Reducing the need for external inputs in high value protected horticultural and ornamental crops

SEVENTH FRAMEWORK PROGRAMME
THEME KBBE-2007-1-2-04

WP1 Environmental and economic assessment

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IRTA RECERCA I TECNOLOGIA AGROALIMENTARIES

APPLIED PLANT RESEARCH WAGENINGEN UR

Pisa, March 2009

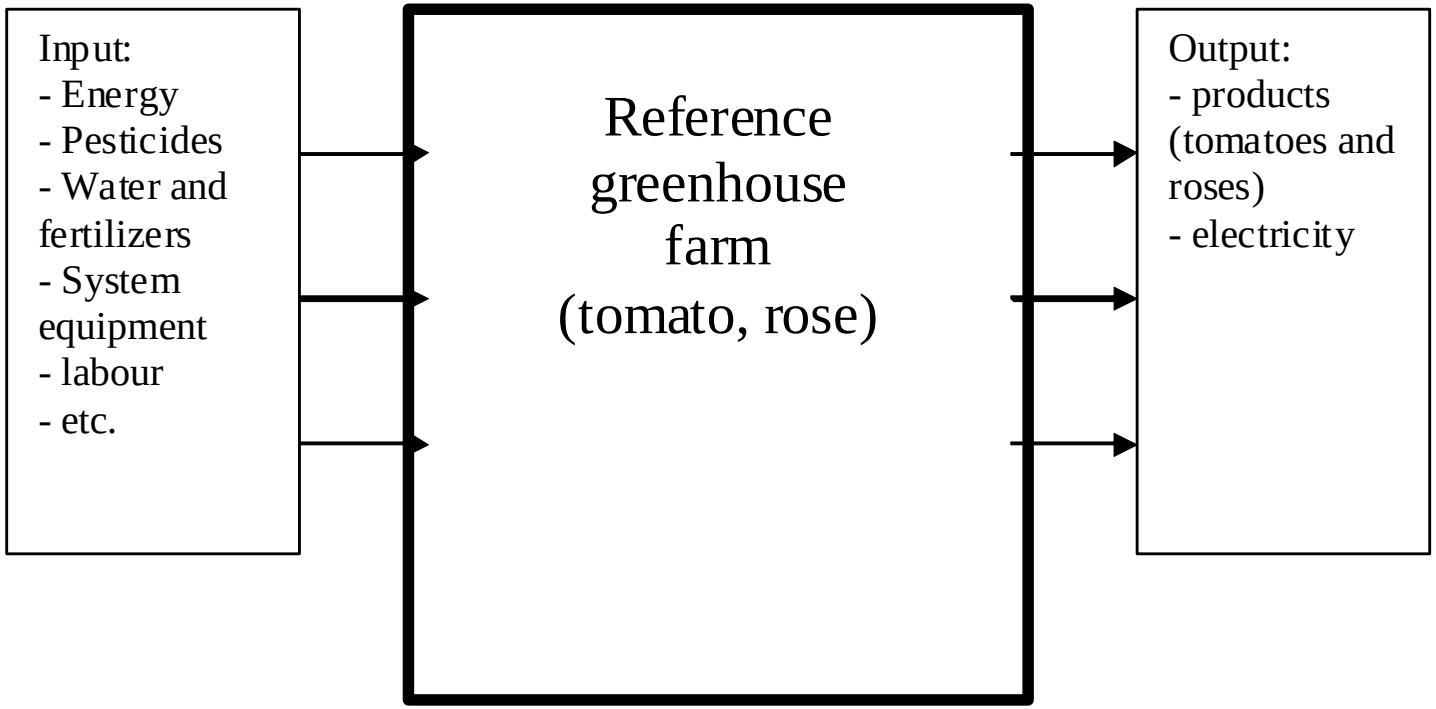
Objectives

1. Environmental and economic analysis of the current situation of greenhouse production in EU
2. To assess the environmental impact of the tools developed in this project.
3. To assess economic soundness (profitability)
4. Analysis of impact and economic soundness of the combinations of tools
5. Greenhouse clusters to minimize the environmental impact

Description of work

Task 1.1 Analysis of the resource inputs and cost-benefits of existing greenhouse operations (IRTA & PPO, with input from all).

Methodology
System boundary of the cost-benefit analysis



Methodology
Cost-benefit analysis

- (Partial) Cost-benefit analysis
  - Goal and system boundary definition
  - Inventory phase
  - Cost-benefit analysis
  - Interpretation
  - Sensitivity analysis

Reference greenhouse farm for four European scenarios

- **Tomato in Venlo structure in The Netherlands**
- **Tomato in Venlo structure in Hungary**
- **Tomato in multi-tunnel structure in Spain**

- **Rose in Venlo structure in The Netherlands**

Dutch tomato in Venlo structure

- **General description**
  - **Greenhouse area: 4 ha (200 x 200 m)**
  - **Building area: ca. 1200 m2**
  - **Cultivation: year round truss tomato (wk 51-48)**

Dutch tomato in Venlo structure

- **Greenhouse structure**
  - **Gutter height: 6 m**
  - **Span width: 8 m; span depth: 5 m**
  - **Glass pane on top, front and side wall**
  - **Covering washer**
  - **High wire system**

Greenhouse structure

Dutch tomato in Venlo structure

- **Climate system**
  - **Water boiler and condenser**
  - **Co-generator (0,5 MW/ha) + combustion gas cleaner**
  - **Pipe heating system: bare pipes and pipe-rail support**
  - **Heat storage tank (350 m3)**
  - **Moveable energy screen: 50% alum, 50% poly-ester**
  - **Roof sprinklers**
  - **CO_2 distribution system**

Climate system

Dutch tomato in Venlo structure

- **Cultivation and fertigation system**
  - **Hanging gutter: rock-wool slabs**
  - **Drip irrigation**
  - **Rainwater tank: 2500 m3/ha**
  - **Fertilizer dosage unit**
  - **Recirculating system**
  - **Drain water disinfection unit (heating)**

Cultivation and fertigation system

Dutch tomato in Venlo structure

- **Other equipments**
  - **Crop protection techniques**
  - **Sorting and packaging machines**
  - **Internal transport**
  - **Other machineries**

Other equipments

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Cost-benefit Dutch tomato farm (4 ha)

Preliminary results

Farm results

		farm	per m2	
Benefits				
Turnover tomatoes		1864500	46,61	
Other output		468000	11,70	
Total output		2332500	58,31	

Costs		farm	per m2	in %
Planting materials		65000	1,63	3
Fertilizers		36000	0,90	2
Water		800	0,02	0
Crop protection agents		20000	0,50	1
Other crop assets		120798,8	3,02	5
Energy		732000	18,30	31
Tangible assets	*depreciation and maintenance*	545459	13,64	23
Paid labour		602000	15,05	26
Contractors		20000	0,50	1
Interest payments		115870	2,90	5
General costs		74000	1,85	3
Total costs		2331928	58,30	100
Net financial result		**572**	**0,01**	

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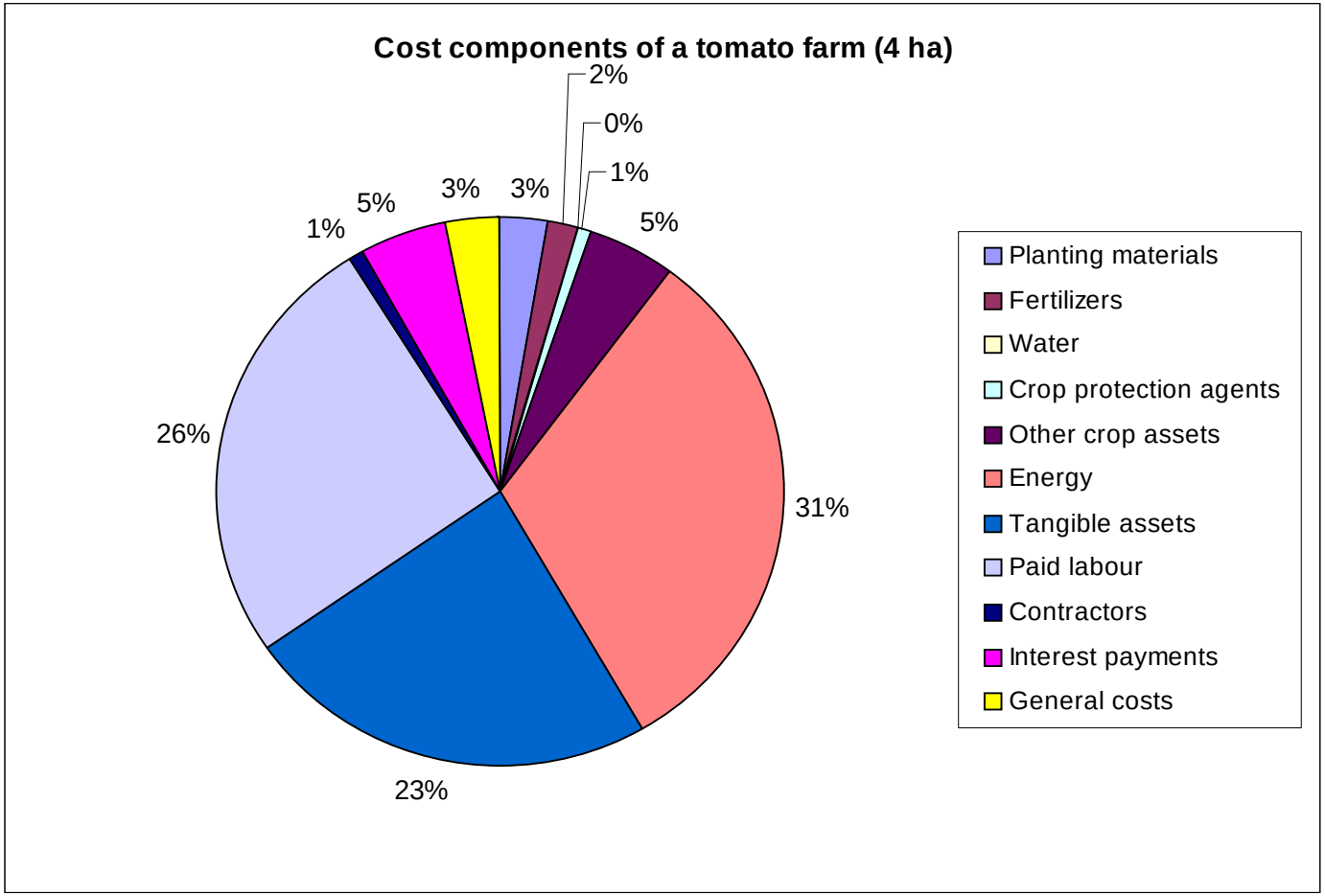
Cost-benefit Dutch tomato farm (4 ha)

Preliminary results



Hungarian tomato in Venlo structure

- **General description**
  - **Greenhouse area: 2,35 ha (256 x 92 m)**
  - **Building area: ca. 650 m2**
  - **Cultivation: year round tomato (wk 50-46)**

Hungarian tomato in Venlo structure

- **Greenhouse structure**
  - **Gutter height: 6 m**
  - **Span width: 8 m; span depth: 5 m**
  - **Glass pane on top, front and side wall**
  - **High wire system**

Hungarian tomato in Venlo structure

- **Climate system**
  - **Geothermal water**
  - **Pipe heating system: bare pipes and pipe-rail support**
  - **Heat (thermal water) storage tank (? m3)**
  - **Circulation fans**
  - **Pure CO_2 (storage tank) and CO_2 distribution system**

Hungarian tomato in Venlo structure

- **Cultivation and fertigation system**
  - **Rock-wool slabs**
  - **Drip irrigation**
  - **Well water tank (? m3/ha)**
  - **Fertilizer dosage unit**

Hungarian tomato in Venlo structure

- **Other equipments**
  - **Crop protection techniques**
  - **Sorting and packaging machines**
  - **Other machineries**

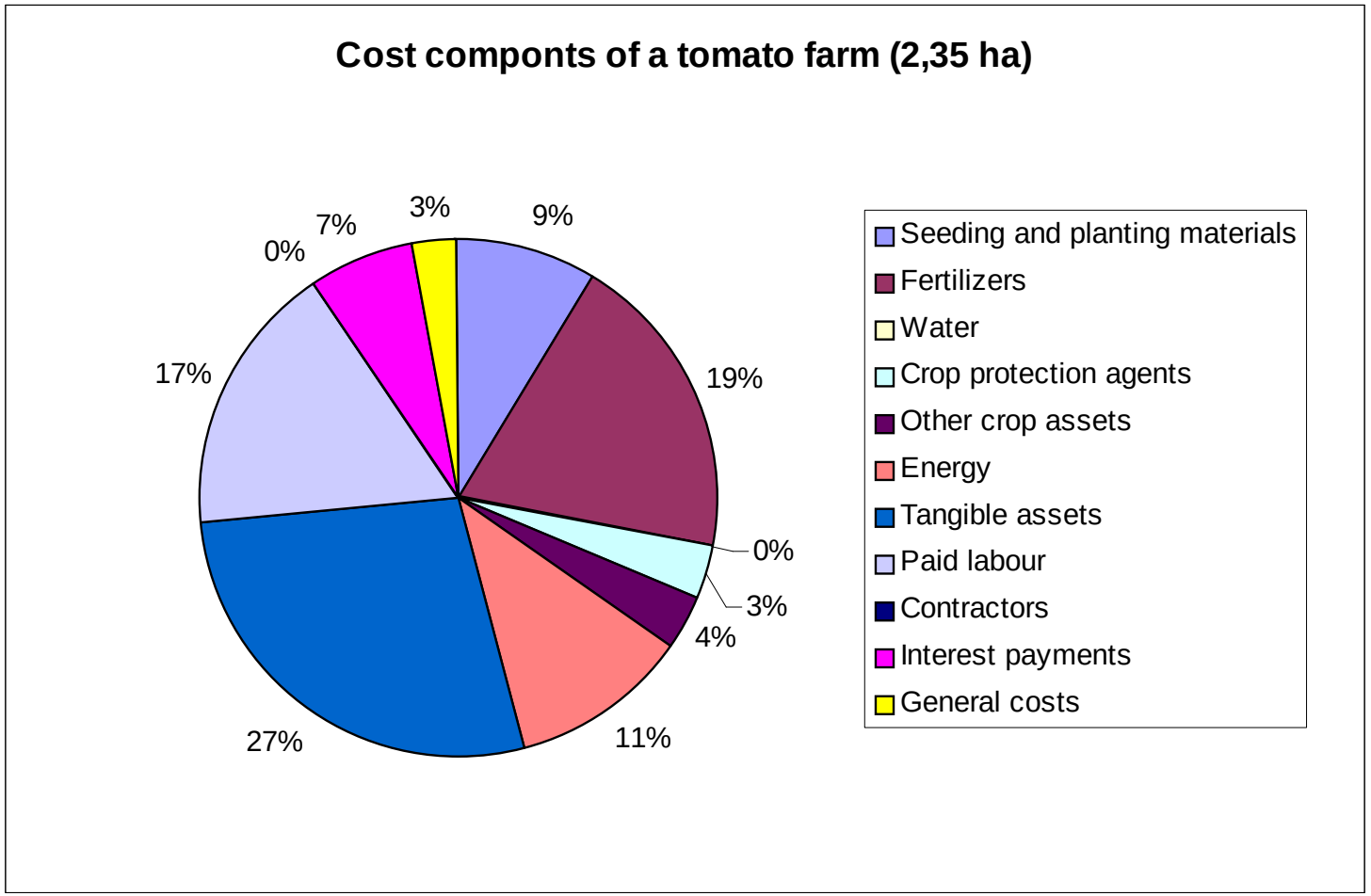
Cost-benefit Hungarian tomato farm (2,35 ha) - Preliminary results

Farm results

	farm	per m2
Benefits		
Turnover tomatoes	871169	36,99
Other output	0	0,00
Total output	871169	36,99

Costs		farm	per m2	in %
Seeding and planting materials		73080	3,10	9
Fertilizers		154556	6,56	19
Water		628	0,03	0
Crop protection agents		25797	1,10	3
Other crop assets		28527	1,21	4
Energy		90146	3,83	11
Tangible assets	*depreciation and maintenance*	222089	9,43	27
Paid labour		139960	5,94	17
Contractors		0	0,00	0
Interest payments		53976	2,29	7
General costs		23552	1,00	3
Total costs		812310	34,49	100
Net financial result		**58859**	**2,50**	

Cost-benefit Hungarian tomato farm (2,35 ha) - Preliminary results



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Dutch rose in Venlo structure

- **General description**
  - **Greenhouse area: 4 ha (200 x 200 m)**
  - **Building area: ca. 1200 m2**
  - **Cultivation: 4 year cultivation of cv. Passion**

Dutch rose in Venlo structure

- **Greenhouse structure**
  - **Gutter height: 6 m**
  - **Span width: 8 m; span depth: 5 m**
  - **Glass pane on top, front and side wall**
  - **Covering washer**

Greenhouse structure

Dutch rose in Venlo structure

- **Climate system**
  - Water boiler and condenser
  - Co-generator (0,6 MW/ha) + combustion gas cleaner
  - Pipe heating system: bare pipes and pipe-rail support
  - Heat storage tank (350 m3)
  - Moveable energy screen: 50% alum, 50% poly-ester
  - Roof sprinklers
  - CO_2 distribution system

Climate system

Dutch rose in Venlo structure

- **Cultivation and fertigation system**
  - **Support benches + gutter: rock-wool slabs**
  - **Drip irrigation**
  - **Rainwater tank: 2500 m3/ha**
  - **Fertilizer dosage unit**
  - **Recirculating system**
  - **Drain water disinfection unit (heating)**

Cultivation and fertigation system

Dutch rose in Venlo structure

- **Other equipments**
  - **Crop protection techniques**
  - **Sorting and packaging machines**
  - **Internal transport**
  - **Other machineries**

Other equipments

Cost-benefit Dutch rose farm (4 ha)

Preliminary results

Farm results

	farm	per m2
Benefits		
Turnover roses	4320000	108,00
Other output	300000	7,50
Total output	4620000	115,50

Costs		farm	per m2	in %
Seeding and planting materials		131750	3,29	3
Fertilizers		46000	1,15	1
Water		4800	0,12	0
Crop protection agents		120000	3,00	3
Other crop assets		257500	6,44	6
Energy		1653000	41,33	36
Tangible assets	*depreciation and maintenance*	1007805	25,20	22
Paid labour		997600	24,94	22
Contractors		14000	0,35	0
Interest payments		185977	4,65	4
General costs		120000	3,00	3
Total costs		4538432	113,46	100
Net financial result		**81568**	**2,04**	

IRTA RECERCA I TECNOLOGIA AGROALIMENTARIES

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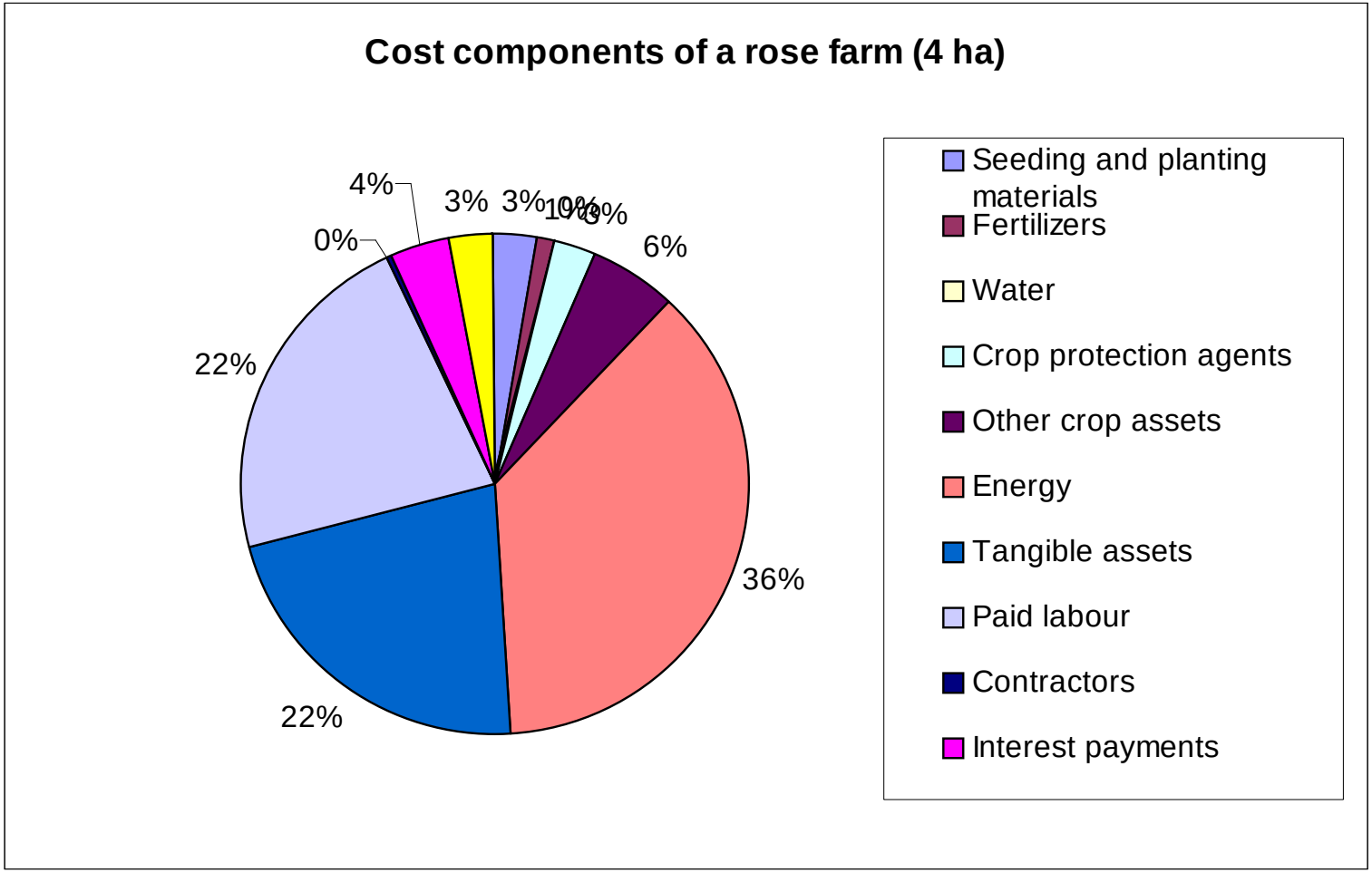
Pisa, March 2009

Cost-benefit Dutch rose farm (4 ha)

Preliminary results



Spanish tomato in multi-tunnel structure

- **General description**
  - **Greenhouse area: ca. 1 ha**
  - **Building area: ca. 350 m2**
  - **Cultivation: tomato (wk 38-23)**

Spanish tomato in multi-tunnel structure

- **Greenhouse structure**
  - **Gutter height: 3 m**
  - **Span width: 7,5 m**
  - **Plastic film on top, front and side wall**
  - **High wire system**

Spanish tomato in multi-tunnel structure

- **Climate system**
  - **Natural ventilation system**
  - **No heating system**
  - **No fans**
  - **No additional CO_2**

Spanish tomato in multi-tunnel structure

- **Cultivation and fertigation system**
  - **Bags with perlite**
  - **Drip irrigation**
  - **Rainwater and well water tank (? m3/ha)**
  - **Fertilizer dosage unit**

Spanish tomato in multi-tunnel structure

- **Other equipments**
  - **Crop protection techniques**
  - **Sorting and packaging machines (collective?)**
  - **Other machineries**

Cost-benefit Spanish tomato farm (1 ha)

Preliminary results

- **Unfortunately no results because of incomplete data**

Summary of most relevant cost components in reference situation

Most relevant cost components	*The Netherlands*		*Hungary*
	Tomato	*Rose*	*Tomato*
	%	%	%
Equipment	23	22	27
Labour	26	22	17
Plant material	3	3	9
Energy	31	36	11
Fertilizers	2	1	19
Pesticides	1	3	3

Economic opportunities of input reductions

- **Input reduction offers perspectives to invest in:**
  - **Equipment (hardware): investment capacity**
  - **Management support tools (software): investment capacity**
  - **Management control: operational management on the field of energy, pest control and nutrition**
  - **Example: Canopy density spraying (PRI)**

Investment capacity of the reduction of different inputs

Dutch tomato in Venlo structure (4 ha)

Costs component		Reduction in costs 10% = euro/m2	50% = euro/m2	Annual equipment costs * %	Investment capacity at 10% euro/m2	at 50% euro/m2
energy	total	1,8	9,2	17,5	10,5	52,3
	gas	1,6	8,0	17,5	9,1	45,7
fertilizers		0,1	0,5	20	0,5	2,3
pesticides		0,1	0,3	20	0,3	1,3

* sum of depreciation, maintenance and interest (%)

Investment capacity of the reduction of different inputs

Hungarian tomato in Venlo structure (2,35 ha)

Costs component		Reduction in costs 10% = euro/m2	50% = euro/m2	Annual equipment costs * %	Investment capacity at 10% euro/m2	at 50% euro/m2
energy	total	0,4	1,9	17,5	2,2	10,9
	thermal water	0,2	1,0	17,5	1,1	5,7
fertilizers		0,7	3,4	20	3,4	17,2
pesticides		0,1	0,6	20	0,6	2,9

* sum of depreciation, maintenance and interest (%)

Investment capacity of the reduction of different inputs

Dutch rose in Venlo structure (4 ha)

Costs component		Reduction in costs 10% = euro/m2	50% = euro/m2	Annual equipment costs * %	Investment capacity at 10% euro/m2	at 50% euro/m2
energy	total	4,1	20,7	17,5	23,6	118,1
	gas	2,5	12,7	17,5	14,5	72,6
fertilizers		0,1	0,6	20	0,6	2,9
pesticides		0,3	1,5	20	1,5	7,5

* sum of depreciation, maintenance and interest (%)

Potential extra operational pest control

Reference situation	*Possible extra pest control due to pesticide reduction*			
	at 10%	at 50%	at 10%	at 50%
	hours/ha	hours/ha	hrs/ha.wk	hrs/ha.wk
Dutch tomato *	**31**	**156**	**0,6**	**3,1**
Hungarian tomato **	**144**	**719**	**2,9**	**14,4**
Dutch rose *	**188**	**938**	**3,8**	**18,8**

* 16 euro/hour
** 8 euro/hour

Economic opportunities Example

- **Canopy Density Spraying - PRI©**
  - Sensor steered spray-tops
  - Crop oriented application technique
  - Expected pest reduction up to 90%

  - Investment capacity:
    - Assumption: 50% crop oriented crop protection agents
    - Input reduction: 90% of 50% pesticides costs > 45%
  - Results:
    - Dutch tomato farm: 1,15 euro/m2 or 45,000 euro (4 ha)
    - Hungarian tomato farm: 2,60 euro/m2 or 60,000 euro (2,35 ha)
    - Dutch rose farm: 6,75 euro/m2 or 270,000 euro (4 ha)

Monitoring effects of input reductions from economic point of view

Recommended variables for monitoring

(besides savings of energy, pesticides and fertilizers)

Variable	Potential effect (0: none; +: higher; -: lower)
• Yield and yield related costs	0/-/+
– labour	
• Product quality (super/1e/2e class)	0/-/+
• Investments	+
– hardware/software/operational management	
• Costs of other crop assets	0/+/-
• Not foreseen	0/+/-