Attendance at Greensys 2019 - International Symposium on Advanced Technologies and Management for Innovative Greenhouses – 16th-21th June 2019

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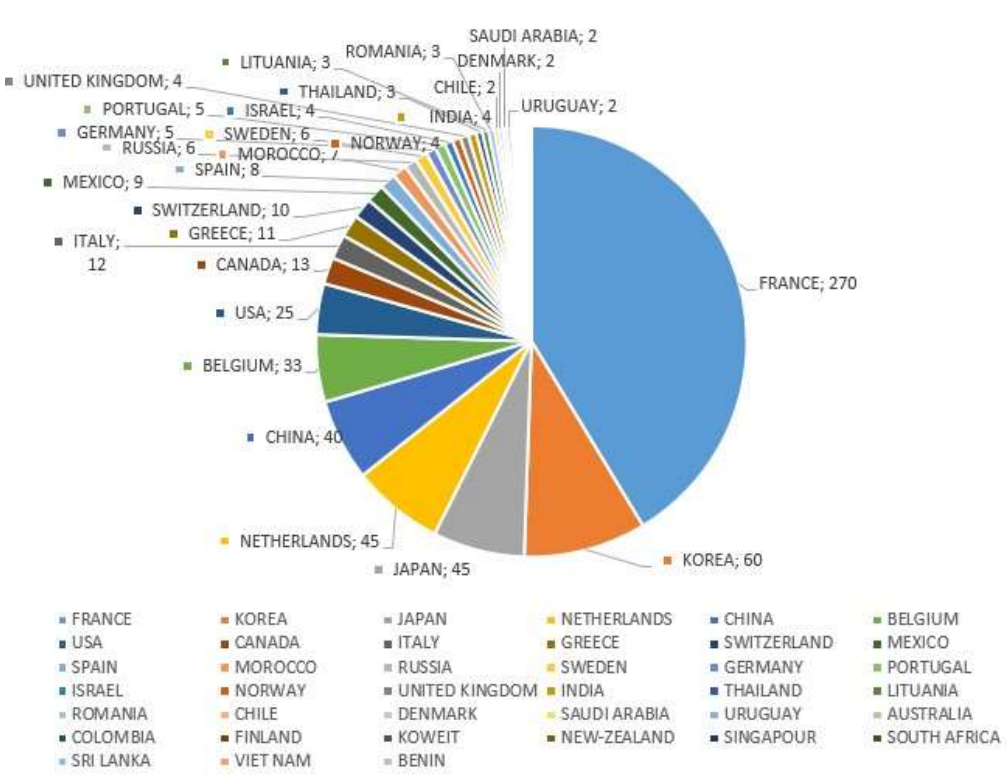
A travel report to the GCRI Trust

The purpose of this travel was to attend the 'GreenSys 2019 conference - International Symposium on Advanced Technologies and Management for Innovative Greenhouses' to understand the areas of research that are currently being undertaken internationally, and the approaches which are being developed to improve and advance glasshouse and protected crop production systems

Conference Background

GreenSys2019 was organized by Agrocampus ouest, CTIFL and INRA, with the support of Angers Loire Métropole and the city of Angers, the District Council of Maine-et-Loire, the Region Pays de la Loire, and the partnership of Végépolys (French competitive cluster). About 600 participants attended, including 400 scientists and 200 professionals from 40 countries (Figure 1). About one hundred PhD students presented their work.



FRANCE	270
KOREA	60
JAPAN	45
NETHERLANDS	45
CHINA	40
BELGIUM	33
USA	25
CANADA	13
ITALY	12
GREECE	11
SWITZERLAND	10
MEXICO	9
SPAIN	8
MOROCCO	7
RUSSIA	6
SWEDEN	6
GERMANY	5
PORTUGAL	5
INDIA	4
ISRAEL	4
NORWAY	4
UNITED KINGDOM	4
LITUANIA	3
ROMANIA	3
THAILAND	3
CHILE	2
DENMARK	2
SAUDI ARABIA	2
URUGUAY	2
AUSTRALIA	1
BENIN	1
COLOMBIA	1
FINLAND	1
KOWEIT	1
NEW-ZEALAND	1
SINGAPOUR	1
SOUTH AFRICA	1
SRI LANKA	1
VIET NAM	1

Figure 1: Conference participants by country.

Conference Programme and Technical Tour 16th – 20th June

This event brought together researchers, technicians and other professionals to present their research innovations in greenhouse horticulture and plant factory, to share ideas and knowledge and discuss state-of-the-art and future perspectives for the sheltered crop production sector.

There were several scientific themes addressed through 127 oral conference presentations and 215 posters (Figure 2), which covered the following aspects of glasshouse crop production:

- Greenhouse systems and design
- Climate control and modelling
- Plant production, protection and quality
- Crop modelling and management
- Covering materials
- Lighting technology
- Energy
- Fertigation, water and growing medium
- Plant factory
- Sensors, automation and robotics
- Organic greenhouse horticulture
- Environmental Impact and sustainable production

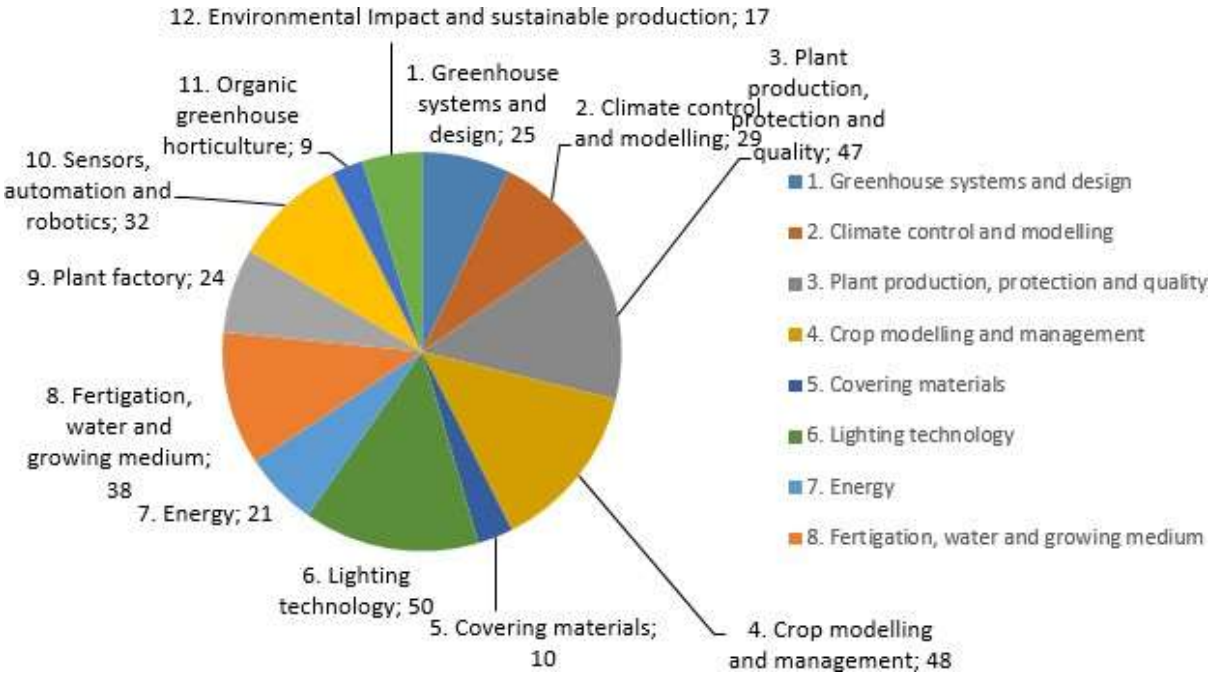


Figure 2: The number and categories of scientific presentations at the GreenSys 2019 conference.

Conference Programme

Sunday 16th June - Registration & Welcome Reception

Monday 17th June - Scientific sessions on: Climate control and modelling; Plant production, protection and quality; Plant factory; Energy

Tuesday 18th June - Scientific sessions on: Greenhouse systems and design; Fertigation, water and growing medium; Lighting technology; Covering Materials; Crop; Modelling and management

Wednesday 19th June - Scientific sessions on: Environmental impact and sustainable production; Crop modelling and management; Lighting technology; Sensors, automation and robotics; Organic greenhouse horticulture

Thursday June 20th - Technical tour - ANGERS - Visit of the RICHEL Equipement & Maison BARRAULT

Conference Highlights and Findings

Ariane Grisey, CTIFL, provided an excellent overview of the greenhouse production industry in France. The area of high greenhouse crop production in France has increased by 7% over the past 10 years providing a total of 7,431 ha of horticultural production. Of this figure, 6,100 ha consist of non-heated greenhouses or polytunnels, whilst 1,300 ha are heated greenhouses mainly for production of tomatoes, cucumbers and strawberries (Table 1). The average energy consumption for greenhouse heating requirements and operation is 317 kWh m^{-2} yr^{-1}, with 77% of the total area using natural gas and 15% using biomass.

Table 1: Greenhouse crop production in France

Greenhouse Crop	Production (tons per annum)	EU Rank (Production volume)
Tomato	530,000	6th
Cucumber	130,000	4th
Strawberry	57,000	6th

With regards to ornamental horticulture in France, there are 1,105 ha of greenhouses (57% glass, 43% plastic) and 466 ha of polytunnels, supporting the production of pot plants, young plants, cut flowers and nursery stocks. Heated greenhouses account for 38% of ornamental production systems with 33% semi-heated systems and 29% remaining non-heated. Over half of the ornamental greenhouse area is located in either the Pays de Loire or the Provence-Alpes-Côte d'Azur regions. However, the positive trend in increasing area of production as experienced by the protected edibles industry is not replicated in the protected ornamental industry, which has seen a 2% year on year decline in greenhouse area since 2011. The decline is mostly explained by cut flower difficulties in the South of France. The average energy consumption for ornamental crop production in heated greenhouses is 159 kWh m-2 yr-1, mostly using natural gas as the energy source.

Produce Quality - There are multiple issues facing agriculture and horticulture such as the need to reduce inputs (water, fertiliser, energy) without having a detrimental effect on crop yield and quality. Strategic areas of research are focussed on how to predict produce quality and maintain postharvest value through better understanding of pre-harvest conditions such as genetics, environmental conditions and crop management (GxExM). Key findings and perspectives highlight that quality is a complex dynamic trait that is strongly dependent on GxExM interactions, and that the control of quality after harvest needs to be integrated with crop management from the field. Model-based analyses of GxExM are being developed to identify 'ideotypes' with selected traits such as those adapted to low water inputs, or those with increased phytomicronutrients for health value.

Plant Factories – The planning and design of protected crop production systems is constantly evolving, and the optimal solution for each crop type will depend on many factors including cost and production of energy, policy and regulation, local water and light availability, and capital investment costs in land and infrastructure. An interesting study presented by Luuk Graamans (WUR) in this session compared the resource use efficiency between greenhouses and vertical farms at a high latitude (Tromso, Norway), and between greenhouses at high and low latitudes. Table 2 illustrates the different requirements for each production system i.e. greenhouse versus vertical farming system, whilst Table 3 provides a comparison of the effect of latitude on greenhouse dependencies with extreme local climates.

Table 2: Differences between greenhouse and vertical farming crop production systems.

Greenhouse	**Vertical Farm**
Solar gain for heat	Artificial illumination
Low thermal insulation	High thermal insulation
Ventilation controls temperature	No natural ventilation
➢ **Dependent on climate**	➢ **Independent from climate**

Table 3: A comparison of the effect of latitude on greenhouse efficiency.

High Latitude Greenhouse	**Low Latitude Greenhouse**
Limited solar gain	High solar gain
High loss of heat	Limited loss of heat
Limited natural ventilation	Insufficient natural ventilation
➢ **High heating requirement**	➢ **High cooling requirement**

Examination of the different energy balances led to several key conclusions:

- Dry matter production – vertical farms achieve higher and more consistent production;
- Energy load – The vertical farm is far more **energy** efficient;
- Energy load – The greenhouses are more **financially** efficient – less purchased energy;
- Electricity requirement – The vertical farm requires less equivalent electricity;
- Electricity requirement – The greenhouse is still more financially efficient – less purchased energy;
- Resource use efficiency – The vertical farm achieves higher resource use efficiency, except for electricity;

Energy – There were several interesting themes emerging from the sessions on 'Energy', covering topics on the optimal control of greenhouse climate, energy modelling in greenhouses, technologies for reducing heat load and generating energy, and options for carbon neutral greenhouses.

Meir Teitel (The Volcani Centre, Israel), provided an overview of methods for the reduction of heat load in protected crops under warm climatic conditions where the challenge of growing crops in warm climates are being addressed through existing solutions and new technological developments. Highlighted technologies discussed included:

- Changes in structure
- Changes in covers
- Natural ventilation
- Forced ventilation
- Evaporative cooling
- Solar absorption cooling
- Phase change materials
- Earth heat exchangers

Future research areas will focus on developing effective greenhouse dimensions and structures that can minimise the cost of cooling strategies, combined with computer fluid dynamic modelling approaches to deliver uniform temperature and humidity distribution in the greenhouse. In addition, further work will explore heat storage methods to minimise energy demands and promote the use of renewable energy for cooling.

Robotics and automation - In the UK alone, there is an annual requirement for 80,000 seasonal workers in the horticultural industry. It is increasingly difficult to meet demand, and accompanying this is a reduced 'quality' of labour supply, thereby increasing costs through additional training needs. Ultimately, the industry is spending more per hour to get same quantity of product. The conference sessions on automation and robotics provided an update on the latest developments to address the labour challenges and highlighted several areas of active innovation and research, with significant effort invested in the following areas:

- Robotic harvesting
- Scouting robots
- Swarm robotics
- 3D plant phenotyping
- Monitoring – for yield prediction, plant stress, pest and diseases

Several robotic technologies were discussed including 'Sweeperbot', the commercial pepper harvesting robot, with the conclusion that many other robotic crop harvesting start-up companies in this space are now very close to commercialisation. The future challenges for robotics and automation will require an interdisciplinary approach including mechanics and mechatronics, computer science and machine vision, plant science and interestingly, social science from the viewpoint of ethics and social acceptance of robots. With global businesses, such as Google and IBM, helping to address issues such as deep learning, there are expectations that innovation in commercial horticultural robotics and autonomous systems will emerge much faster.

Banquet Dinner

The Symposium Banquet Dinner was held on June 19 at Saint-Jean barns (Greniers Saint-Jean).
Saint Jean barns is a part of the Hôpital Saint Jean which is a major Gothic-style edifice in the west of France, and one of the last remaining examples of a remarkably well-preserved large hospital complex. Built in the 12th century by King Henry II, it is today considered as one of the exceptional monuments from Angers' heritage. The construction materials are typical of the region: slate for the base and limestone for the raised parts. The elegance and grace of the interior of the attic contrasts with the force and severity of the façade.

Technical tour in Angers Region

RICHEL equipment Group located in St-Barthélémy d'Anjou,

Maison BARRAULT company.

Terra Botanica - the first European thematic park on vegetal

Guided visit of the Domaine du Closel vineyards followed by an apéritif.

GreenSys2019 was an excellent conference to attend. The conference enabled me to meet with many knowledgeable and experienced individuals, and establish links with research groups and other organisations. The cutting-edge research and information presented throughout the conference significantly enhanced my own knowledge and inspired new ways of thinking about the current challenges we face as an industry. Attendance at this conference gave me the opportunity to learn about the latest developments in glasshouse production, providing me with an excellent overview of topical research and innovations across the global protected cropping sector. I am now incorporating this knowledge into my own thinking through my work at AHDB and through my Nuffield scholarship.

Acknowledgements

I would like to acknowledge the kind financial contributions from the GCRI Trust, without which I would not have been able to attend this conference. I would highly recommend attendance at future GreenSys conferences for all involved in protected horticultural crop production and I would encourage them to consider the GCRI Trust when seeking future travel funding.

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