UNIVERSIDAD DE ALMERÍA

FUNDACIÓN cajamar

The greenhouse vegetable production system of south-eastern Spain

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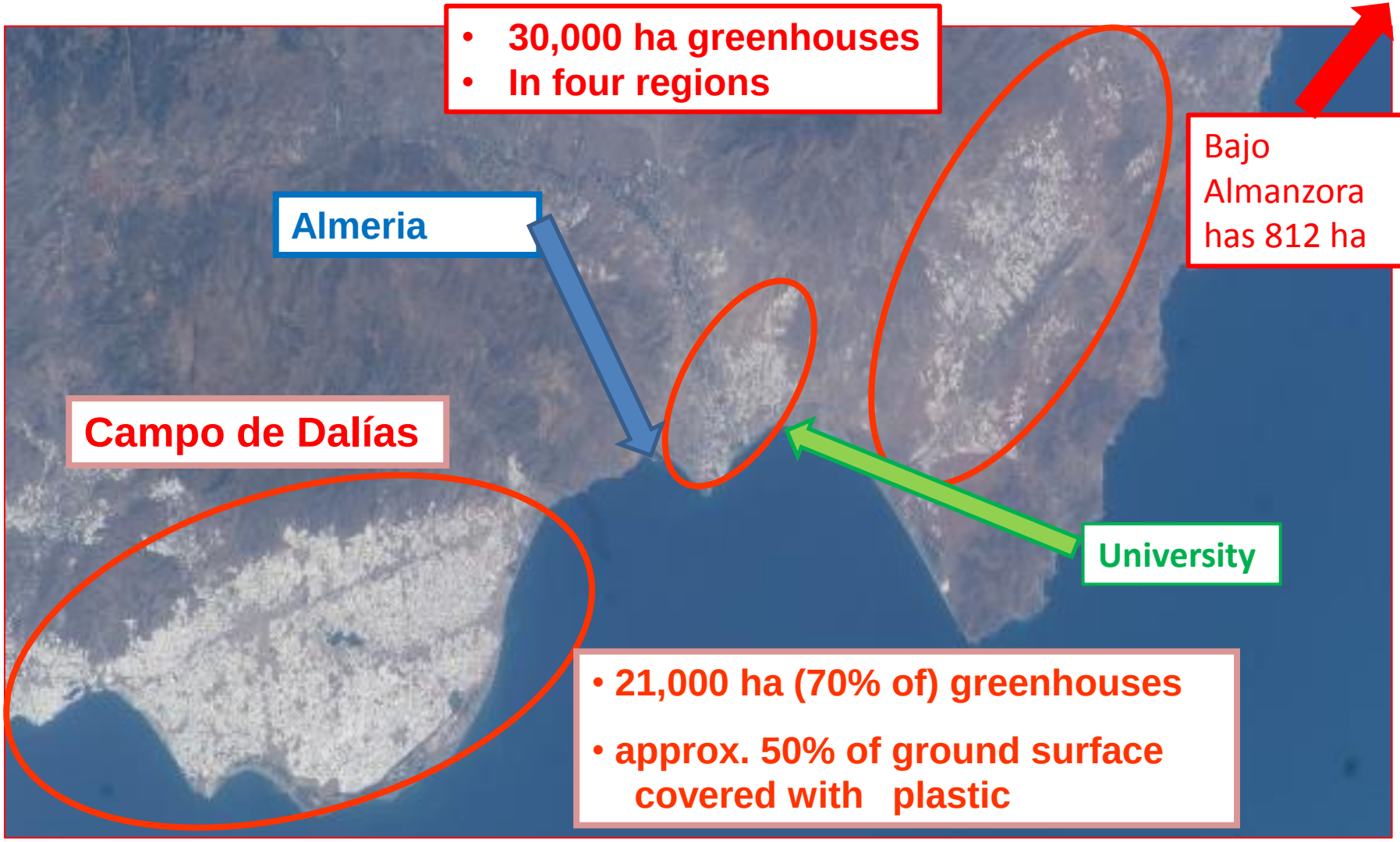
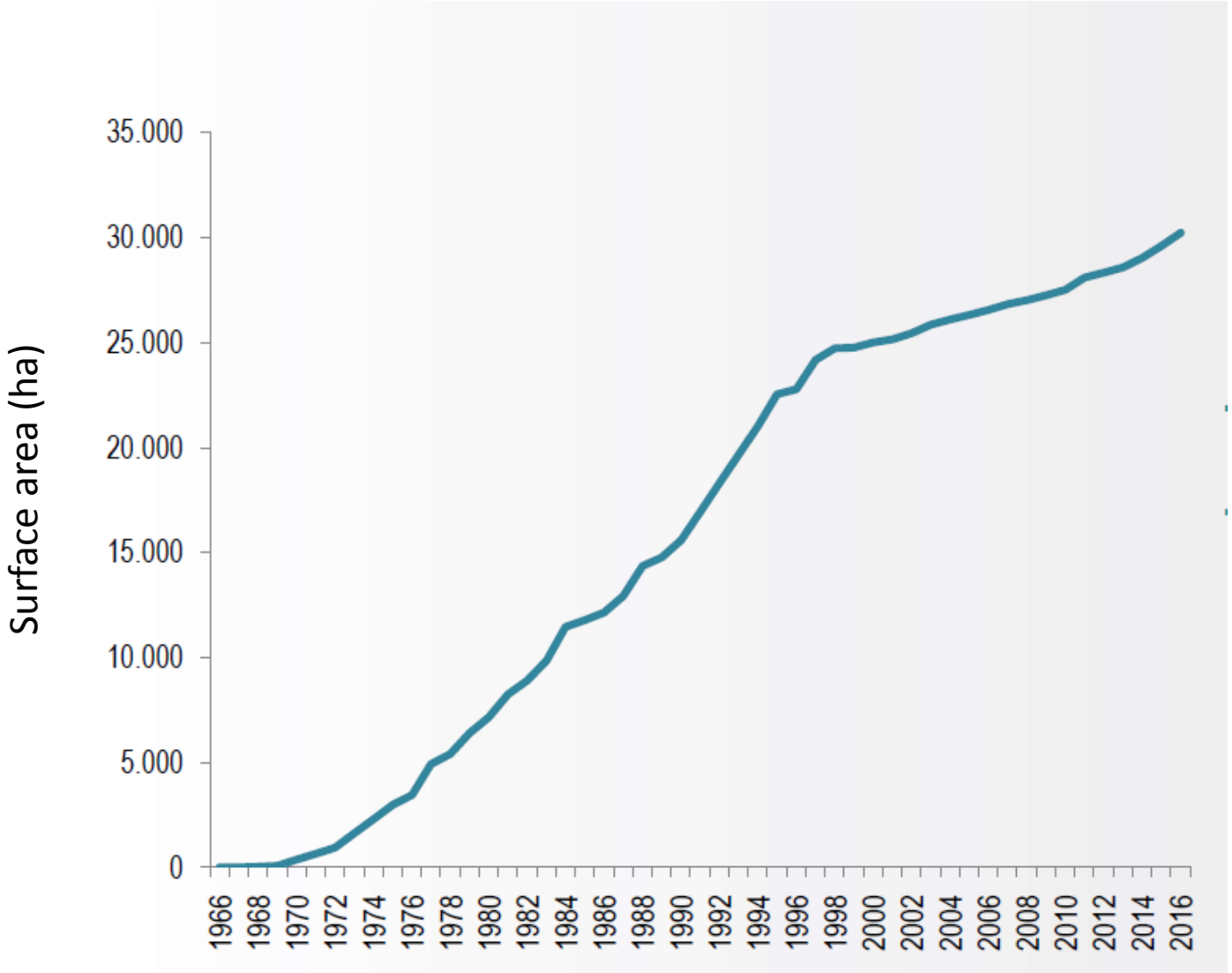
Almeria - The Sea of Plastic

Greenhouse Vegetable Production in Almería



Evolution of surface area of greenhouses in Almeria



Source: Foundation Cajamar

The vegetable industry of Almeria - 1

- Out of season production
- Earlier production than outdoor crops
- Low to medium level technology

Compared to The Netherlands & Belgium

The vegetable industry of Almeria - 2

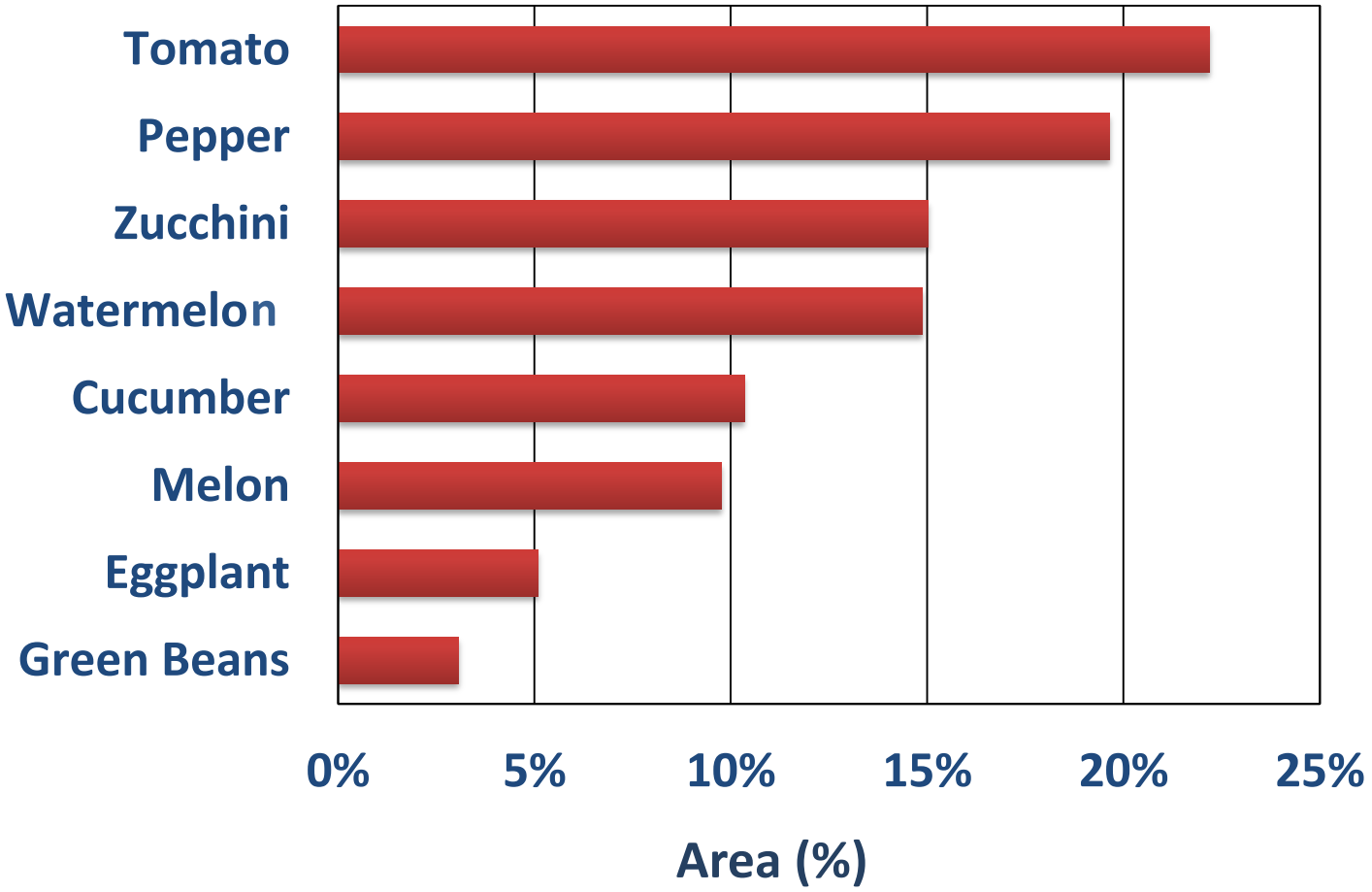
- Total value in 2014 of 1,740 million €
- 70% of production is exported
- 40% of vegetable exports from Spain
- Mostly to NW Europe
- Economic miracle in a previously poor region

Source: "Anuario de Agricultura 2014", Junta de Andalucía

Climatic characteristics of Almeria

- Average of 220 mm rainfall per year
- Mediterranean climate
- Highest number of sunshine hours in mainland Europe
- Mild winters, average winter air temp. of 14°C
  - Permits all year production
- Cooling required with most crops from mid spring to mid autumn

Main crops grown in Almeria (2012-2013)

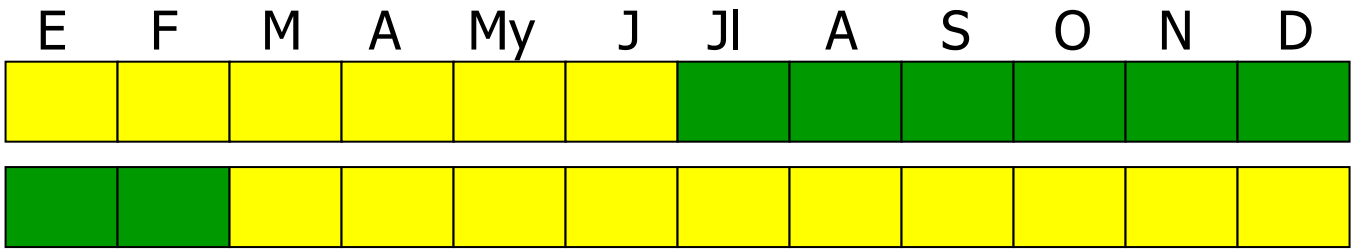


Source: Conserjería de Agricultura y Pesca, Junta de Andalucía 2014

Main cropping cycles in Almeria

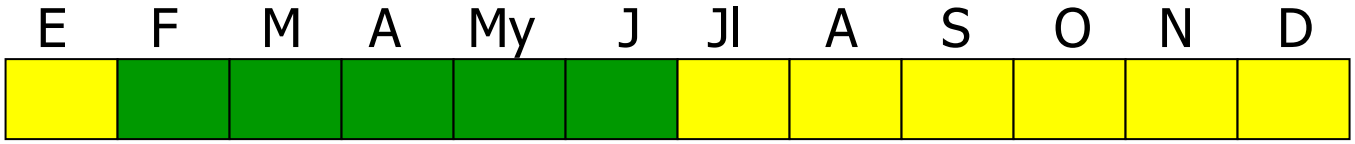
A) Short cycle-Autumn-winter

Tomato, pepper, cucumber, zucchini, eggplant, green beans



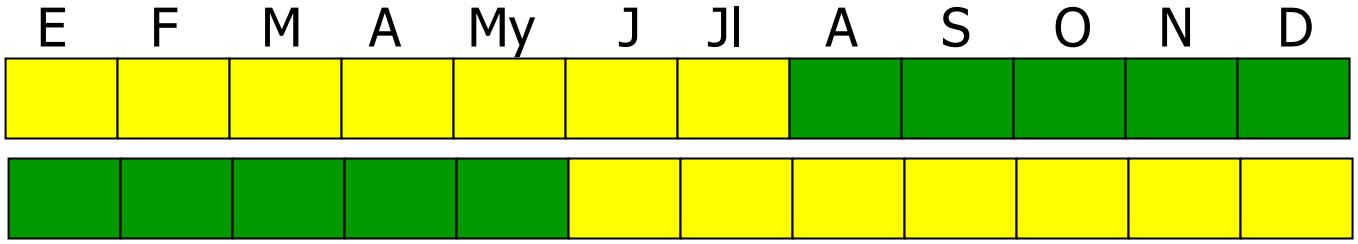
B) Short-cycle-Spring

Watermelon, melon

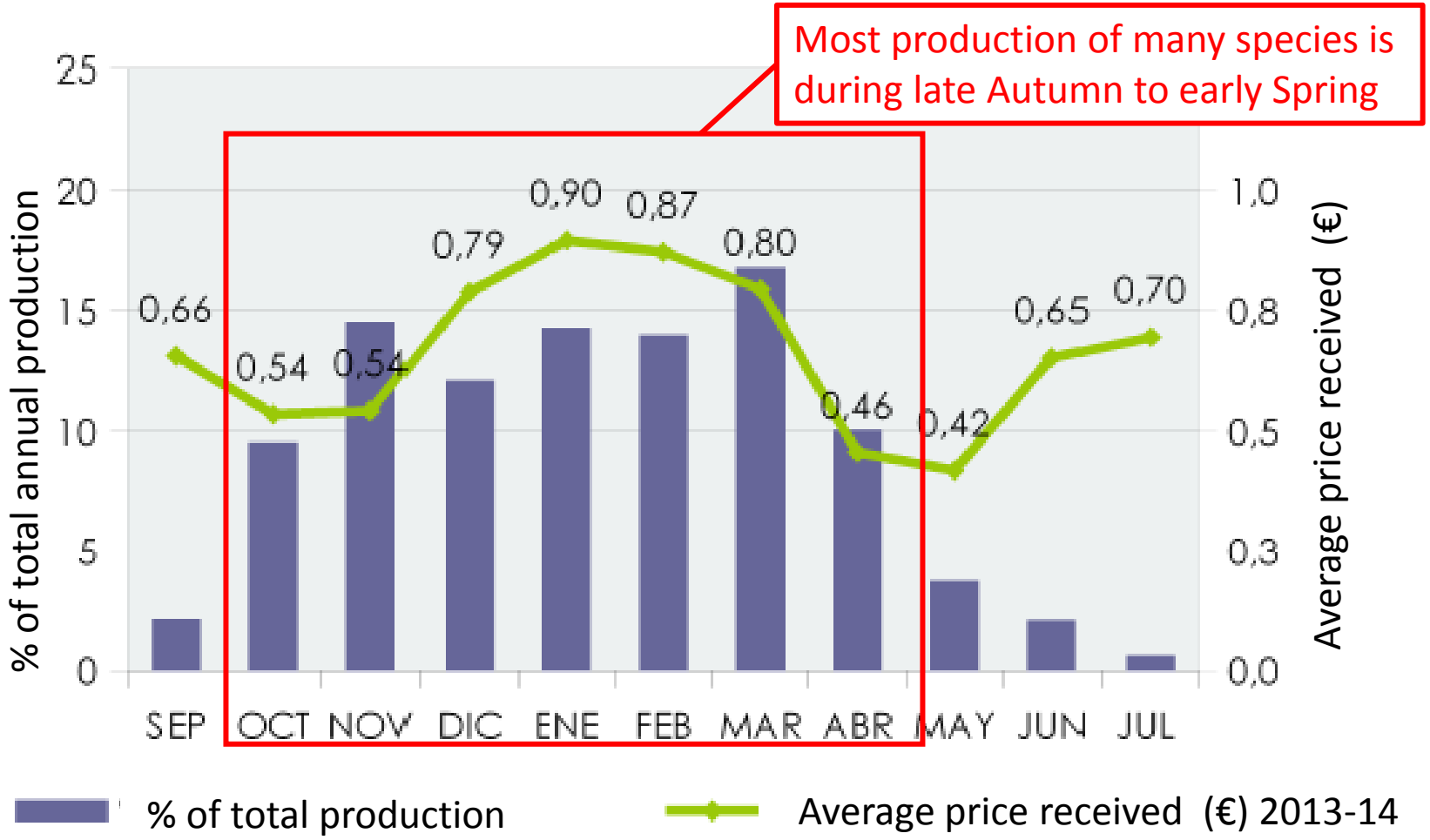


C) Long-cycle-Autumn-Spring

Tomato, eggplant, pepper



Distribution of production of pepper in Almeria greenhouse system (and price of produce)



Source: Evaluación de la campaña de hortícolas protegidos. Almería 2013-2014. Observatorio de precios y mercados. Agencia de gestión agraria y pesquera de Andalucía Consejería de agricultura, pesca y desarrollo rural

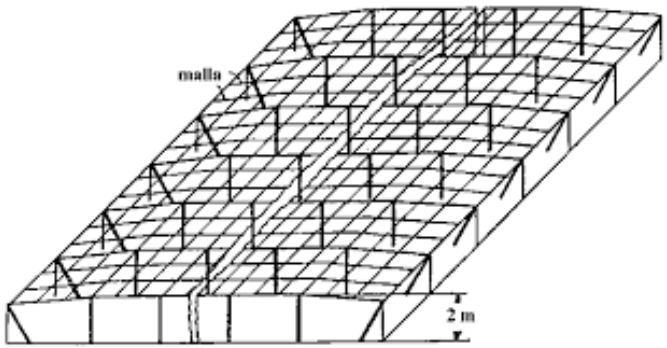
Average crop yields for vegetable crops grown in greenhouses

Crop	Yield (kg/m^2)
Tomato	**9.8**
Pepper	**6.8**
Cucumber	**9.0**
Watermelon	**6.0**
Melon	**3.6**
Eggplant	**8.1**
Zucchini	**6.1**
Green beans	**2.0**

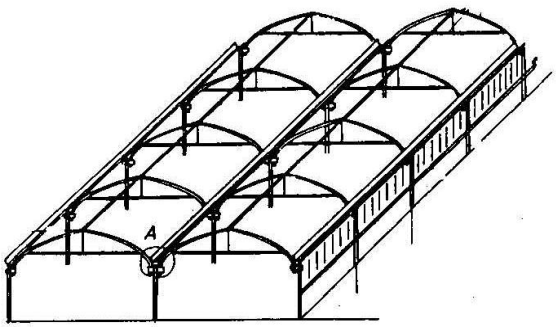
- These are average data
- Variations with cycles, zones, varieties etc.
- Long cycle tomato, average is 15 kg/m^2

Source: Anuario de Estadística Agraria 2013, Ministerio de Agricultura, Pesca y Alimentación

Principal greenhouse structures



Modelo "parral"
"Parral" greenhouse



Invernadero tipo multitúnel
Multi-span greenhouse

There are various forms of the “parral”

- Horizontal roof: 29% of area
- “saw-toothed” roof: 64% of area
- asymmetrical roof: 5% of area

Multi tunnel - 2% of area

“saw-toothed” roof known locally as “raspa y amagado ”

Traditional “parral” greenhouses

Modern “parral” greenhouses

Multi span “parral” with saw-toothed roof

Multi tunnel

Characteristics of greenhouses

- Average area of greenhouse = **0.86 ha**
- Mostly **passive climate control**

Height

Type of structure	Height (m)
Simple flat roof ("parral")	2.8
Modern parral, with multiple sections	4.0
Multi-tunnel	4.2

Greenhouse covering materials

- **Low Density Polyethylene (LDPE), Tri-layer, 200 µm:** 91%
  - Two layers LDPE
  - One layer EVA
- **Low Density Polyethylene (LDPE), single layer, 180 µm**: 9%
- **Ethylene Vinyl Acetate (EVA)**
  - used as a co-polymer,
  - As intermediate layer in tri-layer with two layers of LDPE
  - Good thermal properties
- **Generally, approximately 60% of solar radiation (SR) is transmitted**
- **White washing of plastic cover**
  - Main form of cooling (in addition to ventilation)
  - Reduces transmission of SR to 20 – 45%

Windows for ventilation

- **Side windows**
  - All greenhouses have
  - Traditionally, not large enough
    - Combined with low height ➡ micro climate problems
- **Roof windows**
  - Now 90% have
  - Previously, there was much less
  - Important for effective air movement
- **Mesh used on all windows**
  - To prevent insect entry
  - Issues of how mesh affects air flow

Greenhouse cooling

- Generally required for March to October
- Most crops
- Not for melon, watermelon

Cooling systems

White washing (97%)

Fogging systems (23%, from 6% in 2005/06)

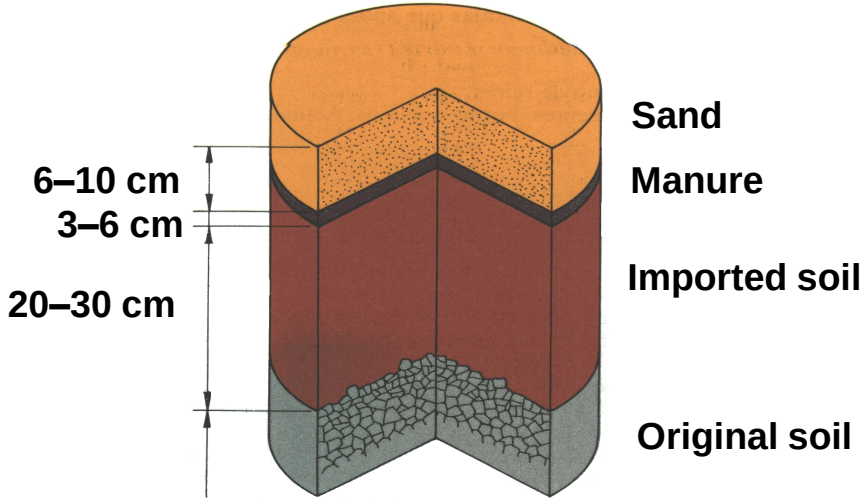
Screens (2%)

WHITE WASHING: Application of calcium carbonate suspension

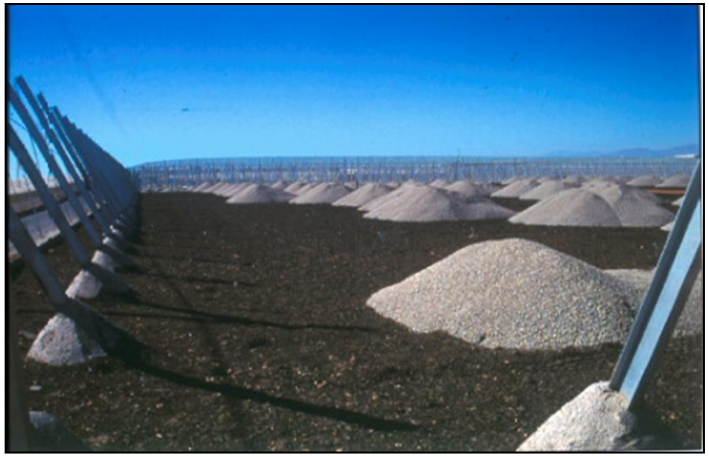
Cropping media – soil

- 90% crops in soil (mostly artificial "enarenado" soils)
  - 20–30 cm of imported loam soil over natural soil
  - Traditionally, large manure application (300–600 m^3 ha^{-1}) at greenhouse construction
    - 2,500–5,000 kg N ha^{-1}
  - 8–10 cm sand mulch on top
  - Traditionally, additional manure every 2–5 years; now less common
  - Now, commonly organic matter "products" added through fertigation

Profile "enarenado" soil



Manure application at GH construction



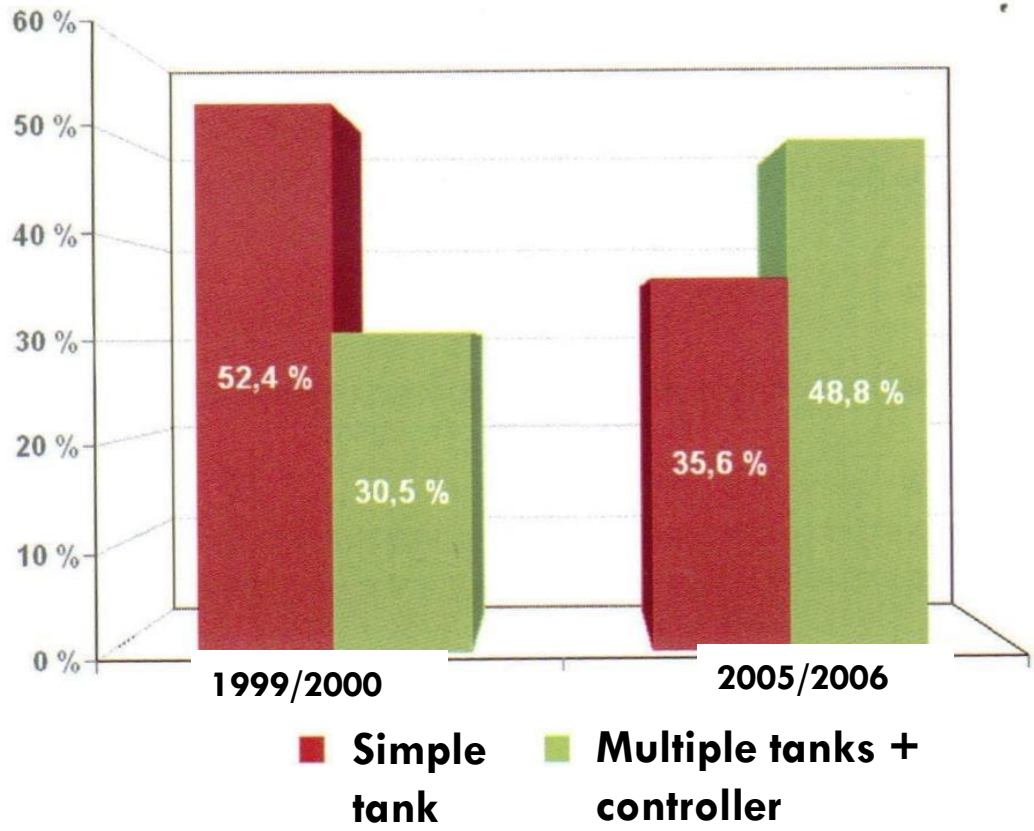
Cropping media – substrate

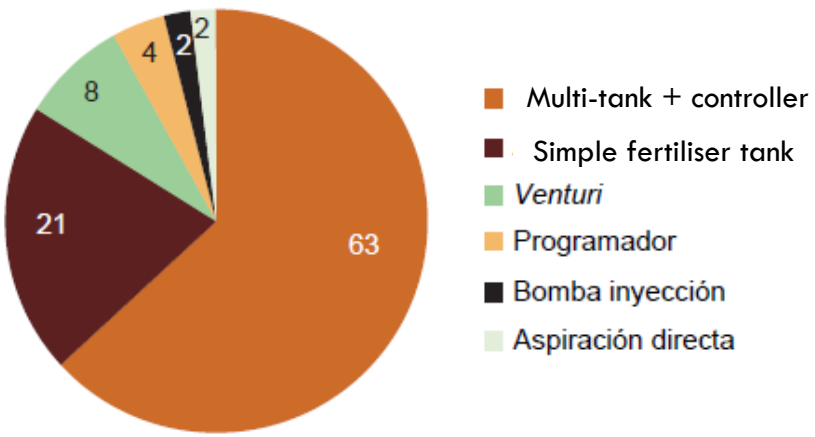
- 10% of crops in “open”substrate (hydroponic) systems
  - Perlite
  - Coconut fibre
  - Rockwool
- Vast majority are free-draining “open” systems
- Salinity of groundwater used is issue for re-circulation
- Tendency to abandon substrate – v. demanding, little advantage

General characteristics of irrigation in greenhouse crops in Almeria in soil

- **Above-ground drip sys**tems
  - 79% inter line
  - 21% auto-compensating
  - Flow rates: 2–4 L/h (generally 3 L/h)
- **Used with fertigation**
- **Average water use**: 500 mm/year
- **Variable water quality**
  - Mostly groundwater (80% of water)
  - Groundwater EC: 1.5 - 4.0 dS/m
  - Increasing EC an issue
- **In substrate** – demand tray system
  - To be explained at Las Palmerillas

In Almeria, has been a very rapid transition from simple fertilizer tank to multi-tank systems with programmers





Commonly, nutrients added on basis of concentration

- Commonly, COMPLETE nutrient solutions
- Nutrient solutions very similar to those used for substrate crops
- Generally, nutrients applied in all irrigations
- Little consideration for nutrients supplied by manure/in soil
- Issues for growers regarding composition of nutrient solution:
  - Balance between vegetative and reproductive growth (N, EC)
  - Fruit quality (EC, K)
  - Concentrations of each nutrient
  - Ratios of nutrients; e.g. N:K, Mg:Ca

Example of standard nutrient solution for MELON, adjusted for phenological phases for multiple tank system (Almeria)

Crop phase	NO_3^- (m*M*)	$H_2PO_4^-$ (m*M*)	SO_4^{2-} (m*M*)	K^+ (m*M*)	Ca^{2+} (m*M*)	Mg^{2+} (m*M*)
Until first flowers	**8**	2.5	2.5	5	4	2
Flowering & Fruit set	**10**	2	2	7.5	6	2
Fruit expansion	**13**	1.5	2	8.5	5	2
Maturation	**11**	1	1.5	7	4	2

Source: Fernandez, E.J. and Camacho, F. (2008). Manual practico de Fertirrigación. Ediciones Agrotecnicas.

N balance for Campo de Dalias

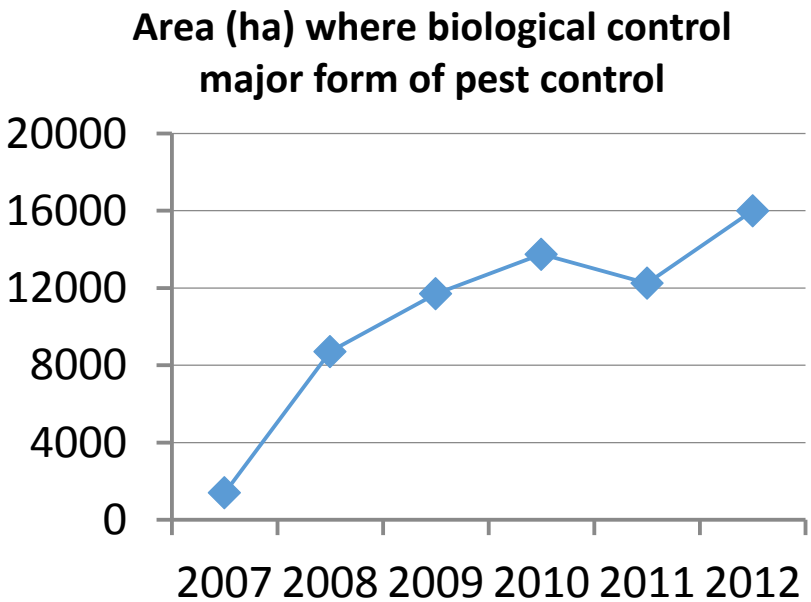
	1987	1997	2007
	(kg N ha^{-1})	(kg N ha^{-1})	(kg N ha^{-1})
Excess N supply over N removed	**1058**	**670**	**517**

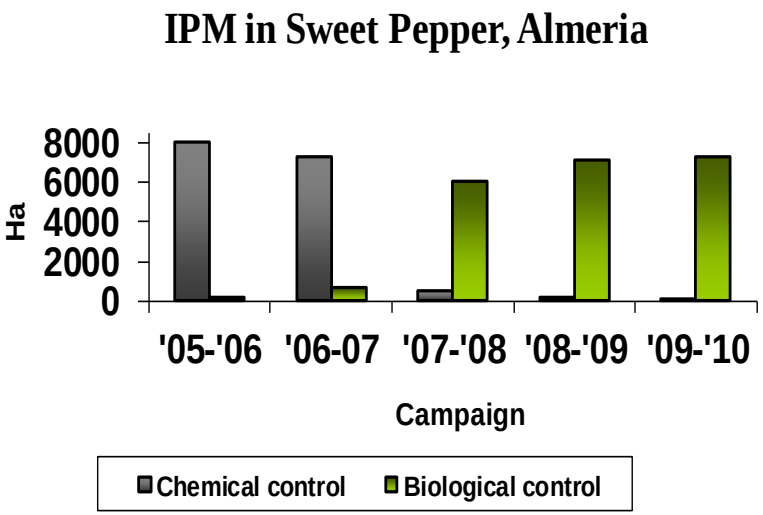
- Large excess of applied N in relation to crop N uptake
  - Reduction in N excess with time
- Initially, manure N made large contribution to N excess
  - Amount of N supplied by manure has reduced substantially
- These results broadly consistent with ^{15}N ^{18}O study

Source: Jadoski S. et al., In: E. Fontana et al., (Eds) Book Abstracts. NEV2013 Workshop . pp. 50-51

Widespread use and rapid adoption of biological pest control

Was very rapid adoption of biological control and integrated pest management





For five major species with total area of 24,400 ha

From: J. van der Blom, COEXPHAL

THANK YOU FOR YOUR ATTENTION