

## Emission-less greenhouses: dream or reality?

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## EUPHOROS: Efficient Use of inputs in Protected HORTiculture

**Aim of the project:**  
In the European protected cultivation to decrease the use of:

- Non-renewable energy
- Water and fertilisers
- Plant protection products
- Substrate waste

Without damage to productivity



## Partners: research institutions

- Wageningen UR Greenhouse Horticulture (NL)
- Estación Experimental de la Fundación Cajamar (ES)
- IRTA – Barcelona (ES)
- Università di Pisa (IT)
- University of Warwick (UK)



## Partners: business


- HortiMaX (NL)
- Ciba poi assorbita da BasF (CH)
- GroGlass (LV)
- Perlite (IT)
- Terra Humana (HU)
- Cooperativa di produttori Morakert (HU), ora sostituita da Szent István University (HU)



## Much good about greenhouses but...


- Even un-heated greenhouse production has a Global Warming Potential equivalent to 250 g<sub>CO2</sub> per kg tomato
- N-leaching can be some 2 g<sub>NO3</sub> per kg tomato  
Euphoros consortium, 2010
- Tomato production is presently hardly profitable across the EU

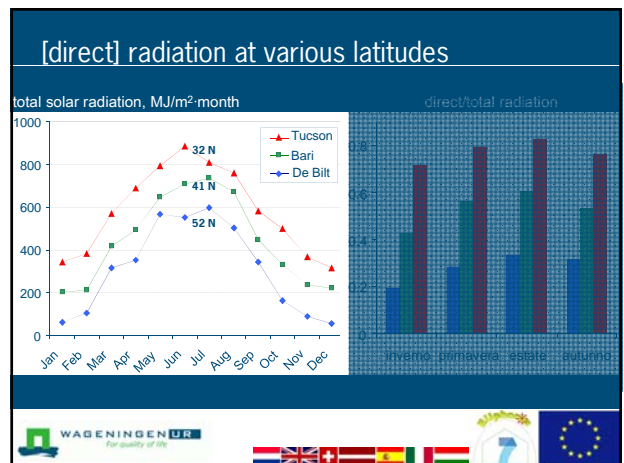
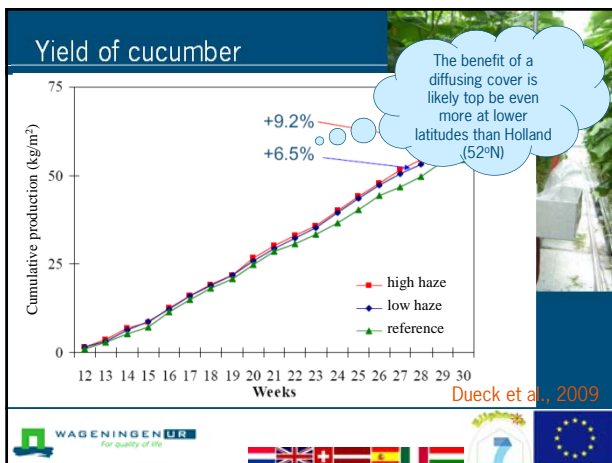
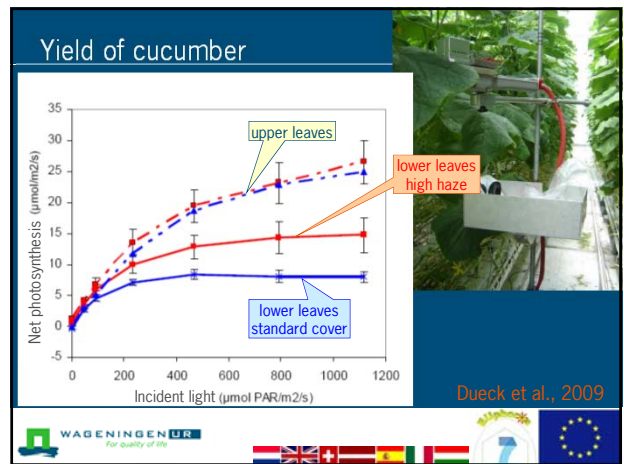
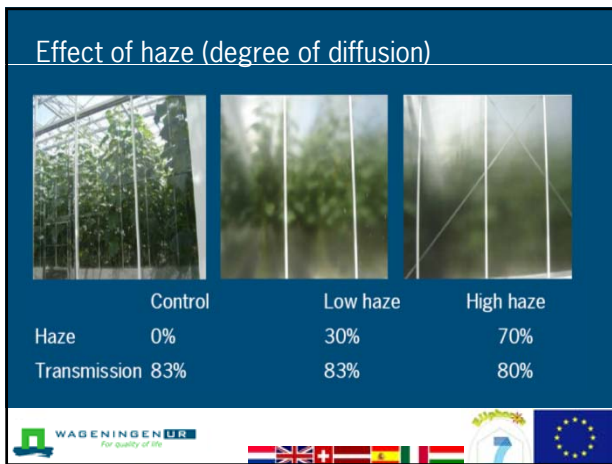
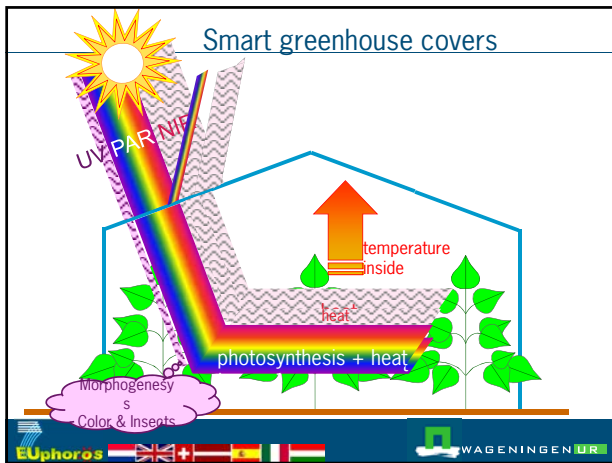
➤ Growers will invest in decreasing emissions only insofar as this improves their balance sheet

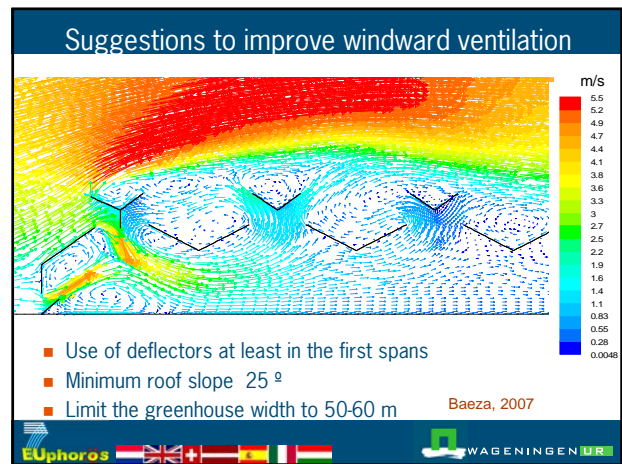
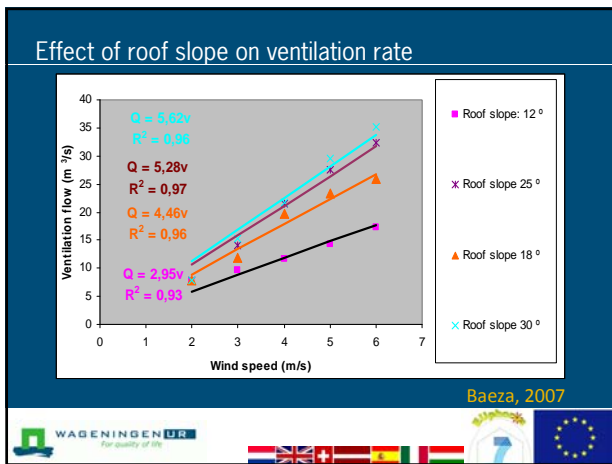
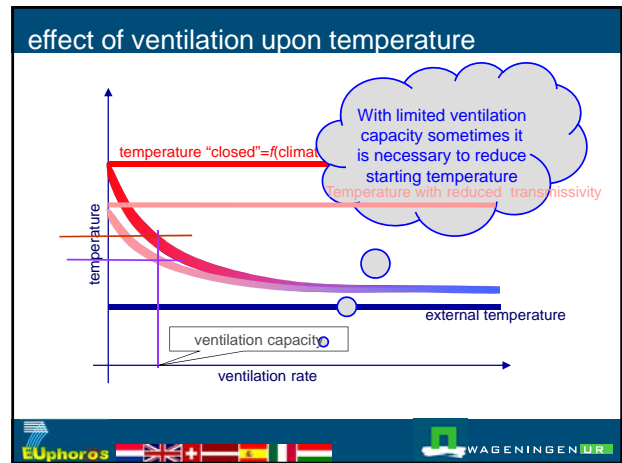
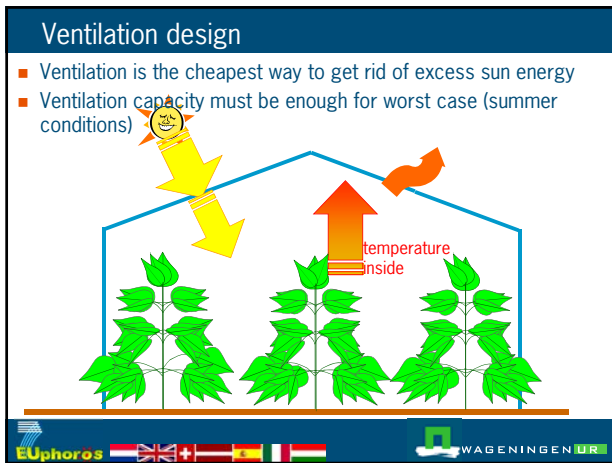


## Examples

- decreasing resource use = smart design
  - cover materials
  - ventilation capacity
- decreasing waste = process management
  - ventilation
  - thermal storage
  - irrigation management
- evaluation of means for decreasing environmental impact of passive greenhouses





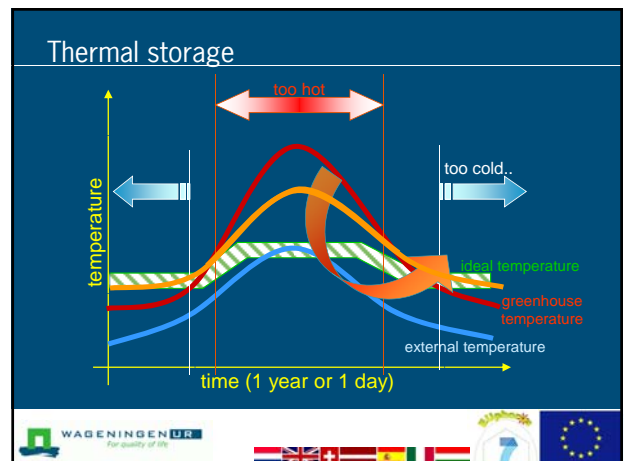
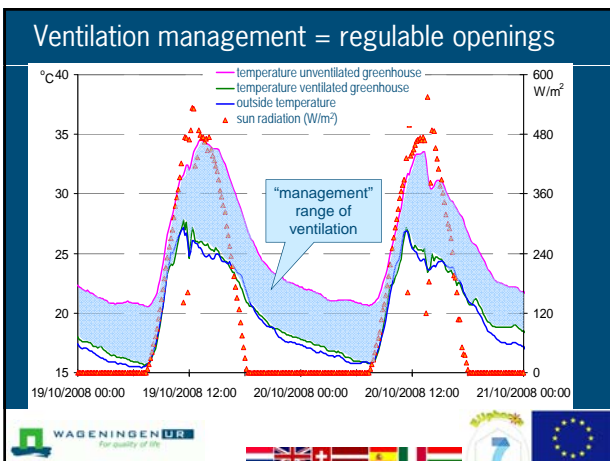
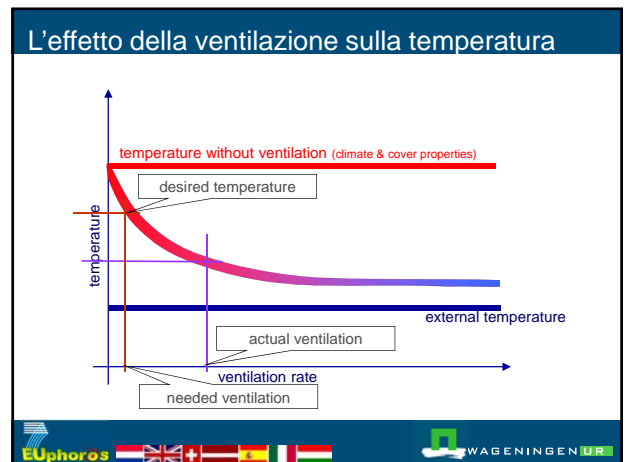




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### Active thermal storage

heating

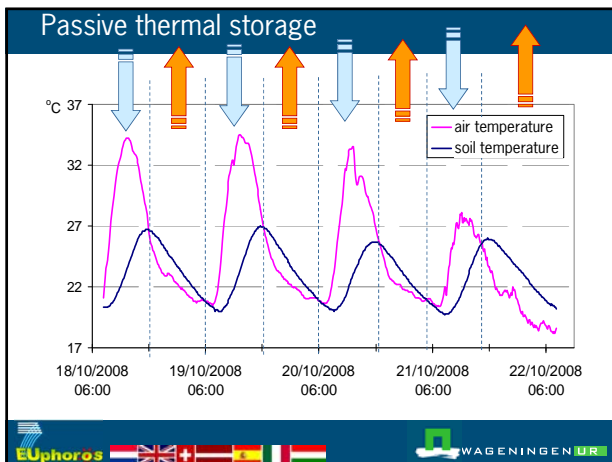
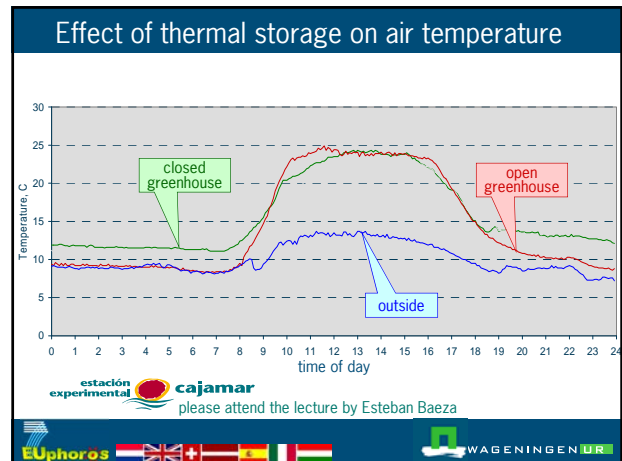
Utilization of warm water

With PERFECT storage a greenhouse has a yearly surplus of energy, EVEN at Dutch latitudes

...and thus much TOO MUCH surplus at lower latitudes!  
→ semi-closed greenhouses

- Low-temperature storage
  - In (underground) water basins, natural or artificial

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### Smart irrigation = less emissions

→ less need for fertilisers

- Fertilisers costs exceed 10% of production costs in Almeria or even 17% in Hungary
  - (Cajamar, 2009; Euphoros consortium, 2010)
- Yet growers are not exactly eager to adopt smart irrigation
  - (Cuadrado Gomez, 2001; Euphoros consortium, 2010)

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### Smart irrigation in soil = water on demand

Treatment	Water Use (mm)	Fertilizer (Kg/ha)	Mean Crop Weight (g)	Class 1 (%)
A (ref)	186	100	516	98.6
B	70	100	528	98.8
C	70	83	592	97.2
D	70	58	595	98.4

Irrigation was sensor-driven and soil water content was controlled to prevent leaching

FLOW-AID consortium, 2010 (EU-FP6)

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### Closed vs open cycle tomato (Italy)

Euphoros consortium, Incrocci, Pisa university: 2010

	Leaching	Supply		Saving %	
		Open	Closed		
Water	$m^3 ha^{-2}$	1067	5334	3982	25
N	$kg ha^{-2}$	211.7	1041	621	40
P	$kg ha^{-2}$	21	196	149	24
K	$kg ha^{-2}$	230.7	1384	1234	11

- Investment could be recovered in 2 years
- Thereafter a saving of some 3500 €/years
- Yet ...
  - Fear of "untested" techniques
  - Poor faith in advisory services
  - Concern for root pathologies


→ The grower won't do it ...unless required by regulations

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### Cumulative evaluation of environmental impact

- Various production systems/countries
- Most promising actions = decreased environmental impact coupled to financial gain
- Implementation in local conditions to evaluate production
- We have determined the environmental impact of the new technologies
- Through Life Cycle Analysis we calculated the decrease of environmental footprint per unit product




### Diminuzione dell'impatto ambientale

#### Tomato production in a multitunnel in Almeria


	Abiotic depletion	Acidificat	Eutrophicat	Global warming	Photoch. oxidation	Cumulative energy
Reducing fertilisers by 30%	3.6	6.0	15.3	9.7	2.7	3.0
Closed loop irrigation	5.2	9.9	48.2	12.3	5.1	4.9
New greenhouse with improved ventilation	42.6	38.8	36.0	39.3	41.8	42.7

M.Torrellas, A. Antón, E. Baeza, J.C. López, J. Pérez Parra, M. Ruijs, N. Garcia, J.I. Montero, 2011



### Conclusion

- There is a strong potential for emission reductions by improving the use of natural resources: particularly sunlight and sun energy
- This is facilitated by technology: innovative structures; process control means
- Other [recycling] technologies are leading towards the zero emissions greenhouse (not discussed here)
- Sustainability is based on three linked issues: environment, economics and social concerns
  - Nothing is achieved until new methods are adopted by growers



### Thanks to:

- Jos Balendonck, Wageningen, NL
- Silke Hemming, Wageningen, NL
- Esteban Baeza, EEFC, ES
- Juan Ignacio Montero, IRTA, ES
- Luca Incrocci, Università of Pisa, IT

Thank you!  
For your attention

Questions?