Fourth webinar on CSA California – Netherlands

Business opportunities of Greenhouse horticulture as a comprehensive CSA solution
WELCOMING & OPENING REMARKS

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Fourth webinar on CSA California – Netherlands
Business challenges of Greenhouse Horticulture
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Business challenges of Greenhouse Horticulture
KEY QUESTIONS

• What is the unique selling point that makes protected horticulture and greenhouses a good climate Smart Ag solution?

• What is the current status quo (technology, applications, legislations) in the two regions?

• What are the cutting edge innovations (Ag tech, hardware, growing) in green growth in protected agriculture and how do they answer the 3 pillars of CSA (mitigation, adaptation and sustainable production)?

• What is in it for CAL and NL? Can partnerships be established and in which specific sectors and under which enabling conditions?
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Business challenges of Greenhouse Horticulture
A HIGH TECH APPROACH - THE INPUTS AND OUTPUTS

Prof. Dr. Heiner Lieth
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Business challenges of Greenhouse Horticulture
Climate Smart
Controlled Environment Agriculture

Dr. Heiner Lieth
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Environmental Horticulture
Plant Sciences, UCDavis
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Protected cultivation

- The type of farming where we improve some or all the factors that affect how the plant grows

- Objective for this type of farming:
  - Reduce plant stresses (primary)
    - Eliminate extreme temperature, light, wind, etc
    - Eliminate pests and diseases
  - Optimize conditions (if possible)
    - Impose best possible temperature, light, CO₂, etc

- Input costs and gross return are higher
  - “Return On Investment (ROI)” can be better
Controlled Environment Agriculture

- Controlled Environment Agriculture (CEA)
  - A system of plant production technologies that enable full control of the environment surrounding the plants, both in the rootzone and above
  - Protected Cultivation
    - A horticultural system where plants/crops are protected from harmful biotic and abiotic influences
  - CEA goes beyond “protection” and aims at total control over the system.
  - Note that when looking for statistics, much of this agricultural activity is considered “Specialty Crops”

- Includes: Greenhouse, tunnels, in-door, nursery
  - Various levels of protection or control
Protected cultivation types

- "cold frames", "tunnels"
- shade house
- screen house
- All these plastic film/screen
- Feasible under mild conditions.
Plastic greenhouses

- Structure can be much lighter (less expensive)
- Single or double layer transparent plastic; film, sheet
- Used extensively in California; in Europe primarily southern countries (eg Spain)
Glass greenhouses

- More expensive
- Better in winter
- These are buildings with transparent roof and walls
Indoor Agriculture

- In a building with a conventional roof (not transparent)
  - Sunlight is not used to provide plants with PAR
  - Instead lamps are used to make light

- Emerging technology – feasible due to:
  - Advanced lighting technologies
  - Advanced soilless culture methods
  - Advanced tools for air handling (CO$_2$, humidity, …)
All types of transparent cover cause “greenhouse effect”

- **Greenhouse effect:**
  - All radiation entering from the sun passes through cover
  - Radiation from inside the enclosed structure leaves at lower rate (long wave radiation, less shortwave)
  - **Effect:** net trapping of energy
  - This energy builds up and within minutes of full sunshine the interior is so hot that it will kill plants and animals

- **Greenhouses which are used to grow plants and animals** must be equipped to remove heat
  - All greenhouses are flow-through systems where outside air is pulled through so as to push hot air out
  - $\text{CO}_2$, water vapor, etc., travel with this air stream
Removal of trapped heat

- Passive (venting) => Active cooling (fan and pad)

- Not cheap! In California, the cooling cost can be as great as the winter heating cost.

- As “Climate Smart” approach, this cost is a key element; if ROI is not insured, then this is not a feasible system
Some opportunities

- **Hybrid system**: Greenhouse/Nursery + Solar PV
- **Many specialty crops benefit from some shade in summer.**
  - **Opportunity**: take excess light and use its energy for profit
  - **Prototype has been built (located at UC Davis)**
Some opportunities

- **Hybrid system:** In-door plant factory
- **Grow specialty crops (high value horticulture)**
  - **Opportunity:** innovations in LED lighting are making it possible to grow many more crops in-doors (no sunlight, no pesticides, very high water-use efficiency, high growth rates) – regardless of climate!!!
  - **Research is needed to help growers adopt technology**
    - Which crops have ROI?
  - **Prototype at UCDavis**
Some opportunities

- **Hybrid system**: In-door plant factory + Greenhouse
- **Grow specialty crops (high value horticulture)** using both tools in optimized way.
  - **Opportunity**: start plants in in-door setting (no pesticides, extreme water-use efficiency, high growth rates) shift plants to greenhouse to grown on to end of crop
- **Research is needed to help growers adopt technology**
  - Still risky
  - Can this result in pesticide-free plant production; higher quality product

Prototype at UCDavis:
Some opportunities

- In California: a large number of greenhouses are being built in areas where the climate is NOT great for greenhouses
  - Specific for Cannabis
  - Plastic greenhouses with lights and black-out curtains
  - At each location they will build as many as the electric supply grid can sustain
- This is an opportunity for CSA
  - Cannabis industry has funds to innovate; try new technologies
- It has already been noted that this segment of ag will be very large, consuming vast quantities of energy and water.
Some opportunities

- Transfer some things we know in CEA to field production:
  - Reuse our irrigation water; discard only when too expensive to clean up
  - Accomplished with soilless culture (substrates which resemble soil but have better water and fertilizer handling properties)

- The CSA opportunity:
  - Develop field production technologies that implement this

- Not as outlandish as it sounds; consider strawberry production
Strawberry field production can use many of the same technologies as greenhouse strawberry production!

How?
Like so?

- California strawberry with soilless culture:

  - Soilless substrate
  - Barrier to restrict exchange between soil and root zone
  - Soil is used to form the bed, not the root zone!
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Smart Climate greenhouses

Webinar The Netherlands – Calofornia

22 June 2017

Dr. S. Hemming, Wageningen University & Research Greenhouse Horticulture
High-value crops, nutritional value

Source: Liz Cook, poster to buy at Amazon.com

Source: https://www.iamafoodie.nl/minder-voedingsstoffen-groente-en-fruit-can-image/
High-yield and product quality

Tomato yield  kg/m²·year

Control of production factors
High resource-use-efficiency

kg fresh product per m³ water

- tomato
- sweet pepper

Control of production factors
- panel heating
- regulated glass
- CO₂ enrichment
- ventilation

For quality of life
Innovations Greenhouse Horticulture last 50 years (primary production)

Focus: to become independent of...

- Soil (substrates)
- Environmental conditions (greenhouses, climate control)
- (Fossil) energy (energy saving, sustainable sources)
- Chemicals (IPM, biological control)
- Labour (Logistics and robotics)
- Water saving (closed cycles, rainwater storage, water purification), no emissions
- Breeding
- Innovations in trade and logistics
From climate conditions to optimum sustainable greenhouse production systems.

Diagram showing the relationship between mean temperature (°C) and sun radiation (MJ/m².month) for January and July in California and the Netherlands (NL). The diagram highlights the need for cooling in July and heating in January to optimize greenhouse production systems.
The adaptive greenhouse method:

Climate
- temperature
- humidity
- sun radiation
- wind

Greenhouse model
- heating
- CO₂ supply
- cooling
- lighting

Active means
- fuel
- electricity
- CO₂
- water

Needed resources

Best possible passive structure
- Ventilation capacity
- Ventilation management
- Radiative properties of the cover
- Insulation (including screens)

Crop model

Production
Research center in Riyadh
### High tech vs Mid tech

**Variety:** Red and Yellow Pepper  
**Sowing date:** 21 December 2016  
**Planting date:** 26 January 2017  
**First harvest:** 27 March 2017

<table>
<thead>
<tr>
<th></th>
<th>Mid tech</th>
<th>High tech</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Production</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.9 kg/m²</td>
<td>4.4 kg/m²</td>
</tr>
<tr>
<td><strong>Water use</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid Tech</td>
<td>375 l/m²</td>
<td>35 l/m²</td>
</tr>
<tr>
<td>High Tech</td>
<td>128.2 l/kg</td>
<td>8.0 l/kg</td>
</tr>
<tr>
<td><strong>CO2 use</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid Tech</td>
<td>0.0 kg/m²</td>
<td>2.2 kg/m²</td>
</tr>
<tr>
<td><strong>Energy use (cooling)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid Tech</td>
<td>0.41 kWh/m²</td>
<td>73 kWh/m²</td>
</tr>
</tbody>
</table>
Greenhouse Horticulture: Vegetables
POLICY and REGULATIONS

Jenny Lester-Moffitt
CDFA

Leo Oprel
Dutch Min of Economic Affairs

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Business challenges of Greenhouse Horticulture
The Dutch approach

Energy innovation for the Dutch glasshouse industry

Kas als Energiebron

22 June 2017
Leo Oprel
Ministry of economic affairs
The arrangement

- *Kas als Energiebron* is the innovation and action programme for energy saving and the use of sustainable energy for the Dutch glasshouse industry. *LTO Glaskracht Nederland* (the growers) and the ministry of Economic Affairs initiate, facilitate and co-finance this programme.

- *Kas als Energiebron* works on long term legal agreements between the government and the sector.

- Yet the *Meerjarenafspraak Energietransitie Glastuinbouw 2014-2017* is an agreement that contains goals and ambitions up to 2020. A new agreement for the following period is under construction.

- The long term goal is a glasshouse industry without CO$_2$ emission in 2050, according to the Paris agreements.
Co-creation and co-altion

- Clear goals (2020 6.2 Mt CO$_2$, 2030 ?, 2050 0)
- Subscribed goals (the future is of all that are involved)
- It must be made possible. Ahead knowledge borders

- Total set of instruments
  - Knowledge development
    (Research, Proof of Principle, demo-centre)
  - Dissemination of new knowledge
  - Subsidy for innovators (market introduction)
  - Subsidy for proven techniques
  - Subsidy for geothermal and other sustainable energy
How

- Trias Energetica – 1\textsuperscript{st} energy saving, 2\textsuperscript{nd} sustainable energy, 3\textsuperscript{rd} rest with optimal fossil fuel (for the time being)

- Earlier years: transition paths
- Later and now: integral but modular

- Research steering on CO\textsubscript{2} (since 2004)

- Operating and thinking from the actors’ perspective (human included)

- Using innovators to convince the others
Governments policy: money and direction for a real transition

- Stable course, even with low energy prices

- Long term agreement and budget – transitions cost time

- Active role of the governmental officers in research direction

- Redirect yearly
  - subsidies adjustments
  - research adaptation to new developed knowledge

- Trust and imagination

- Networking (keep all involved)
Results count

The new way of growing, new glasshouse concepts, new energy-saving screens, breakthroughs in plant physiology, more and better production, less CO$_2$ emission and more sustainable energy
INSIDE THE INDUSTRY

Joep van den Bosch, BSc
Hortimax

David Bell
Houweling’s

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Business challenges of Greenhouse Horticulture
Ridder-HortiMaX Group
Global leader in greenhouse technology

Design, build and maintain greenhouse technology solutions in:

- Water management
- Climate management
- Energy management
- Labour management
- Business intelligence

Greenhouse Control system
Plant Monitoring
Climate Screens
Management Systems
Ventilation Systems
Fertigation Solutions
Disinfection Solutions

Large global customer base
Climate Smart Agriculture

Fresh food production needs controlled environments

Circular

High-tech

Healthy

Local
# Climate Smart Agriculture

## Need for adaptive greenhouse technology

### Greenhouse structure

<table>
<thead>
<tr>
<th>Greenhouse Type</th>
<th>Inside technology</th>
<th>High Investment</th>
<th>Maximum yield</th>
<th>High quality</th>
<th>Predictable yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass Greenhouse</td>
<td></td>
<td>High tech</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Semi) Closed GH Venlo Widespan</td>
<td></td>
<td>High tech</td>
<td></td>
<td></td>
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<tr>
<td>Poly Greenhouse Gutter connected</td>
<td></td>
<td>Low tech</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Poly Tunnel Freestanding</td>
<td></td>
<td>Low tech</td>
<td></td>
<td></td>
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<tr>
<td>Simple Protection Shade and Nethouses</td>
<td></td>
<td>Low tech</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walk-in and Low tunnels</td>
<td></td>
<td>Low tech</td>
<td></td>
<td></td>
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<tr>
<td>Direct Cover and Mulch</td>
<td></td>
<td>Low tech</td>
<td></td>
<td></td>
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<tr>
<td>Solar lean to green</td>
<td></td>
<td>Low tech</td>
<td></td>
<td></td>
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<tr>
<td>Open Field</td>
<td></td>
<td>Low tech</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Investment</td>
<td></td>
<td>Low tech</td>
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</tr>
<tr>
<td>Low yield</td>
<td></td>
<td>Low tech</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Survival of the crop</td>
<td></td>
<td>Low tech</td>
<td></td>
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</tbody>
</table>

### Inside technology

- **Low tech**
- **Medium tech**
- **High tech**

**Closed greenhouse**
- Supplement light/LED
- Forced ventilation
- High pressure fogging
- Central heating
- Climate screening
- Local heating
- Motor ventilation
- Natural ventilation
- Automated fertigation
- Automated irrigation
Climate Smart Agriculture

Need for state-of-the-art greenhouses

How we do use water: The water footprint

Let's Go!

Growing better food, better quality, happy family

Source: Wageningen University Research
Climate Smart Agriculture
Comparing high-tech greenhouses and vertical farming

High-tech glass greenhouses
• Significant lower investment cost per m²
• More energy efficient due to:
  • Use of natural light
  • Active ventilation versus HVAC
• Lower labor cost per kg product

Vertical farming
• Best solution for extreme climates
• No influence from outside weather
• 100% controllable indoor climate
• Automated growing on fixed recipe
Greenhouse Goodness

- Houweling’s grows a wide array of tomatoes and cucumbers from staples such as Tomatoes on the Vine, Roma, and Long English Cucumbers to our Sweetoms Grape Tomatoes, Snacking Medleys, Signature Heirlooms and more

- Each Variety is harvested ripe in our greenhouse to achieve the best flavor, consistency and quality that our fans have come to love and demand

- Over 200 acres of year-round, intercropped greenhouse tomatoes and cucumbers

Houweling’s Farms

Partner Farms

- Delta, BC (50 acres)
- Abbotsford, BC (15 acres)
- Mexico (60 acres)
- Camarillo, CA (125 acres)
- Mona, UT (28 acres)
- Mexico (60 acres)
Sustainability Highlights

Our respect for the earth inspires us to innovate and invest in sustainable practices. Our vision for sustainability is based on the principles of environmental soundness, economic feasibility, and social equity.

- Year-round locally grown tomatoes results in drastically fewer emissions related to freight in comparison to imports.
- Hydroponic irrigation & recirculation results in 1/6th the water usage vs. field grown.
- Ability to capture and store rainwater and runoff in 4 acre retention pond and use for irrigation (CA)
- Annual production of 125 acre CA farm is the equivalent KG to over 3000 acres of field.
- Controlled environment allows for increased effectiveness of biologicals & fewer pesticides (IPM)
- Grafted seedlings deliver stronger plants
GROWING A GREENER TOMATO

One of North America's largest greenhouse tomato growers, Houweling's Tomatoes, built the first combined heat and power (CHP) greenhouse project in the U.S. that captures carbon dioxide (CO₂) for use in plant fertilization.

**CO₂ Fertilization Process**
CO₂ from the engine's exhaust is purified and piped into the greenhouse as fertilizer, diverting 32,100 tons of CO₂ yearly, equal to yearly CO₂ emissions of more than 6,000 cars.

**From Waste to Value**
The process provides power, heat, water and CO₂ fertilization for Houweling's Tomatoes' 125 acres in Camarillo, CA.

**Heat**
Heat produced from the engines during power generation — more than 15.9 MW of thermal power — is captured in thermal storage tanks and used to heat the greenhouses.

**Power**
The gas engines provide 13.2 MW of electrical power — enough for approx. 13,200 average homes — to meet greenhouse needs and supply energy back to the community grid.

**Condensed Water**
Water is condensed out of the exhaust gas system, conserving water from the Central Valley, to provide approx. 14,250 gallons of water per day to greenhouse operations.

WWW.HOUWELINGS.COM
HARNESSING WASTE ENERGY:

- Flue gas from Currant Creek power plant stack are diverted to Houweling’s via above ground duct
- Thermal energy is stored on-site for greenhouse heating on-demand
- Waste CO₂ is directed into greenhouse to promote plant growth
- Condensate captured and utilized to supplement irrigation
HOUWELING’S UTAH H₂O

- Flu Gas Condensate (8.3 million US gallons annually)
- Condensation Recovery (off the inside of glass)
- Potential Rainwater Capture
- Well Water
- No Ag run-off, 100% recycled
PANEL DISCUSSION

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CLOSING REMARKS

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Student Challenge:
Design the ultimate urban greenhouse

Students are being challenged to submit an urban greenhouse design which brings professional food production into urban neighbourhoods, connects it with local energy systems and encourages citizens to engage with sustainable production and consume healthy food.

Registration between 1st and 31st October 2017

Check out www.wur.eu/studentchallenges

Could you design the ultimate urban greenhouse?

Wageningen University & Research is organising a Challenge to Design a Sustainable Urban Greenhouse.

Who for? Students in relevant fields at universities or universities of applied sciences

What’s the challenge? Submit an urban greenhouse design which brings professional food production into urban neighbourhoods and encourages citizens to engage with sustainable production and consume healthy food. Spark the future, improve the quality of life!

When’s this happening? Register between 1st and 31st October 2017. You will present your design for an expert jury during the last week of August 2018.

What’s next? Start putting together your dream team now and get ready to Design a Sustainable Urban Greenhouse.

Check out www.wur.eu/studentchallenges

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