gives no notable increase in disease spore formation. Cornerways Nursery has adopted this practice for past three years, with the crop residue being allowed to rot down in situ.

According to Henry, the CO_2 generated from the composting process creates approximately 800 parts per million (PPM) of CO_2 in the glasshouse environment. The commercial target level for optimum growth is 1000 PPM. Significant reductions in labour costs are also realised by not removing trash from the glasshouse.

Crop reside under growing crop

Cherry type tomatoes

Production is centred around the growing of Cherry and Cocktail varieties of tomato, which are generally harvested as a truss. Larger tomato varieties are also 'truss pruned' to limit each truss to five fruit, then 'whole truss pruned' off as part of the harvesting process.

Varieties grown included:

- Roterno large vine
- Amoroso medium vine
- Encore loose round
- Piccolo cherry vine
- Temptation large vine
- Elegance large vine

The International Experience

The duration of the crop is scheduled for ten months of the year, with planting occurring late December/early January. In general terms, crop productivity levels decline at the end of the production period due to the age of the plants and falling natural light levels.

At the end of production, the rockwool grow slabs are split open and spread across a field area and incorporated into the soil with the aid of a rotary hoe. This process has been undertaken for the past five years with no complications to either soil structure or growth capacity of the soil.

Irrigation water can be sourced from British Sugar and the local Wissey River, and is utilised in the irrigation system after going through appropriate filtration.

Water filtration system

All water used for irrigation is dosed with nutrients and constantly monitored for both electro conductivity levels (EC) and acid and alkalinity levels (pH). Each glasshouse zone, of which there are six in total, has their own probes and measurements. EC levels are generally operated within a range of 4.8 and 5.2, with pH levels aiming at 5.5 to 5.6.

Irrigation is delivered via ‘drip irrigation’ within a closed circuit system. Run-off ‘irrigation water’ is captured and recycled into the nutrient tanks after being treated by an ultra violet (UV) sterilisation system.

Irrigation dosing rigs for fertiliser addition

This re-use of water is seen as the way forward for all controlled environment growers. The amount of 'irrigation water' applied to each plant is linked to accumulated sunlight levels for any given day, and 'gift water' volume is decided on by the grower.

Back up tank irrigation storage is available to safeguard against water supply loss.

The general climate control system is a Priva Intégro system, which handles not only temperature and ventilation, but also has the ability for labour management recording. This system is seen as the industry standard.

In order to pollinate the crop, over 5000 bumblebees, living in 100 artificial beehives are utilised. This is now seen as an industry standard against the older and more intensive system of hand pollinating. Non-aggressive and non-dominating species of bees are used. The bees are not released into the environment, but remain within the glasshouse environment. The bees are supplied by supplied by Biological Crop Protection (BCP) Certis, who also undertake the Integrated Pest Management (IPM) biological control of the crop to eliminate pests and diseases. This is part of the nursery's integrated approach to crop management using natural agents and predators in preference to agrochemicals.

Employees are sourced locally and also from Eastern Europe on six-monthly visas. Agricultural and general students are also given a six-month term of employment under a seasonal agricultural workers scheme. This is largely limited to picking operations. The option is given to employees to either be employed at a row rate or standard hourly rate. The Priva system enables accurate tracking of picking rates to ensure equity of the system.

The higher-level supervisors are largely drawn from the local people who started as crop workers over the past eight years. Recent graduates are sought to fill key positions, and are given exposure to the various aspects of the facility to enable them to grasp the total concept of the Cornerways' operation. According to Henry, new entrants to management in CEH need to be able to use the Priva system, and must be able to problem solve quickly.

To assist the managers, a tomato consultant visits the site once a month and advises growers on all aspects of the crop production cycle. Managers use this as an ongoing professional development exercise and also go to external consultants.

Networking is also facilitated via the British Tomato Growers association. Growers visit each other once a month, and are not afraid to swap ideas and solutions. Industry visits to Holland are also taken on an annual basis.

Fruit Focus Trade Show

Destination – East Malling Research Station, Kent

Objectives

The Fellow was invited to attend the Fruit Focus trade show by the Priva Company. The Fellow was to make initial contact with Michael Powell – Account Manager Export, and to observe growing techniques and machinery associated with field scale hydroponic production of soft fruit.

Outcomes

The visit to Fruit Focus enabled the Fellow to discuss future site visits with Powell, and observe growing techniques and machinery associated with field scale hydroponic production of soft fruit.

The Fellow was also able to identify a model for management training within the Horticultural sector for recently qualified graduates, which has potential for implementation within Australia.

Findings

Fruit Focus is the annual trade show event for the United Kingdom's soft and top fruit industry. The event is held over one day and enables growers to compare products and services from over 100 leading suppliers, evaluate new crop varieties, crop nutrition and crop protection products, observe horticultural machinery in action in a live demonstration arena, and participate in 'Fruit Forums' covering industry debated topics.

Also showcased is a unique combination of crop trials from manufacturers and research bodies. These crop trials are designed to help growers improve yields, quality and performance including, new varieties, breeding and plant stock, agrochemical fertilisers and biological control developments.

Fruit Focus also offers growers a chance to meet with marketing agents and to discover ways to increase returns through efficient post-harvest handling. As the event is hosted at East Malling Research Station, growers are also able to keep up to date with the latest fruit research.

The International Experience

Credits for the British Agrochemical Standards Inspection Scheme (BASIS) and the National Register of Sprayer Operators (NRoSO) apply. Fruit Focus 2009 was registered for British Agrochemical Standards Inspection Scheme (BASIS) and National Register of Sprayer Operators (NroSO) points. The purpose of both of these schemes is to:

- Provide a means of recognising, through the maintenance of a register, suitably qualified professionals in pest and vegetation management, plant nutrition and related activities recognised by both the industry and by the general public:
- Encourage and provide evidence of continuing professional development for sprayer operators.

Members are required to collect a minimum of 30 Continuing Professional Development (CPD) points from 'registered activities' over a three-year period from their registration date in order to meet the scheme criteria.

The scheme criteria requires a minimum of eight points in Application Practice, eight points in Environment and four points in Crop Protection, with the remaining ten CPD points gained from any or a mixture of the three categories.

Three BASIS points (two x Crop Protection, one x Environment) were awarded for attending Fruit Focus. Three NRoSO points (two x Crop Protection, one x Environment) were also awarded for attending Fruit Focus.

Hydroponic channels for strawberry production

Of particular interest to the Fellow was the use of hydroponic crop channels for strawberry production, which raise the crop to an ergonomic working level.

The International Experience

Fruit Focus also allowed the Fellow to investigate a model for management training within the Horticultural sector for recently qualified graduates offered by Management Development Services Ltd (MDS Ltd).

The MDS Ltd training program is an accredited two-year fast track career path comprising of four practical 'real job' secondments combined with formal off-the-job training. On successful completion of the program management trainees graduate with a Postgraduate Certificate in Food and Fresh Produce Management validated by Harper Adams University College.

Management Trainees are employed by MDS Ltd at a salary of £19,000 in the first year rising to £20,250 in the second year. Secondments can be undertaken in the UK or overseas.

MDS Ltd represents a consortium of 25 member companies comprising growers, suppliers and supermarkets. Member companies contribute towards the salary and training costs of management trainees, as well as providing work placements. The strength of MDS Ltd comes from members working in partnership with a common goal, even though some may be competitors in the commercial world. It is run by a board of directors appointed from within the membership, with day-to-day management support from a full-time staff of three.

The program is open to graduates of all degree disciplines, and MDS Ltd is particularly interested in land-based, food related, life sciences, business management, marketing and languages graduates.

Candidates must show a practical, hands-on approach to management and an ability to work in cooperation with others, as well as being open to change, keen to accept demanding roles and be responsible for their own learning. More important are personal qualities combined with a realistic appreciation of what is involved in the fresh food and produce industry: long hours at times, a need to handle the demands of many different stakeholders and the high expectations of product quality and service.

Off-the-job training comprises of 27 days over the two years, this includes an induction session, three individual weeks of formal training with additional two-day seminars spread throughout the period.

Each management trainee attends the off-the-job training to develop skills in self-management, people management and managing a business. The Postgraduate Certificate accredited by Harper Adams University is built around both the experience gained whilst on secondment and also the different training courses.

Progress whilst on secondment, is monitored by a designated secondment manager within the member company who takes joint responsibility with MDS Ltd for the trainees' personal and professional development. This close liaison ensures a realistic understanding of the trainees' strengths and those areas which may need attention.

Thanet Earth

Destination – Thanet Earth, Kent, UK

Objective

The objective was to visit a world-class commercial production nursery utilising hydroponic growing techniques to observe the production methods and technologies utilised within the controlled environment production of tomatoes, capsicums and cucumbers.

Outcomes

The visit to Thanet Earth enabled the Fellow to gain a high level of insight into the process of managing controlled environments, crop production techniques and emerging technologies associated with tomato, capsicum and cucumber production in a controlled environment. This allowed The Fellow to address identified skills deficiencies 1, 2 and 3. He was also able to observe the operation of production planning technology as identified in skills deficiency 4. With this understanding, the Fellow was able to observe current 'best practice' in both crop growing facilities and husbandry practices. He was able to observe first hand the integration of Combined Heat and Power (CHP) units in co-generation, and the use of Buffer Tanks to store excess production of heat.

Findings

Thanet Earth site map

In a ground-breaking joint venture agreement, the UK's largest fresh produce supplier, Fresca Group, has joined forces with Dutch growers, Rainbow Growers Group, Redstar and A&A to create the UK's largest salad growing and marketing company. Each company will be operating glasshouses on-site at Thanet Earth and growing either tomatoes, capsicums or cucumbers.

The 91-hectare site, based in north Kent, is now officially named Thanet Earth and will accommodate seven eight-metre high glasshouses, each with an average size of over seven hectares. It is anticipated that Thanet Earth will provide an additional 15 per cent to current UK production levels.

Thanet Earth is an exceptional greenhouse development based on the Isle of Thanet, in Kent. It is currently the largest greenhouse complex in the UK, and cost over £80 million to become operational.

Three of seven planned glasshouses are now in operation. The largest of these three structures, devoted to tomatoes, covers close to ten hectares.

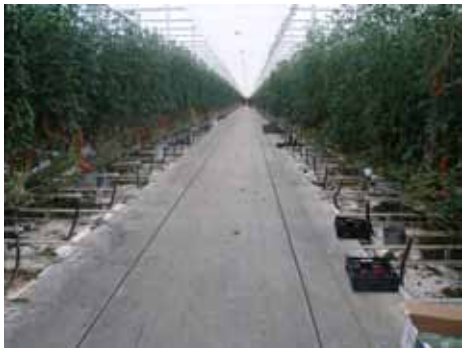
The International Experience

According to Steve McVickers, the Managing Director of Thanet Earth, the actual site on the Isle of Thanet was chosen because it was the only area in southeast England that has urgent regeneration status for agriculture. The site has quite a temperate climate and also offers a national grid connection for connection of CHP generated electricity.

Destination – Red Star Tomatoes, Thanet Earth

Production Manager, Gert van Straalen, provided a tour of the facility and gave an explanation of the issues associated with running the facility. Glasshouses construction was only completed in October 2008, so at the time of the Fellow visiting the facility it was producing its first crop.

Red Star Tomatoes facility



Production facility

The production is based on a hanging gutter system, with rows radiating from a central path. Each row is 125 metres long. Heating pipes act as tracks for inter row harvesting and crop maintenance machinery.

Heat is sourced via hydronic heating with the aid of a buffer tank, which enables produced heat from the boiler to be stored during the day and retrieved at night.

Heat buffer tank

Hot water boiler

CO_2 is also used to enrich the glasshouse environment and is sourced from the flue of the hot water boiler and the CHP units.

The nursery currently has three Jenbacher CHP units with a capacity of 3.3 megawatts (MW) of electrical generation capacity per engine. The engines run on natural gas, and revenue received from the generated electricity offsets heating costs.

Jenbacher CHP unit

Crop aeration fans

Large plastic tubes are also used for air circulation around the crop. These are positioned under the gutters.

The whole climate control process is centred around a Priva Intégro control climate control system.

The tomato crop is grown in the inert substrate called rockwool. The Grodan company supplies the rockwool slabs and also collects the waste at the end of the crop. This product is then taken back to Holland where Grodan arrange for the recycling of the same.

Ten varieties of tomatoes are grown so as to satisfy the requirements of the multiple customer base that Red Star service. All crop plants are grafted.

Grafted tomatoes

Tomato variety Elegance

Examples of varieties observed were:

- Megano – a large vine variety for bulk production, picked as a total vine for supermarket chains Tesco and Asda
- Classey – a smaller vine variety for the supermarket chain Marks & Spencer
- Elegance – a premium tasting variety for the supermarket chain Marks & Spencer

Crop debris

As part of the maintenance process of the crop, de-leafing occurs with leaves being left on ground. This was identified as a cost saving issue. The leaves were taken out en masse after a period of time, via a plastic sheet that was dragged towards the central pathway.

Crop pollination is undertaken by bumblebees; a queen excluder is used to prevent the queens migrating. The bees are imported from Holland. After ten weeks there is an over supply of queens in the hives and the bees are exterminated, new hives are then introduced into the glasshouses.

The International Experience

Bumblebee hives

As part of the harvesting process, inter-row trolleys are utilised, which can then be placed on a chain system, allowing the trolleys to automatically return to the ‘packhouse’ facility.

Inter-row trolleys

Inter-row trolleys on chain system

Data relating to the trolley, such as the person picking, trolley number and boxes picked is entered in to the keypad, which records the information and relays it to a central computer location.

Keypad for recording data

A shade cloth screen is permanently located over the central path to protect the picked crop from sun scorch. Due to the size of the facility, the trolleys can take up to 30 minutes to travel back to the 'packhouse', in which time strong radiant heat from the sun can scorch them.

According to Van Straalen, at the time of visiting, the market was experiencing an extreme oversupply of tomatoes giving growers a minimal return of 20 Euro cents per kilogram. Van Straalen estimated that production costs of tomatoes were at a level of 70 to 80 Euro cents per kilogram to produce.

In order to achieve production across 365 days of the year, the glasshouse has the capacity to deliver two crops that overlap in growing times. The standard crop sees planting occurring in mid December with production ceasing at the end of November. A second crop is planted at the end of August to allow production to continue after the first crop is removed.

This process is planned for by placing empty grow slabs in the rows that are currently in production. New plants can be placed directly within the current crop canopy and allowed to grow up to replace the original crop.

Spare rockwool slab

In order to accommodate this method, the positioning of crop rows has been modified. Standard spacing of tomatoes between each row is 1.6 metres per row. Red Star space their rows at 1.7 metres per row and the inter-row spacing of the crop is condensed. Additional lighting is also used to supplement the light levels to the new crop.

Crop row

Irrigation rigs

Pest and disease control relies largely on IPM as the main process. Good results are being delivered with the use of the predatory bug *Macrolophus caliginosus*. This is an omnivore that eats most pests.

Irrigation water is harvested from the roof area and stored on site for further use. All water is sterilised and fertiliser is added via the on-site dosing rigs. The feed system has the capacity to deliver multiple recipes to the various crop areas, and is controlled by the Priva system.

Staffing is undertaken by local or eastern European workers who do the basic crop maintenance and harvesting work, and management level positions are predominantly filled by Dutch growers.

Destination – Rainbow Growers, Thanet Earth

Production Manager, Tom Zwinkels, provided a tour of the facility and gave an explanation of the issues associated with running the facility.

Like the neighbouring Red Star facility, Rainbow has only been operational since late 2008 and according to Zwinkels the structure is 83,000 square metres in total size. This represents an investment of 210 euros per square metre, or a total of 1,743,000 Euro ($2.8 million approx).

General view of glasshouse

The Rainbow Growers Nursery is subdivided in to six compartments, which are utilised to grow three differing colours of capsicums. The ratio of these compartments is four red, one yellow, one orange. The orange and yellow varieties require warmer growing temperatures.

The specific varieties that are grown are:

- Red—Coppra – a smaller fruit variety that is ideal for the UK market
- Orange—Orange Glory
- Yellow—Kelly

The glasshouse itself consists of 280 metres of central pathway, with crop rows radiating off either side of the pathway. These rows are 120 metres long.

The crop itself is grown in rockwool in a hanging gutter system, with a planting rate of five plants per grow slab. This results in a planting density of 7.4 plants per square metre. Although this density is higher than the accepted Dutch standard, the crop yields more total weight but with resultant smaller fruit. The fruit weigh on average 180/190 g.

Capsicum row

Grow slabs

Crop support string

The crop was first planted in week 51, 2008, and the first production was realised in weeks 13–14. At the time of the visit it was envisaged that the crop would run until the end of November 2009, and possibly even into December if production levels were maintained.

In the initial stages, strong feeding was encouraged to promote vegetative growth, this is seen by Zwinkels as investing in the 'green parts' of the plant before focussing on fruit production. Each plant is pruned to deliver two stems with the crop support strings attached to base of each plant.

Fertiliser application rates are monitored to deliver an EC between 2.9 and 3.1, and a pH level of 5.2.

The feed system stems from a central irrigation room with double main pipes delivering and returning the irrigation water. The double pipes are a safeguard against damage or blockage in the pipes, thus providing a backup system in case of malfunction.

Water supplies are sourced from roof/rainwater, bore water, and mains water.

Hot water heating is sourced from a 9,200 kilowatt (kW) boiler and two CHP units, which have a capacity of production of 3 Megawatts (MW) and 2.4 MW respectively. At the time of visiting only the CHPs were running to provide night-time heat for the crop. A buffer tank is utilised for the storage of hot water. Hot water pipes are utilised as tracking for inter-row maintenance and harvesting equipment.

Hot water buffer tank

A Priva climate control system was utilised for all climate control and labour tracking systems.

Pest and disease control is mainly undertaken by the use of IPM strategies, and traditional sulphur burners are used at night to combat fungal diseases. To date, the use of the sulphur burners has had no detrimental effect on the IPM process.

No de-leafing of lower leaves was undertaken with the crop. This was seen as unnecessary and by removing this practice from the crop maintenance strategy, a reduction in labour costs could be realised. At the time of visiting some debris could be observed on the ground, but the general hygiene issues of removing fallen fruit were limited to set time frames. In general the crop areas were cleaned after harvesting.

Crop debris

Final product

Staffing is undertaken by local or eastern European workers who do the basic crop maintenance and harvesting work, and management level positions are predominantly filled by Dutch growers.

Destination – A & A Growers, Thanet Earth

Although not part of the scheduled Fellowship programme, the Fellow was able to gain access to the cropping area of A & A Growers. This resulted in limited information as the 'growing staff' on site were unable to afford time to provide a guided tour.

A & A growers are focussed on cucumber production. Observation revealed that production was carried out in a rockwool medium within a hanging gutter system. Drip irrigation was utilised for feeding plants. The growing area utilised shade screening to meet the requirements of the cucumber crop.

Hanging gutter system

Single crop support wire

Crop support saw plants being trained up a single hanging metal wire, and the extension growth was allowed to pass over a top wire and return down again.

Sensors for the Priva Assist labour management program were clearly visible, indicating the use of this software.

Supported crop and blue Priva Assist sensor

Tangmere Airfield Nursery

Destination – Tangmere Airfield Nursery, Chichester, UK

Objective

The objective was to visit a commercial production nursery utilising hydroponic growing techniques to observe the production methods and technologies utilised within controlled environment production of capsicums.

Outcomes

The visit to Tangmere Airfield Nursery enabled the Fellow to gain a high level of insight into the process of managing controlled environments, crop production techniques and emerging technologies associated with capsicum production in a controlled environment. This allowed the Fellow to address identified skills deficiencies 1, 2 and 3.

The Fellow was also able to observe the operation of Priva climate control systems and production planning technology, as well as Priva Assist, a labour tracking technology. This allowed the Fellow to address identified skills deficiency 4.

The Fellow was able to observe current ‘best practice’ in both crop growing facilities and husbandry practices, as well as discussing issues relating to managerial staff selection with Tangmere Technical Manager, Mark Knight.

The International Experience

Findings

Tangmere Airfield Nurseries Ltd is a leading European capsicum grower, based near the market town of Chichester in West Sussex, with further large glasshouses in both Somerset and Extremadura, Central Spain. The company is based on the old Battle of Britain airfields, which was originally the home of Royal Air Force Tangmere.

Tangmere Airfield Nursery facility, UK

In Spain, higher light levels allow a high-quality crop to be produced between December and July thus supplementing the English production cycle.

This highly sophisticated and efficient operation, now covers in excess of 40 hectares of biologically controlled crop, and allows for the continuous supply of high-quality sweet capsicums all year round to markets.

The airfield is now the home to one of Europe's largest capsicum nurseries with more than 50 acres of some of the most modern glasshouse facilities in Great Britain.

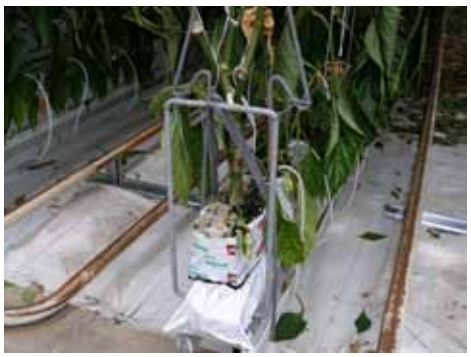
CHP plants produce electricity from natural gas. The by-products of heat and carbon dioxide, coupled with energy saving screens, are utilised to promote energy efficient plant growth.

'Irrigation water' is drawn from a bore on site that accesses the South Downs natural limestone aquifer.

Priva's Michael Powell – Account Manager Export, provided a tour of the facility and gave an explanation of the issues associated with both the climate control system and the production methodology.

Capsicum Crop

The capsicum crops are grown in the hanging gutter system, with rockwool being utilised as the growing substrate. Customised grow slabs are utilised, with each slab measuring approx two metres long. This allows for the planting of eight plants to a slab, with plants being trained to three stems a plant. No de-leafing was undertaken during the lifetime of the crop.



Hanging gutter system

Capsicum crop trained to three stems

The total duration of the crop runs from planting in December, to removal in October. The rockwool growing medium is processed on site at the end of the crop.

Circulation fans are positioned at the bottom of the crop to move air at ground level. The increased air movement leads to less incidents of botrytis, and also encourages a buoyant air temperature around root zone. Traditional sulphur burning pots (now known as Ecopots), are utilised to assist in the control of fungal diseases.

Pollination of the crop is assisted by the use of bumblebees. The bees are not comfortable with very hot climatic conditions and tend to exit the glasshouses via the vents to cool off, but do return as the temperatures cool down.

Climate control is monitored and coordinated by a Priva Intégro system. Strong use is made of the Priva Assist technology which allows for labour tracking and reporting across the whole nursery.

Priva Assist Technology

Priva also has a number of technology-based operating systems across the facility, which are being trialled for further development to the wider industry. The most notable of which is the closed glasshouse trial. This is a climate control system that looks at recirculating air within the structure to counter higher temperatures.

A main slave unit is situated at one end of the glasshouse, and a blend of air is then blown through tubes to provide a uniform air temperature. Valves within the system allow for the intake of air from either the top or the bottom of the glasshouse.

The system also has a heat exchanger located within it. One of the main differences of this system is that it looks to utilise the vents for exhausting air. Priva see huge potential for the development of this system within Australia in combination with a pad and fan cooling system.

Air tubes under crop

Main slave unit

Time was also spent in an interview with Mark Knight, Technical Manager. Discussion focussed on how Tangmere sourced its management staff. As the company has increased, it has identified changing skill sets for its managers. Tangmere currently has a staff of 200 employees.

According to Knight, the highest level of personnel sourced would be a 'growing manager'. Finding a good grower with the talent to run the business is a challenge. Some employees have left to further careers in the United States of America, (USA) and Tangmere see this as a positive to assisting the broader industry.

Knight is of the firm belief that whilst the Priva system assists the growers, it is the instinctive and intuitive grower who will have the advantage in the industry. Natural talent is required. Identifying this talent and taking the person to the next level is the challenge. The Honing of these skills is the requirement to make people fulfil their ability.

Donaldsons Flowers

Destination – Donaldsons Flowers Ltd, Chichester, UK

Objectives

The objectives werre to visit a commercial cut flower nursery utilising the latest in labour saving techniques, and to observe the production methods and technologies utilised within the controlled environment production of Chrysanthemums.

Outcomes

The visit to Donaldsons Flowers enabled the Fellow to gain a basic understanding of the processes involved when utilising technology to reduce labour costs within a controlled environment.

With this understanding, the Fellow was able to observe the different stages in the production process of cut flower growing from initial planting through to harvest. This allowed the Fellow to address identified skills deficiencies 2 and 3.

Findings

Although not within the sphere of commercial vegetable production, the Fellow was able to visit Donaldsons Flowers to observe the high level of mechanisation that this particular organisation has embraced in order to remain competitive in an aggressive market. This visit was facilitated by Michael Powell of Priva U.K.

Based on the south coast near Chichester, Donaldsons Flowers Ltd are the largest growers of all-year-round stem chrysanthemums in the UK. With cheap European imports swamping U.K. markets, Donaldsons Flowers survival was largely due to efficiencies in labour and space utilisation.

In 2006 they opened a new state-of-the-art nursery covering 3.8 hectares (ha). This new facility expanded the company's total production area to 6.5 ha.

Energy efficiency was a major consideration when the new nursery was built. With some of the most up-to-date energy saving technology at their disposal the challenge for Donaldsons Flowers was to ensure that it delivered the benefits derived from the recent investment.

Alan Frampton, joint owner of the business, provided a tour of the facility and gave an explanation of the issues associated with the production methodology and adoption of technology.

Despite Donaldsons Flowers research into modern growing techniques, intensive Chrysanthemum cut flower production is still best suited to a border soil-based system. The large intensity of plants does not suit hydroponic systems.

According to Frampton, the only drawback with the soil-based production is that it takes up to 16 years to get the border soil in good condition, but this long time frame often sees the glasshouse requiring replacement.

Production is facilitated in a modern Venlo style, Van der Hoogen designed glasshouse with 4.5 metre wide bays. The glasshouse structure houses 52 bays in total, and this usually sees three to four bays being harvested a week. The recently constructed glasshouse gives 20 per cent better light transmission than the old glasshouse structure.

Heating for the facility is provided by a natural gas boiler that provides hot water, steam, and CO_2 enrichment. A heat buffer tank is also utilised, which has a 400,000 litre storage capacity. 'Irrigation water' is held in a reservoir with an 11 million-litre storage capacity. Water is sourced from the structures roofs as rainwater, and condensation is also captured from the inside of the structure.

Main glasshouse unit

CHP is not utilised at the moment due to cost. An estimate for purchase and installation of a suitable CHP unit was given as £600,000 ($1.2 million approx).

The production cycle sees all crop areas being cultivated by tractor mounted rotary hoe. The soil is then steamed with high-pressure steam to eliminate pathogens and sterilise crop residues and soil.

Soil cultivations

Chrysanthemum cuttings under plastic

Cuttings are initially grown in peat blocks in an intensive production area, and the crop is placed under plastic for one week at a temperature of 21° Celsius.

The crop is then transferred to the prepared soil area, and is planted out with only one path. This realises massive space utilisation. The crop is also subjected to two weeks of long day treatment, via the use of 5000 lux lights which are suspended overhead of the crop.

The large planting intensities would normally require a high labour input. Current employees are able to plant 2,750 rooted cuttings per hour by using overhead gantries.

Overhead gantry units

Planting operations

These allow staff members to work whilst lying down, easing potential Occupational Health and Safety (OHS) risks to back injury and strain, and vastly increasing productivity. As the crop grows, both crop support netting and heating pipe raising is done automatically. All maintenance work is carried out via the use of the overhead gantries.

Developing crops

Crop spraying via robotic sprayer

Pest and disease spraying is also undertaken by robotic sprayers, which give accuracy in both spray direction and application rates.

The harvesting process is also highly mechanised. Stems are cut by robotic cutting gear that has sensors that only allow them to proceed so far down a crop row.

The cut flowers are then manually collected and placed on a conveyer belt that transfers the flowers to the central glasshouse pathway.

The cut flower stems are then transferred to a further conveyer belt that is situated under the concrete path. The ‘under floor’ conveyor belt them moves the plants directly to the ‘packhouse’.

The International Experience

Robotic cutting gear

Transfer of harvested product via conveyer belts

The conveyer belt system is serviced every six months and provides no problems. By using this mechanisation, two female staff members can harvest 50,000 cut flower stems a day within an eight-hour shift.

Underground conveyer belt system

Underground conveyer belt system

Product arriving at the 'packhouse'

Once reaching the 'packhouse', a further machine measures stems for length, and then cuts the stems and binds the product. Off-cuts from the cutting process travel via conveyer to a waste trailer. Each individual packing machine is capable of processing 25,000 stems a day.

Hill Brothers

Destination – Hill Brothers, Chichester, UK

Objectives

The objectives were to visit a commercial pot plant nursery utilising the latest in labour saving techniques, and to observe the production methods and technologies utilised within the controlled environment production of flowering pot plants.

Outcomes

The visit to Hill Brothers enabled the Fellow to gain a basic understanding of the processes involved when utilising ebb and flow irrigation systems to produce large numbers of pot plants. The Fellow was also able to observe established technology to reduce labour costs within a controlled environment. The Fellow was able to observe the different stages in the production process of pot plant growing from initial planting through to harvest. This allowed the Fellow to address identified skills deficiencies 2 and 3.

Findings

The Fellow was able to visit Hill Brothers in Chichester, to observe an intensive pot plant production facility. This visit was facilitated by Michael Powell of Priva U.K., and a guided tour was conducted by the proprietor, Peter Hill.

Production at Hill Brothers is centred around providing a range of differing products to major multiples in the UK, with the main focus being house plant production. In general, production is based in three nursery sites, with the Chichester site having the latest glasshouse construction. The company has a lot of customers, so a big range of product is offered. Hill Brothers see the need to invest time with their individual customers and ensure them that they have the next product readily available to satisfy their specific markets.

The new glasshouse was constructed to give flexibility, and a vertical thermal barrier was used to close down the size of the glasshouse at the end of the season.

New glasshouse

To ensure flexibility, production was purposely kept on the floor with ebb and flood irrigation. Each of the ebb and flood beds measured approximately 500 square metres in area, and was serviced from internal feeding tanks. The floors of the beds also had woven matting placed on them to add to the absorption rate of the plants.

Fertigation storage tanks and ebb and flood production area

Plant movement was facilitated by a complex range of conveyer belts that saw all potting operations centred in one location, and stock moved to the growing areas via the conveyer belts. This saw minimal labour input in plant movement operations. Dutch contractors built the ebb and flood bed areas utilising preformed plastic beds as opposed to concrete. According to Hill, the costs of the preformed units and associated conveyer belts were probably the same as would have been levied for concrete beds. However, Hill felt that the acquisition of the conveyer belts gives a lot of flexibility in all stages of the production cycle and general product movement.

Conveyer belts moving product

Handling of potted plants

Within the glasshouse area, a twelve-month crop cycle saw the production of hybrid cineraria, followed by fuchsias, followed by hydrangeas then poinsettias.

At the time of visiting, (July) poinsettias were being potted into 13 centimetre pots and were scheduled to be marketed two weeks before Christmas. According to Hill, this was not the most profitable crop, but there was no real alternative. Final pricing was only advised to growers from the purchasing supermarket chains at a very late stage in production, with supermarkets only advising growers of the final price once they had evaluated what competitors were charging. In order to streamline production and keep costs low, Hill Brothers were only growing one variety.

After potting, the poinsettia crop was covered with netting to alleviate stress on the plant. The production cycle required the crop to be pinched to five true leaves.

Poinsettia crop under netting

The plants were moved again on conveyer belt to transport the pots past two female workers. The speed of the belt was reduced to allow ease of work. The crop was pinched again at a second space to pinch to four breaks. Although this process has a higher labour input, this guarantees four breaks on each plant as opposed to pinching to four breaks and not having all the resultant breaks develop. This process guaranteed the uniformity that the supermarket clientele demand.

As part of the marketing process, Hill Brothers adds value to the base product by placing plants into a ceramic pot. Plants are then packed, and taken straight to the supplier.

In the remaining part of the nursery, production is focussed on a range of plant types, but with begonias, cyclamen, and orchids forming the major focus in volume.

Begonias

The begonia crops are grown from cuttings (sourced in Brazil or Kenya) within the glasshouse environment, based on a 14-week year-round crop cycle. Hill Brothers currently produce 9,000 begonia plants a week. Production of cuttings in-house is being developed so that the need to import will be removed. The plants are produced on ebb and flood benches, and watering is carried out from underneath so that the flowers do not become wet. The production of the begonias is mechanised to enable efficient production but there are still three stages performed by hand (pinching, caning and spacing) where each plant is appraised and high standards of quality observed.

Begonia crops

New varieties for colour, shape and longevity are currently being trialled and work is being carried out in particular to develop new varieties that give good results outdoors.

Cyclamen

Cyclamen are grown from seed and are one of the slowest growing seed crops, taking around 12 weeks from sowing until potting. The young plants are potted and can take another 18 weeks until flowering. In order to produce a robust plant, the crop is grown at low density and at low temperatures. This increases production time but maximises quality.

Orchids

Phalaenopsis Orchids are by far the best selling product on the UK supermarket shelves at the moment.

Phalaenopsis orchids

The market has suffered through oversupply of inferior product. Hill brothers import plants on a weekly basis from Taiwan

Within the production cycle, the plants roots need a certain amount of light so plants are grown in transparent pots.

Transparent pots

Proefcentrum

Destination – Proefcentrum, Hoogstraten, Belgium

Objective

The objective was to visit an International research station and observe European research on tomato and capsicum production methods.

Outcomes

The visit to Proefcentrum Hoogstraten enabled the Fellow to gain a basic understanding of the research being undertaken at the establishment in relation to developments in controlled environment crop production. The Fellow was also able to observe first-hand the concept of the 'closed glasshouse'. The visit allowed the Fellow to address identified skills deficiencies 2 and 3.

Findings

Proefcentrum Hoogstraten is a research station located in Northern Belgium. The centre focuses on research activities, which are linked to greenhouse capsicum, tomato and strawberry crops.

Research is divided into eight main themes comprising of variety trials, cultivation methods, fertilization evaluation, water resources, disease and pest management, and energy.

Variety trials are conducted to generate information relating to total production and varietal properties through the growing season with parameters such as grade, per unit weight, and total marketable yield.

Conducting research on new or improved cultivation practices is essential to optimise vegetable production. Strong attention is devoted to grafting, growing systems, substrate comparisons, planting densities, and new developments, such as the closed glasshouse systems.

Fertilisation research focuses on the reduction of fertiliser consumption, new practices to prevent nutrient discharge into the environment, and new fertiliser forms and technologies. For soil-less substrate-based cultivation, research attention is directed to 'irrigation water' circulated in a closed system.

With agricultural water becoming an increasingly rare and expensive resource, it is critical that utilisation of available water resources be maximised whilst consumption of water is minimised. Research on substrate-based production is focussed on better collection and recycling of drainage water.

Crop protection is necessary to minimise or eliminate the impact of diseases and pests on yield and crop quality. Research primarily focuses on optimising biorational plant protection strategies, as well as developing and improving integrated plant and pest management practices.

Continuously increasing energy costs combined with low vegetable prices have prompted the sector to seek ways to make climate control more efficient and cost effective. Proper climate control helps greenhouse horticulturists to combine high yield with good marketable quality, whilst also helping in disease management. The movement toward more sustainable climate control strives for optimal integration and use of various climate control components including heating systems, shading screens, supplemental lighting, and covers to minimise the energy inputs and losses.

A guided tour was conducted by capsicum Crop Research Scientist, Christien Sauviller. The capsicum research that was observed was based on variety trials in red, green and yellow capsicums. The research focussed on yield, fruit quality, and shelf life. The crop was grown in a rockwool growing medium, and water was recycled. 'Irrigation water' and soluble fertiliser rates were standardised at an EC of 2.1, and pH of 5.5. All crops in the glasshouses are given CO_2 enrichment, and glasshouses are heated via hydronic hot water heating. A complex central fed rig system is utilised to service the whole glasshouse complex as each compartment has differing and varied feed requirements.

Capsicum crop for research

Pest and disease control was achieved by the use of IPM, and the training of stems was achieved by the use of single strings attached to the plant. Grow screens provided shading for the crop in warmer weather.

The capsicum plants had been pinched at an early stage to allow for the development of three stems per plant. Future research was planned to look at limiting plants to a single stem but planting at a much higher density, as well as leaving additional shoots on plants for higher production.

The trials were carried out in conjunction with growers, and reflected the needs of the growing community. Support and feedback for growers was given on an ongoing basis by designated crop advisors, and results were relayed to growers via open days and specific meetings. Localised websites were also used to relay detail online. An electronic magazine (e-zine) and hard copy magazine also provided growers with relevant results.

The tomato research that was observed was based on variety trials. Beef tomato and cocktail tomato varieties were being trialled at the time of the Fellows visit. The crop was grown in a rockwool growing medium, and water was recycled.

Capsicum crop for research

Closed glasshouse concept

The crop itself was grown on a standard glasshouse system as previously identified for the capsicum crop. Energy screens were available to protect the crop in warmer weather. Individual variety names were not available but varieties were grafted onto rootstocks. Pollination was undertaken with the use of bumblebees.

A tomato crop was also utilised with research into the closed greenhouse concept.

The concept is based on a control system that mixes calculated quantities of greenhouse and outside air and then distributes this throughout the crop using air tubes. The aim of the system is to create a cooling capacity by introducing cooler air from outside the greenhouse. As a result, the conventional roof ventilation can stay closed for longer and this leads to a more stable temperature. Furthermore, this means that the CO_2 stays in the greenhouse longer; the aim being to create a more stable, optimal crop-growing climate. This ultimately leads to both energy savings and higher production levels.

According to Sauviller, initial work has now led Proefcentrum to look at a revised semi-closed greenhouse concept. Limited results were available on the findings of this concept.

Strawberry Research—Proefcentrum focuses on research into strawberry production within the glasshouse environment, and field-grown crops within plastic houses and non-protected areas. Proefcentrum is currently looking to be the lead research agent for all-year-round (AYR) production.

Sauviller was unable to give detailed information to the Fellow on the strawberry programs as her area of expertise only lay with capsicum crops. At the time of visiting, the Fellow was able to observe strawberries grown in a hydroponic channel system. Recycled water was used to feed the plants and trials were also being undertaken with grass as used a foliage floor covering for the floor area between the rows.

Hydroponic strawberry crop with grass foliage floor covering

The cropping plan involved planting one-year-old plants in August with a view to realising fruit production between September and December. The crop was then left in the glasshouse across the Northern hemisphere winter (December to March) with a view to gaining further fruit production in April and May. Following this, the crop would then be removed, with external crop production taking place in June.

Outdoor strawberry crops with plastic cover

Outdoor production of Strawberries—this is seen as a strong product in Europe in terms of sales of picked fruit. Plant material is bought into the research station rather than using 'motherstock' to reduce the incidence of disease. Bacterial diseases are now becoming a problem with soil-borne crops due to soil splash.

In order to supplement mains irrigation water, rainwater is harvested from the glasshouse roof area and filtered before use.

Trials were also being undertaken with the use of reed beds to filter out nitrates.

Priva

Destination – Priva, De Lier, Netherlands

Priva De Lier building

Objectives

The objectives were to visit the headquarters of the market leader in climate control technology and observe firsthand the software and hardware available to monitor and control all parameters within a controlled environment glasshouse.

Outcomes

The visit to Priva enabled the Fellow to gain an overview of the latest technology available for utilisation within the commercial CEH industry. The Fellow was able to gain a clear vision of the capabilities of the corporate structure of Priva and in particular, the methodology associated with the climate control system known as Priva Intégro, as well as the Labour management system, Priva Assist.

The visit allowed the Fellow to address identified skills deficiencies 1, 2, 3 and 4, with comprehensive emphasis on 4.

Findings

Priva is an established leader in climate control in both the horticultural and building intelligence sectors, and their own recently completed company headquarters at De Lier, Netherlands, provides an excellent example of this, being one of the few CO_2 neutral office buildings in the world.

The Fellow attended a meeting with Marketing Advisers, Kees Huijben and Dylan Schalke, to discuss the issues relating to the industry standard climate control system, Priva Intégro, as well as the Labour management system, Priva Assist.

Priva Intégro

Priva has been well established as the worldwide market leader in the field of greenhouse process computers. The Priva Intégro system is a complete line of process computers that give the modern greenhouse business a high level of automation.

Intégro can be installed either centrally in one computer space, or decentralised and spread across the nursery.

Ventilation control in the Priva Intégro is based on a calculation model with which the 'energy balance' is calculated. This model calculates how much energy enters the greenhouse, taking into account aspects including greenhouse roof translucency and outside conditions. The Priva Intégro can calculate how far the vents must be opened to remove surplus heat energy.

This 'energy balance' ultimately results in a temperature balance known as Intelligent Temperature Integration

One of the most important mechanisms for any modern horticultural business is energy management. Priva Management programs pass on the demand from the greenhouse for electricity, CO_2 and heat to the available electricity, CO_2 and heat sources.

Because the energy supply and demand is based on power calculations, supply and demand can be brought perfectly in balance. Naturally, account is taken of matters such as the availability of energy and the status of the sources concerned.

OutdIntergro systems undergoing testing

Within Europe, CHP installations are playing a more important role in greenhouse operations. Such installations not only supply heat, CO_2 and electrical power, but many growers also use the installations for re-supplying power to the mains network.

Priva Intégro communicates with the power company, and the supply profile for the following day is automatically collected and registered in the Priva Intégro system. As a result, the quantity of electricity agreed with the electricity market is automatically re-supplied

The Priva Intégro also offers a multitude of possibilities for water management. Besides the standard options of starting a crop water dose, based on the measured inside and outside conditions, various supplementary starting options are available. The water dose can be started based on the calculated transpiration or the humidity level of the substrate.

Priva Intégro is able to keep irrigation water flows separate depending on their composition. Accordingly, it is simple to set from which tank the water is to be sourced, and which tank it must be returned to after use. U.V. Water treatment via a Priva Vialux system is fully integrated in the Priva Intégro software.

Priva Vialux system under test

Priva Vialux system nearing final assembly

Control, based on the measured plant temperature, is one of the many possibilities of the Priva Intégro. If the plant has the conditions it prefers, that is the guarantee for (crop) success.

A completely new method of control originates by matching the settings of the Priva Intégro with the plant temperature. All heating and ventilation control can be activated in this way.

It is also possible to control misting (incl. roof irrigation), CO_2 and grow screens based on the measured plant temperature.

Besides standard operation, it is also possible to remotely operate the Priva Intégro on the Internet. Using a mobile phone in combination with an Ipaq, the climate control system can be accessed and data changed from remote locations.

Priva PrivAssist

Virtually every business owner's biggest challenge is labour. Finding and keeping good staff, training, managing productivity, managing staff politics and the rising costs of labour are common challenges to all businesses.

This is even more difficult for the horticultural industry as conditions are often uncomfortable and the wages are often relatively low. Priva has developed a new system called PrivAssist Smartline, which makes labour management much easier and makes everyone accountable.

The system uses a Smartline Reader to scan a Radio Frequency Identification Device (RFID) tag to record a process. RFID is becoming the leading data gathering system in factories and other industries. PrivAssist Smartline has the following features:

- Saves labour – records data with increased speed and accuracy due to no manual data entry.
- Makes staff accountable for their own actions in a very clear, easily documented way.
- Rewards staff for their efforts.
- Is designed solely for horticulture, with outputs being displayed in understandable jargon.
- Modular system – offers the ability for expansion.
- Has a built-in comprehensive payroll system with provision for hourly rate plus piece rate (contract) or a combination of both.
- Records how many kilograms harvested, who picked them, how long it took to pick, date, quality, cost per kilogram by various employees, varieties etc.
- Increases awareness of employee productivity, crop productivity and disease incidence so you can make informed decisions.
- Quality can also be tracked and as a result of being accountable, quality and productivity rise together.

The new Smartline RFID tags are placed throughout the greenhouse. When crop workers arrive in the morning, they pick up their Readers and scan their personal ID tag, clocking them in for the day. They then start their first task for the day, for example picking.

When finished picking in a particular row they scan the row (tags are mounted at every row), the task (picking), the variety, and the production. They continue to work like this throughout the morning.

Then when they go for their first break, they take the Reader to an upload point (usually located either at the entrance to the greenhouse and/or at the entry to the staff room) and in a few seconds all the data is sent to the computer for analysis.

At the end of the week, or at any time, the grower/manager can create reports from the data that will show all the information that has been collected for each employee, in a format that is easy to read and can be used to calculate pay and bonuses for performance.

The Fellow was able to forge strong links with Priva and is working towards the expansion of these links.

Metazet Demonstration Nursery

Destination – Metazet Demonstration Nursery, Honselersdijk, Netherlands

Objective

The objective was to visit a unique central location offering working examples of the latest technology associated with growing techniques and equipment utilised in controlled environment horticulture.

Outcomes

The visit to Metazet Nursery enabled the Fellow to gain an overview of the latest technology available for utilisation within the commercial CEH industry. The Fellow was able to observe a variety of mechanical systems designed to assist in materials handling, as well as trial production systems for a range of crops.

The visit allowed the Fellow to address identified skills deficiency 3.

Findings

Metazet's Demonstration Nursery is a greenhouse of over 5000 square metres, in which effective growing of flowers, vegetables and pot plants is combined with a unique presentation of all kinds of growing techniques.

The facility allows a number of leading companies in the horticultural industry to showcase some of their most important products, especially in relation to their latest innovations and creative plant production techniques.

Whilst cultivation and harvesting techniques are showcased, the latest in transport systems, lighting, irrigation, and heating can be seen at the Metazet Demonstration Nursery.

The facility operates on the theory that before purchasing, growers like to see and touch a product (or system); and see if it will works for them and discuss its possibilities. The demonstration nursery fulfils this theory, and combines the cultivation of flowers, vegetables and pot plants via a unique presentation of techniques.

As a result of the rapid changes in the horticultural sector, the systems and products on display are improved constantly. This allows growers, study groups and industry associations to gain an insight into both current products and the latest developments that will meet their specific crop and company layouts.

Proprietor, Peet van Adrichem provided a tour of the facility and gave an explanation of the various production systems on display.

According to Van Adrichem, the facility is funded by companies renting space at Metazet to promote their products to the wider industry. The concept has also been driven by a need for industry to raise production levels. Van Adrichem sited the tomato industry as being a prime example, where seven years ago production levels in tomato crops aimed at a level of 50 kg per square metre. The industry now has target levels of production of up to 65 kg per square metre. This has been achieved by fine tuning production methods. The ongoing challenge is to raise crop production to the next level and lower costs. This may be achieved by either reducing labour costs or introducing modern technical applications to raise the efficiency of the growing methodology.

The following examples were observed as part of the tour:

Cultivation Techniques

Automated Gutter System for Pot Plants

A production system that maximised space utilisation and minimised plant handling.

Automated pot plant gutter system

Roll system used for tomatoes

Plant pots were loaded onto the gutters, which then proceeded to the rear of the glasshouse over the crop growth duration, before returning at a higher level as a finished product. Supplementary lighting was placed under the higher-level gutters to give adequate light levels for plant growth

Roll System Used for Tomatoes

Crop is grown on a large 'drum' that rotates with the ultimate aim of eliminating the need to train the crop on an endless string system, thus reducing labour costs.

Water is sprayed on top of the stem to encourage rooting. The stem of each plant rotates one full circle and is then cut off. At the time of observation, this system was returning less yield than a traditionally trained crop.

Tomato System Growing in Deeper Channels than Nutrient Film Technique (NFT)

The crop was placed in a free flowing stream of water and nutrients and at the time of viewing had been crop in production for ten months.

Deep channel NFT system

The object of the trial was to look at a production system that cost less to establish and would give a longer crop life.

Pepper Crop Growing in Moving Gutters

This system utilised moveable gutters that allowed all crop training and harvesting to be undertaken at a central location. The crop was moved around on the gutters giving better space utilisation. In order to evaluate if movement had a diverse effect on yield, the crop gutters were constantly moved to give an advanced indication of potential yield decline.

Harvesting Techniques

On display were a variety of harvesting carts for tube rail and monorail, plant order systems, flower harvesting and processing systems, as well as plastic harvesting boxes and crates.

Harvesting carts

Internal Transport Techniques

On display were tube rail systems, monorail systems, chain systems, wire monorail systems, and conveyor belts.

Lighting Installations

On display were lighting installations for tomatoes, capsicums, roses and gerberas, which included moving lights and Light Emitting Diode (LED) lights. The LED lights were being used in a trial to evaluate colour spectrums and the intensities of prototype models

LED crop lighting

Hoisting Systems

On display were hoisting systems for heating, crop support, lighting and gutter systems.

Hoisting system for hanging basket crop support

Rijk Zwaan

Destination – Rijk Zwaan Seed Technology Centre, De Lier, Netherlands

Objectives

The first objective was to visit the Rijk Zwaan seed technological centre and gain an overview of the operation of the Rijk Zwaan company, and observe the processes utilised in the preparation of commercial seed. The second objective was to visit the company's trial nursery to observe production techniques and emerging varieties.

Outcomes

The visit to Rijk Zwaan enabled the Fellow to gain an overview of the process utilised in the collection and preparation of commercial vegetable seed, as well as observing growing trials of the latest commercial varieties of tomato. The Fellow was able to observe the workings of the centre and the trail nursery, as well as forging strong links with the Rijk Zwaan company. The visit allowed the Fellow to address identified skills deficiency 2 and 3.

Findings

Ahmet Tunali, (Area Manager) provided a tour of the facility and gave an explanation of the various seed treatment equipment that was operating.

Rijk Zwaan specialise in breeding and supplying vegetable seed for commercial cultivation in glasshouses, polythene tunnels and outdoor crops. With more than 80 years experience in the area of vegetable breeding and seed production, and with sales in more than 100 countries, the company has grown into a major world player in vegetable breeding.

Rijk Zwaan makes use of production locations all over the world. The seed for each crop is produced in areas where conditions are the most suitable for not just growing but also the ripening process of the seed.

Untreated seed arriving at the Rijk Zwaan Seed Technological Centre in De Lier

In order to have good quality seed it is important that the seed is harvested at the right time and with great care. Depending on the crop, it is either harvested manually, in stages, or mechanically in one operation. Once the seed has been harvested, each batch, wherever in the world it is produced, goes to the Rijk Zwaan Seed Technological Centre in De Lier, Netherlands.

On arrival, various tests and treatments take place to make the seed saleable. The ultimate aim is to supply the customer with a reliable, quality product.

These tests include:

- **Germination vigour –** samples are taken from the new seed batches and these are tested for germination vigour in different conditions.
- **Purity –** The seed is examined for the presence of, half-seeds, weeds, soil particles and other undesirable elements. These are removed if necessary.

The International Experience

- **Varietal trueness/varietal purity –** there are two methods for checking varietal trueness and varietal purity. Either a batch is checked when a sample of the seed is sown at Rijk Zwaan's trial nursery, or seed is checked via fast DNA techniques in Rijk Zwaan's laboratory in Fijnaart.
- **Seed-borne diseases –** some of these tests are partly carried out in Rijk Zwaan's own laboratory and others are contracted out to specialist laboratories. The tests are all carried out in accordance with officially laid down test protocols.
- **Tailored treatments –** based on customers' wishes, seed can undergo various treatments besides the quality tests. These may include disinfection or coating against germination diseases.

Seed being graded for size

Seed treatment machinery

Bulk processing of seed

Display of product marketing packaging

Once the quality demands have been satisfied and the necessary treatments have taken place, the seed is made ready for dispatch and delivered to the customer. The designated seed containers can be printed in any language depending on their final destination.

Seed may also be stored for a period of time. This allows a ready reserve of viable seed to be held for customers. The seed is stored in a controlled environment that maintains a temperature of 15° Celsius and a relative humidity of less than ten per cent. The seed store itself is 15 metres high and requires forklift access.

Seed storage area

Rijk Zwaan trial crop

The Fellow was then taken to Rijk Zwaan's trials nursery at Steenbergen, where a guided tour of the facility was given by the trials Manager, Harry Augustijn.

The purpose of the trial nursery is to evaluate the performance of tomatoes currently marketed by Rijk Zwaan and to monitor the development of new and novel future varieties.

The Nursery was managed with a Priva control system that included labour tracking.

The trial crop being grown in grow slabs is placed on the ground rather than in a hanging gutter system. According to Harry Augustijn, the temperature of the grow slab is important to sustained plant growth. If the slab temperature goes over 27° Celsius, this can cause blossom end rot (BER) in the fruit.

However, in Augustijn's experience, the symptoms of BER will not show up for a couple of weeks, so it is vital to monitor the slab temperatures. To counter this, cool water can be blended into the feed solution. Nutrient was supplied at a pH of 5.5–5.6, with all nutrient solutions being recycled. CO_2 injection was also utilised, along with pollination by bumblebees. Grow screens were used to act as thermal screens at night, and to provide shade when excessive sunlight occurred. All leaf litter was removed to counter Botrytis infections.

Augustijn explained the history of the trial crop and advised that the total crop was sown on the 3rd November 2008, and rootstocks (that some of the plants were grafted to), two days earlier. The plants arrived at Steenbergen on the 17th December, and were planted on the 9th of January 2009. All grafted plants were planted at a density of 2.5 per square metre. Cherry varieties were planted at a distance of 33 cm apart and at a density of 3.7 stems per square metres. Larger varieties were planted at a distance of 37.5 cm apart and at a density of 3.3 stems per square metre. The crop was grown in rockwool with CO_2 enrichment at 1000 PPM. In order to assist with heat conservation at night, a thermal screen was used.

Display of product

Tag to show truss and fruit numbers

The Fellow in full PPE with Harry Augustijn

As part of the trial process, six control plants for each variety were tagged to record specific data such as leaf length, truss numbers, fruit numbers

The remaining plants in each variety were grown without the same intense level of tagging. Fruiting product from the trial varieties was placed on display for growers to evaluate.

In order to inspect the crop, the Fellow was expected to don personal protective equipment (PPE) that covered the body and shoes. This was to prevent against the possible spread of pathogens from other crops he had visited.

Discussion with Ahmet Tunali & Harry Augustijn revealed a strong liaison between Rijk Zwaan and the growers. Ongoing trial data relating to crop progress can be accessed by the growers and a team of consultants liaise widely with growers to enable them to get the best performance from Rijk Zwaan varieties. Open days are held to promote new varieties to growers.

The expectation of a good grower using Rijk Zwaan varieties is to realise a yield of 65–66 kg per square metre for standard tomatoes, with 60 kg per square metre being seen as an average.

Cocktail varieties only realise 45 kg per square metre, but higher prices are required to cover the additional cost of harvest.

PTC+

Destination – PTC+ Training Facility, Ede, Netherlands

Objectives

The objective were to visit a well established training provider and gain an overview of current training programs and facilities suited to controlled environment horticulture.

Outcomes

The visit to PTC+ enabled the Fellow to gain a basic understanding of the range of courses that are being offered to new entrants and existing industry practitioners. The Fellow gained knowledge of the current issues facing PTC+ in its move to establish facilities for the future.

The Fellow was able to observe the current training facilities that PTC+ have established in order to prepare students for entry into the controlled environment industry, as well as industry-based training for current practitioners.

Findings

PTC+ is a modern practical training institution delivering expertise in the fields of plant growth and horticultural technology.

Training is conducted in a practical environment, giving students the ability to independently implement new skills.

PTC+'s mission is to give every participant new skills and a unique training experience, which in turn will encourage students to speak enthusiastically to others about the trainers, facilities and opportunities at PTC+. In this way,

PTC+ aims to further expand and strengthen its position in the field of practical learning. PTC+ also shares its knowledge and expertise with a wide range of partners from the research field and development world.

Practical learning is central to PTC+, with all training programs delivered in practical settings. Practical experience is supplemented with theory when necessary.

Because PTC+ believes in paying attention to participants' individual learning objectives, courses are delivered to small groups of no more than 12 people. Psychologically, learning in small groups enables participants to quickly feel at ease, so that they feel less inhibited and can absorb new information more easily. Ample space for students to undertake practical tasks is also seen as vital.

Teaching staff member Ben Van den Brink, provided a tour of the facility and gave an explanation of the culture behind PTC+.

Entrance to PTC+ glasshouse facility

Typical individual cell

PTC+ currently has a glasshouse facility comprising of ten compartments, each having a total area of 250 square metres. By design, each compartment has a different style of heating control system and energy screen to offer maximum exposure to students of differing systems and products. Each cell also has the ability to take in three separate water sources including potable water, recycled water, and nutrient enriched water.

Heating is derived from hydronic heating with CO_2 enrichment, with natural gas being the primary heating source.

PTC+ aim to change growing systems within the cells every three years to try and keep pace with industry developments.

A central general corridor linking the cells is also used for training, and for activities such as slab set out. Linked to the glasshouse facility are five classrooms, which allow for differing specialisations. Within these classrooms, students are able to pull systems apart without disrupting any production facility equipment.

A glasshouse area with border soil is also utilised to allow students to undertake cultivations in winter months when the outside soil is frozen.

According to Van den Brink, PTC+ is looking to replace the current structures with three growing areas of 500 to 600 square metres in size. This size of structure will give PTC+ the ability to produce more commercial sized crops, and this in turn will allow them to train students up to middle management level.

Van den Brink explained that it was vital for student projects to allow students to have total control of a designated crop. This underlined the theory of PTC+. has of ‘learning by doing’ that gave students the ability to ‘experience it yourself’. As a precursor to practical training, students were also expected to find markets for crops before they started production of a crop.

Individual student groups were catered for via specialist allocation of resources. The Fellow was shown a capsicum crop that had been adapted for South Korean growers. 10–12 grower groups a year travel to PTC+. to undertake a level three course, and participants range from basic to professional levels. Rockwool medium was utilised with a variety of capsicum that is grown in South Korea.

With the crop running across a ten-month duration, both current and past students were able to retrace key crop events via computer access to climate control records and recorded plant growth and production data. According to Van den Brink, the computer access gave the students an ability to develop strategies and develop a philosophy of dealing with issues across both short and long time frames.

Capsicum crop under production

As well as offering students the ability to undertake practical training, Van den Brink saw ongoing support and liaison with his students as vital. Currently students are able to communicate with instructors via email, and observation of crop progress is also available via the internet.

Class area facility

Fertiliser rig for student use

PTC+. also gained strong support from industry. At the time of visiting, the Fellow observed that Grodan sponsored all of the grow slabs for free. Climate control systems were initially installed by Priva at a commercial cost, but Priva give regular updates of software and hardware to enable PTC+.to keep pace with technological advances.

Computer system linked to growing system

Knowledge Transfer: Applying the Outcomes

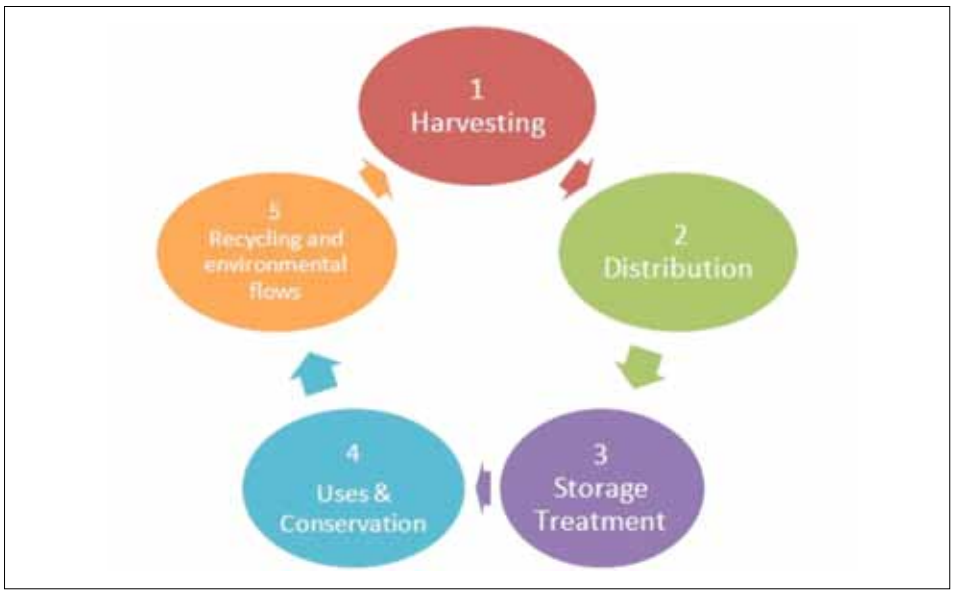
One of the positive outcomes from the Fellow's international experience is that a vehicle is currently being developed to allow for knowledge transfer to both the local and wider regional and national industry.

Chisholm Institute of TAFE had previously initiated stage one of the construction of a Centre for Sustainable Water Management to offer training to both the direct and wider water service industry.

This currently allows for training in:

- Pipe laying (sewer and water mains)
- Pipe laser levelling
- Trench shoring
- Confined space training
- Manhole building
- Work site traffic management
- Quick-cut saw training
- Chainsaw training
- Plant safety

Chisholm Institute of TAFE recognised that there was a relationship between water harvesting, distribution, storage and treatment, uses and conservation, and recycling and environmental flows.



Chisholm Institute of TAFE sought federal funding to develop stage two of the Centre for the Sustainable Water Management project to address these relationships, and to develop facilities that would offer a focus on water supply, treatment, distribution, environmental water management and the production horticulture industries. The funding was approved and stage two is now due to be constructed in 2010.

Knowledge Transfer: Applying the Outcomes

The proposed facilities will include:

- Water treatment and testing pilot plant
- Technology-rich workshops and general-purpose classrooms
- Live work CEH glasshouse complex
- Plant and equipment storage
- Integrated linkages to the existing wetlands

Concept Design of Stage Two – Centre for Sustainable Water Management Development

Main Entrance

North West Aspect

The Fellow has been actively involved in the CEH component of the project. In order to ensure that current 'best practice' and growing techniques are adopted into any future developments in both facilities, the Fellow has been working closely with a consortium of three commercial companies (Faber Glasshouse, Greenworks, and Powerplants) to achieve this aim.

This has led to the development of a design and technical specification that will see the establishment of the most advanced CEH facility in Australia. This facility will offer a strong focus for industry-based training.

The training centre itself will see an initial construction of 1000 square metres of six-metre high commercial glasshouse. A further expansion of an additional 1000 square metres of glass is proposed within a two-year time frame.

Contained within this structure will be the latest technology in environmental management, staff management, and crop production. The facility will also contain specialised computer-based and practical teaching resources that will allow students to adopt a hands-on, 'learning by doing' approach to their training.

Construction will begin in January, with a completion date set for June 2010. This will coincide with Chisholm Institute of TAFE hosting the 2010 Hydroponic Farmers Federation (HFF) Conference at the Cranbourne campus.

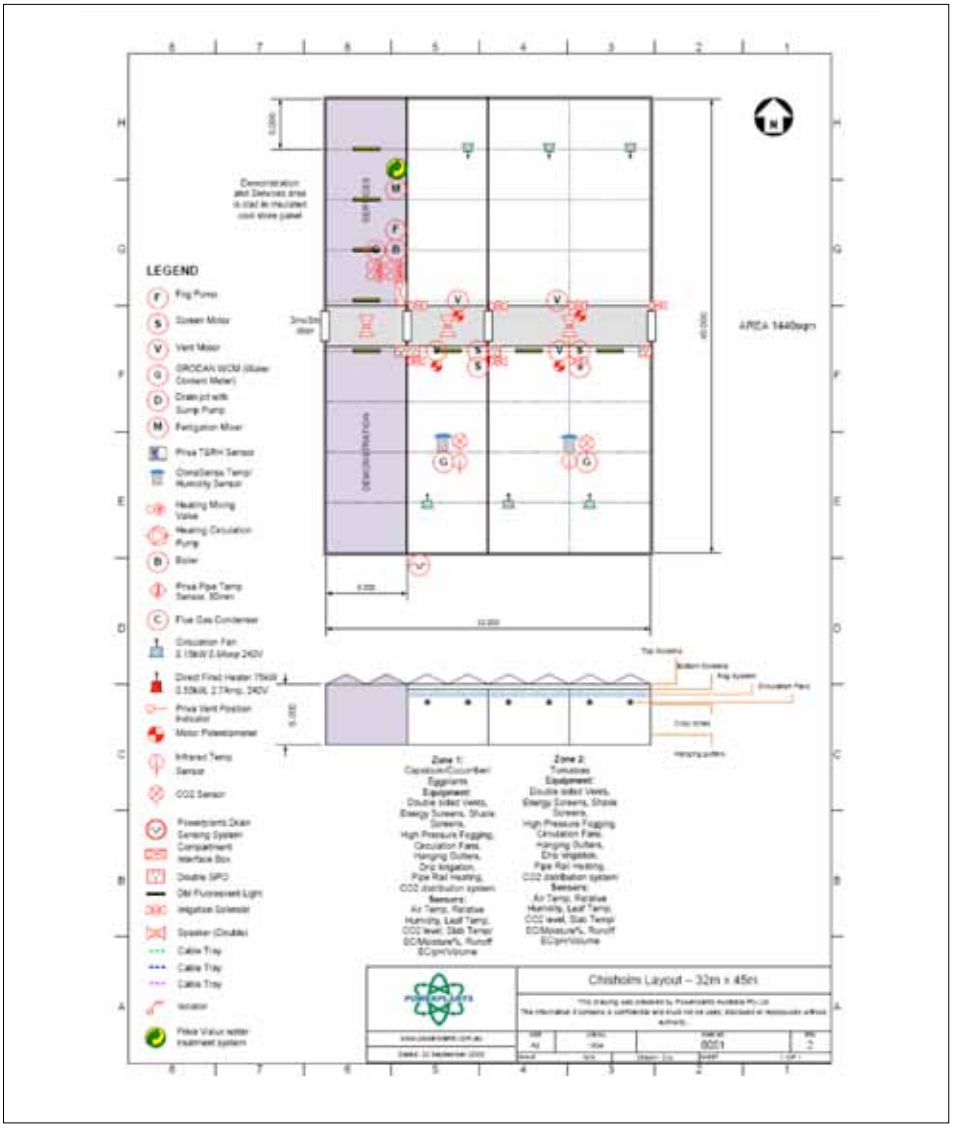
As part of this development, the Fellow will be actively involved in the initial project management of the glasshouse complex, and will then be involved in developing new and emerging training opportunities. Part of this program will see the Fellow having the ability to impart the knowledge that he gained overseas into both the facility development process and the resultant training opportunities.

Knowledge Transfer: Applying the Outcomes

The Chisholm Institute of TAFE marketing department is also working closely with the Fellow to actively promote the development of the CEH facility and the associated career paths.

The completion date for the new glasshouse complex is at the end of June 2010. This date will also coincide with Chisholm Institute of TAFE hosting the 2010 HFF Conference at the Cranbourne campus between Wednesday the 30th June and Friday the 2nd July. Part of the conference proposal is to allow industry to have access to the facility to see first hand the developments that have taken place.

From these dates onwards, Chisholm Institute of TAFE should have the facility running at capacity, and will be able to deliver a number of training initiatives using this unique resource.



Proposed CEH Glasshouse Layout

Recommendations

Identified Skills Deficiencies – What the National Industry Lacks

As previously mentioned in this report, the Protected Cropping Industry has clearly identified that it is looking for its future management to have the skills that are needed to monitor and manage both the growing structures and the environment within them, in order to achieve maximum output from intensive systems.

Currently the industry is looking to either employ overseas practitioners who have these skills, or send staff members overseas to gain these skills.

These skills are based on the following issues:

- Manage controlled environments via complex computer-based technology to enhance plant growth rates
- The interpretation of data that can be translated to practical applications via computer-based technology to enhance plant growth rates
- Determining the most appropriate growing mediums, and suitable irrigation

  fertigation and pest and disease control programs for specific crops
- To determine current 'best practice' techniques in the use of both IT and plant handling systems associated with commercial horticulture (production and farm planning)
- To become skilled in the use of software based packages to undertake 'whole farm' planning and monitoring.

To address these skills deficiencies the following recommendations and solutions are made.

Government – Federal, State, and Local

In order to access training, individuals and companies are required to invest both time and finances into gaining new skills. Government based financial incentives are required to undertake training and greatly assist business in facilitating time release for training.

Initiatives such as the government FarmReady program offer focuses on the following key learning areas that relate to the skills deficiencies identified:

- Integration of new techniques, including high-level technical skills, for sustainable production as a result of climate change
- Farm business management, risk assessment and identification of management options
- Development of analytical skills to be applied in a primary production enterprise
- Holistic 'whole farm' planning
- Human resource management/people management

It is the belief of the Fellow that this type of initiative should continue to be endorsed by both the Federal and State Government.

Chisholm Institute of TAFE will be working towards making sure that the training it offers to help address the skill deficiencies, will be aligned to the needs of the individuals, as well as falling within the scope of the FarmReady program. Through this report other training providers may take up aspects of the findings and therein multiply the outcomes of the Fellowship.

Recommendations

Industry

Chisholm Institute of TAFE is an example of one partnership arrangement to facilitate training.

Whilst growers can purchase and install the required technology to assist them with crop production, the industry lacks a centre for training for such equipment. There is a demonstrated need to have a facility that will enable industry practitioners to observe and operate such systems.

Chisholm Institute of TAFE is currently undertaking active discussions, to establish partnership programs with technology suppliers. The aim of this process is to enable Chisholm Institute of TAFE to deliver training at the new Cranbourne facility, which is directly linked to the specific operation of the suppliers' technology. The Fellow is currently working with Priva to establish a model for training that will cater for participants who wish to undertake training in basic and advanced use of this technology. As the technology is updated, it is hoped that Priva will assist in supplying upgraded equipment at a competitive price.

It is also envisaged that Chisholm Institute of TAFE will be able to supply initial training to clients of the technology companies on a 'fee for service' basis as part of the client's installation fee.

Professional Associations

It is recommended that the aforementioned professional associations encourage their members to advance their capabilities to meet current market needs using new technologies. For example, Chisholm Institute of TAFE is currently working on developing its capacity to satisfy local and regional CEH clients in their training needs.

Whilst Chisholm Institute of TAFE has a focus on training, it is important that the industry sees the new facility as a centre for not only it's training requirements, but also one that can be used to both promote and develop the generic industry.

As previously mentioned, the 2010 HFF Conference and Trade Show will be held at Chisholm Institute of TAFE.

To date no progress has been made on the formal identification of a National Training Centre for the industry; however, interstate students will be able to access training at the Chisholm Institute of TAFE Cranbourne campus.

Education and Training

By the very nature of the fact that skills deficiencies have been identified by the industry, training of participants to address this shortage would seem a natural solution. The training that would be required to address the deficiencies will depend on the level of responsibility that is given to the industry operative.

Chisholm Institute of TAFE currently offers accredited training through its profile funding to a range of students. The aim for 2010 is to integrate current profile training into the new glasshouse facility.

The individual competencies that will be delivered as part of the courses will also be chosen to align with the proposed AHGA Controlled Environment Horticulture competencies identified by the Pathways to Production program.

Recommendations

Whilst courses identified in this program currently do not have national accreditation, the competencies identified are accredited. This means that if the CEH course does gain accreditation in the future then Chisholm Institute of TAFE students will have the option to gain an additional qualification through credit transfer.

The competencies that will be offered are drawn from the National Rural Production Training Package RTE03.

A Certificate II – Horticulture (Production) stream course RTE20603 will be offered to prospective new entrants to the industry, and competencies for this course will be drawn from the following:

- RTC2210A Maintain properties and structures
- RTC2301A Undertake operational maintenance of machinery
- RTC2401A Treat weeds
- RTC2404A Treat plant pests, diseases and disorders
- RTC2701A Follow OHS procedures
- RTC2702A Observe environmental work practices
- RTC2704A Provide basic first aid
- RTC2705A Work effectively in the industry
- RTC2801A Participate in workplace communications
- RTE2003A Carry out post-harvest operations
- RTE2010A Establish horticultural crops
- RTE2018A Regulate crops
- RTE2021A Support horticultural product harvesting
- RTE2308A Operate ride-on vehicles
- RTE2707A Follow site quarantine procedures

A Certificate III – Horticulture (Production) stream course RTE31603 will be offered to registered apprentices working in the industry, and competencies for this course will be drawn from the following:

- RTC3401A Control weeds
- RTC3404A Control plant pests, diseases and disorders
- RTC3704A Prepare and apply chemicals
- RTC3705A Transport, handle and store chemicals
- RTC3805A Coordinate work site activities
- RTE3002A Coordinate a crop regulation program
- RTE3003A Coordinate horticultural product harvesting
- RTE3013A Implement a post-harvest program
- RTE3611A Operate pressurised irrigation systems
- RTE3612A Implement a maintenance program for an irrigation system

Recommendations

- RTE3713A Carry out workplace OHS procedures
- RTE3801A Provide on-job training support
- RTE3904A Keep records for a primary production business
- RTE3907A Use hand held e-business tools
- RTF3012A Implement a plant nutrition program
- RTF3033A Implement a maintenance program for hydroponic systems

The Certificate IV – Horticulture (Production) stream course RTE40503 will be offered to new higher level entrants and existing employees in the industry, and competencies for this course will be drawn from the following:

- RTC4702A Minimise risks in the use of chemicals
- RTC4703A Plan and implement a chemical use program
- RTF4004A Develop a plant nutrition program
- RTF4023A Promote plant health
- RTC4306A Supervise maintenance of machinery and equipment
- RTC4701A Implement and monitor the enterprise OHS program
- RTC4908A Supervise work routines and staff performance
- RTE4002A Develop a crop regulation program
- RTE4012A Supervise horticultural product harvesting
- RTE4609A Implement, monitor and adjust irrigation schedules
- RTE4913A Analyse and interpret production data
- RTE4915A Implement and monitor quality assurance procedures

The Certificate Five Horticulture (Production) stream course RTE50303 will be offered to prospective new higher-level entrants and existing employees in the industry, and competencies for this course will be drawn from the following:

- RTC5701A Establish and maintain the enterprise OHS program
- RTC5913A Collect and manage data
- RTC5914A Prepare reports
- RTE5012A Manage a controlled growing environment
- RTE5016A Develop production plans for crops
- RTE5702A Develop and manage a chemical use strategy
- RTE5807A Manage staff
- RTE5901A Develop a marketing plan
- RTE5902A Develop and review a business plan
- RTE5903A Plan, implement and review a quality assurance program
- RTE5906A Monitor and review business performance
- RTF5005A Manage plant health

Students will also be able to access training for either individual competencies or 'skill sets' of competencies that are required by their work sites.

Chisholm Institute of TAFE will also be looking to deliver training to satisfy the skills deficiencies identified by employers. It is envisaged that these supplementary units identified by industry will be delivered as short-course modules to meet specific enterprise needs or 'skills sets'.

In order to gauge the industries requirements, the Fellow has been consulting both local and regional industry practitioners to conduct training needs analysis for the industry.

The Fellow has initiated an online survey, and data gained from this process is being utilised to offer industry driven training.

An extensive schools-based program is also being initiated to offer current school-based students an insight into this vibrant industry, and to offer new entrants a training program to facilitate their entry into the industry.

ISS Institute Inc

In order to assist in the knowledge transfer process and to build on the work that has been undertaken, the Fellow would make the following recommendations to the ISS Institute to:

- Facilitate the running of a workshop to promote the adoption of modern growing practices. This workshop is to be held at the Cranbourne campus of the Chisholm Institute of TAFE, with its aim being to allow participants to experience the 'journey' that the Fellow has personally taken. The workshop should also be timed to coincide with the new growing facility becoming fully operational. This will allow participants to see modern technology in operation, and to experience first hand the systems that go into making the facility such a cutting-edge example of modern technology.
- Facilitate an additional Fellowship that would allow a future prospective Fellow to travel to the Netherlands and undertake training at Priva headquarters to gain a full understanding of the operation of the Priva Intégro system, and its integration with crop growing methodology and husbandry techniques.
- Publish an addendum to this report on the development of the Chisholm Institute of TAFE CEH facility in Cranbourne and its impact on providing ongoing and effective training to the Controlled Environment Horticulture Industry.

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