

Innovative cultivation systems: new conditions for disease and pest management in protected horticulture

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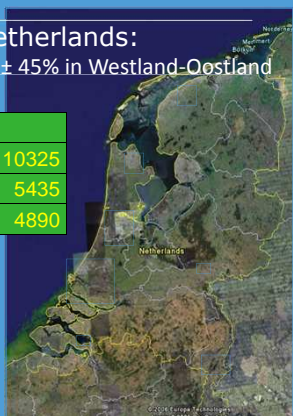
Outline

- Introduction
- Innovative cultivation systems with focus on:
 - Water use efficiency/ reduced water use
 - Energy use efficiency/ reduced CO₂ emission
 - Automation
- New techniques and concepts
- Impact and interaction with crop protection

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Protected cultivation Netherlands: 10000 ha, ± 45% in Westland-Oostland

Total area (ha)	10325
Floriculture	5435
Food	4890



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Protected Horticulture: Vegetables

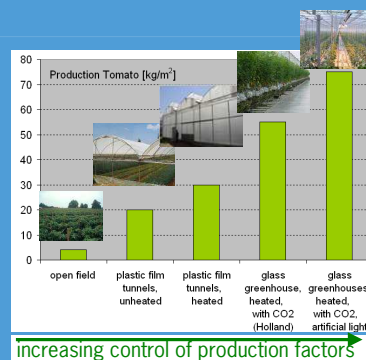


Challenge for sustainable production:

Twice as much with 50% inputs




Twice as much: better controlled conditions




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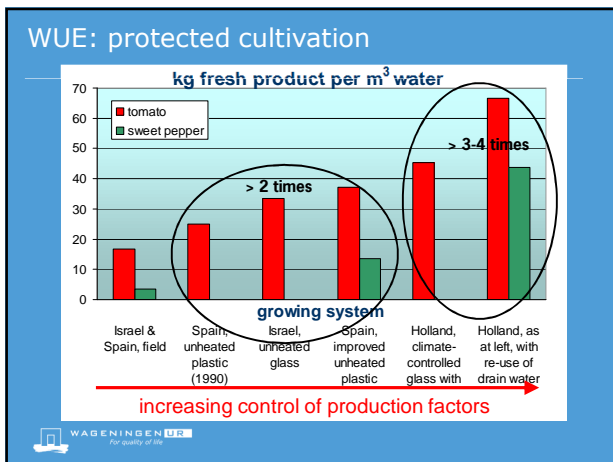
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Water Use Efficiency (WUE)




From soil to substrate & from open to covered





Efficient irrigation/ fertilization strategies


Sensor technology and combination of (soil) physics and physiological information




Lysimeters



Water content meters




Robust tensiometer

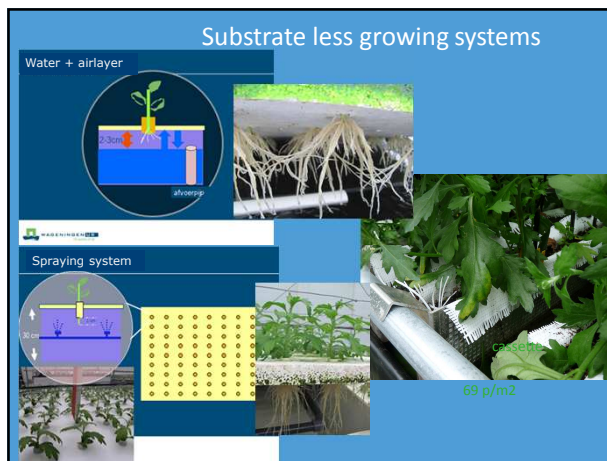
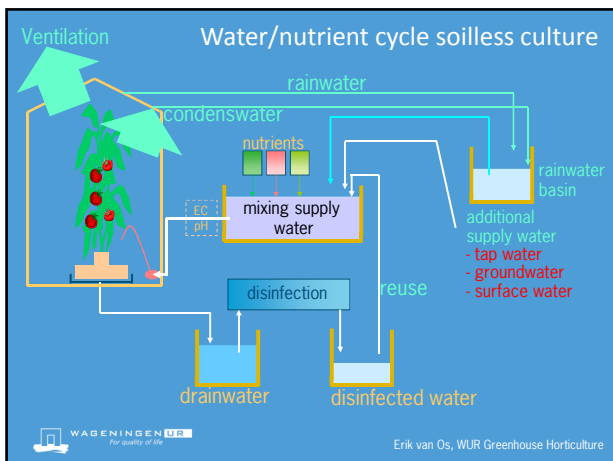


Water Use Efficiency: irrigation based on soil water content

Crop	Water Use traditional (mm)	Water Use optimized (mm)	Water Saving Index (%)
Cucumber (Turkey)	717	545	19
Tomato (Jordan)	425	275	25
Egg plant (Lebanon)	95	71	35
Lettuce (Netherlands)	186	66	69

From Balendonck et al., FlowAid



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Reduction energy use (i.e. CO₂ emission)

Five steps:

1. Maximum use of solar energy
2. Reduction of energy use
3. Efficient conversion, heat storage and re-use
4. Efficient use: unit product per unit energy
5. Replace fossil fuel by other renewable energy sources

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1. Maximum use of solar energy

Radiation = energy, radiation = cropgrowth
Minimal construction parts and optimal transmission of the materials

- Anti reflex coating: +6%
- Shape of the material
 - Nanotechnology: V structure, Principle: multiple reflection increases light transmission

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2. Reduction of energy use: Insulation

Effects of covers at equal control settings for temperature and humidity in greenhouses

Greenhouse cover	(fossil) energy use <i>m³ natural gas/m²</i>
Single (glass)	53 (100 %)
Single (glass) with screen	40 (75 %)
Double cover	40 (75 %)
Double with screen	33 (62 %)
Double with low emission	28 (53 %)
Three layer with low emission	26 (49 %)



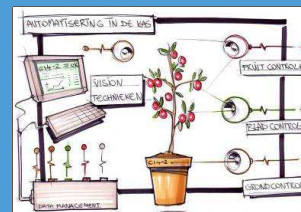
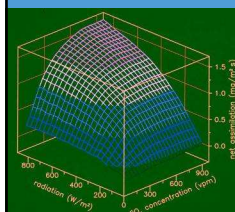
Source: the Solar greenhouse, G.P.A., Bot et al.



4. Efficient energy use: control strategies

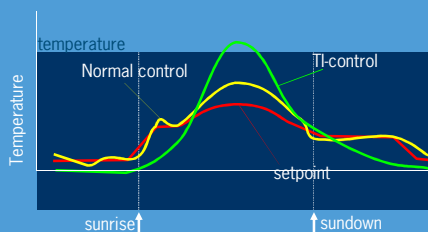
Aim: Optimize crop response (growth, production) with minimal energy input

The key: combine greenhouse physics (energy loss) and physiological information (crop growth)



4. Efficient energy use: control strategies

Temperature Integration



Energy saving: up to 10% lower temperature during heating
higher temperature during sunlight



4. Efficient use by integration of techniques: new growing concept tomato

Changed conditions:

- high insulation (single glass + 2 screens)
- 1°C lower heating temperature
- Increased ventilation set point → more CO₂
- Active cooling
- Humidity set point ventilation > VPD 1.5g/m³
- air circulation



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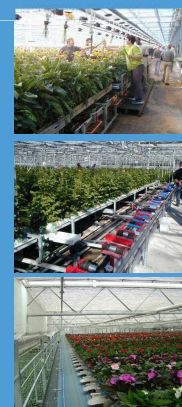
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Automation and optimal use of area


Production systems with high grade of automation and robotics

- Systems with mobile benches, gutters and individual (pot) plants




Automation and optimal use of area

- Multilayer production

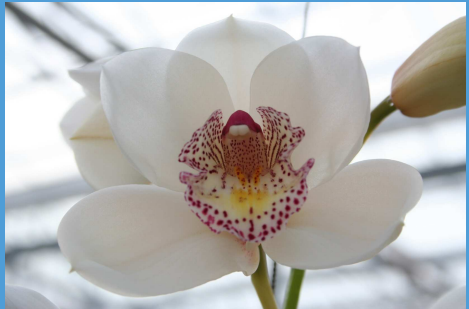



Pictures: Codema




Automation: robotics

- Sorting/grading with vision


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New techniques and concepts



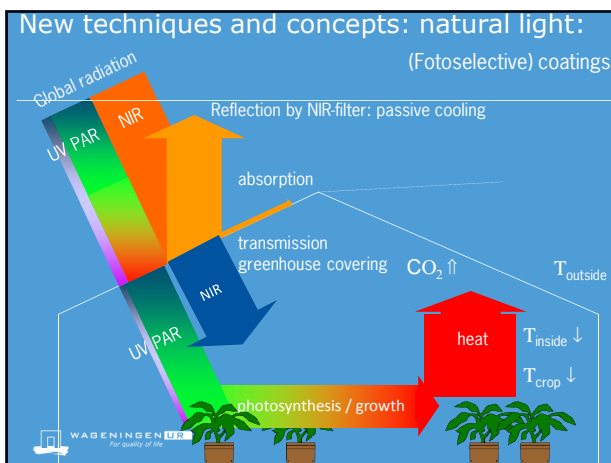
Diffuse light



reference	low haze 27%	high haze 74%
Spring crop 54.4 Kg/m ²	+6.5%	+9.2%
Autumn crop 2008	+8.8%	+9.7%

No light loss 3% less light

Hemming et al.


New techniques and concepts: additional (LED) light




New techniques and concepts

(Semi) closed/ completely controlled greenhouses:

- No or minimum ventilation openings
- Independent control of Temperature, humidity and CO₂
- Water recovery
- Less crop protection
- Higher CO₂ concentration, production increase (to 10-20%)
- Energy saving (+30%)




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Semi closed greenhouses: other climate conditions

- Leaf temperature with cooling from below

top
below
+ cooling

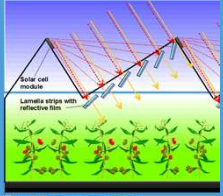
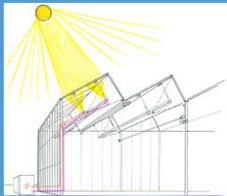
— Gesloten Kas Plant temperatuur boven
— Gesloten Kas Plant temperatuur onder
— Open Kas Plant temperatuur boven
— Open Kas Plant temperatuur onder



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New techniques and concepts: Electricity producing greenhouse

- Separation of solar radiation PAR -- NIR
- Focusing of the NIR or direct radiation (Fresnel system)
- Conversion of radiation to electrical energy (photo voltaic cells)

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New techniques and concepts: Electricity producing greenhouses



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Recent developments: robotics

- Prototype harvesting robot cucumber
- [Harvesting robot cut roses](#)
- Sorting/grading with vision

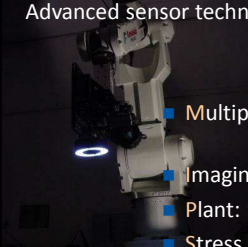




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Exploring new techniques and concepts :

Advanced sensor technology: Multiple Imaging Plant Stress: MIPS as early warning system

- Multiple: chlorofyl fluorescence, colour, Infra red
- Imaging: time samples
- Plant: leaf, plant, crop
- Stress


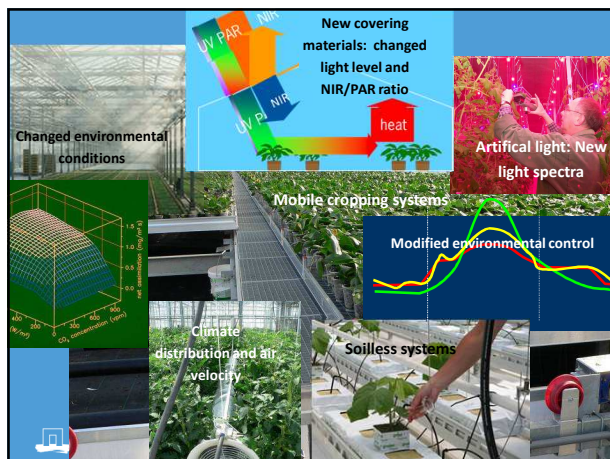



chlorofyl fluorescence colour IR

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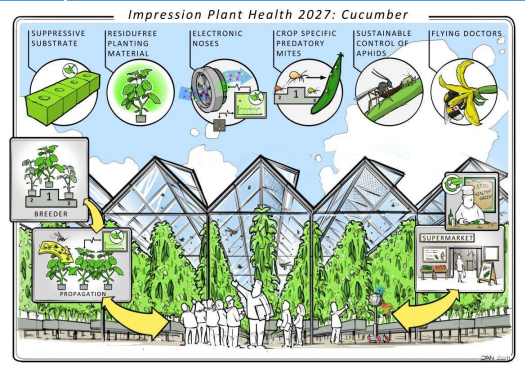

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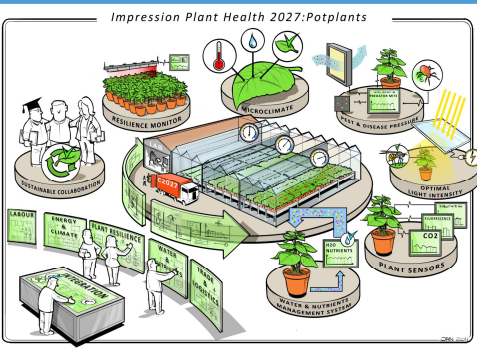

Examples

Impression Plant Health 2027: Cucumber

Examples

Impression Plant Health 2027: Potplants


Development and optimization of new production systems requires integral approach of disease and pest control

Acknowledgements

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