

PROTECTED CROPS IN SPAIN:

Technology of fertigation control.



- Evolution and actual situation of protected crops in Spain
- Water/fertiliser problems, policy and substrates systems

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The object of this communication is to expose the present status of protected cultivation of fresh vegetables from Spain, with special emphasis on the evolution and present status of the greenhouse sector in the south eastern Spain (Almería and Murcia provinces).

On the other hand, Analyse the water and fertilizers associated problems in this intensified horticulture, and the mayor policy and perspectives proposed for remain the principal source of progress in the area: The vegetables greenhouse production.

In a second step we talk about several methods of soilless crops contribute to solve problems because of water availability, water and soils salinity and soil pathology. Finally we focused on technologies on fertigation control and different strategies to increase water and use efficiencies without significant losses on yield.



Spain is one of the membership countries of the European Union.

43% of total area of European union were used for agricultural purposes, with a total of 138 million hectares

Between 1985 and 2015, the total agricultural area declined by 2.7 %, whereas the output increased by 5.4%

Farmers intensified their output by increasing their use of input. These intensification of crop production is more important in the Mediterranean area, and leads to a significant increase in fertilizer input and water extraction for irrigation.

The local climate of the south-eastern Spain is Mediterranean sub-desert and the vigorous development of protected vegetable crops have notably increased water and fertiliser demand



In the Mediterranean area and Canary Islands, hundreds of Has of land are covered with polyethylene film, supported by wooden or iron posts to form a single greenhouse structure called “parral” or “arbour” greenhouse

This light greenhouse structure help to protect plant from the permanent presence of the wind; from the rainstorms; for reduce the transpiration losses of water; and finally for protect the crops from temporal adverse climatic conditions

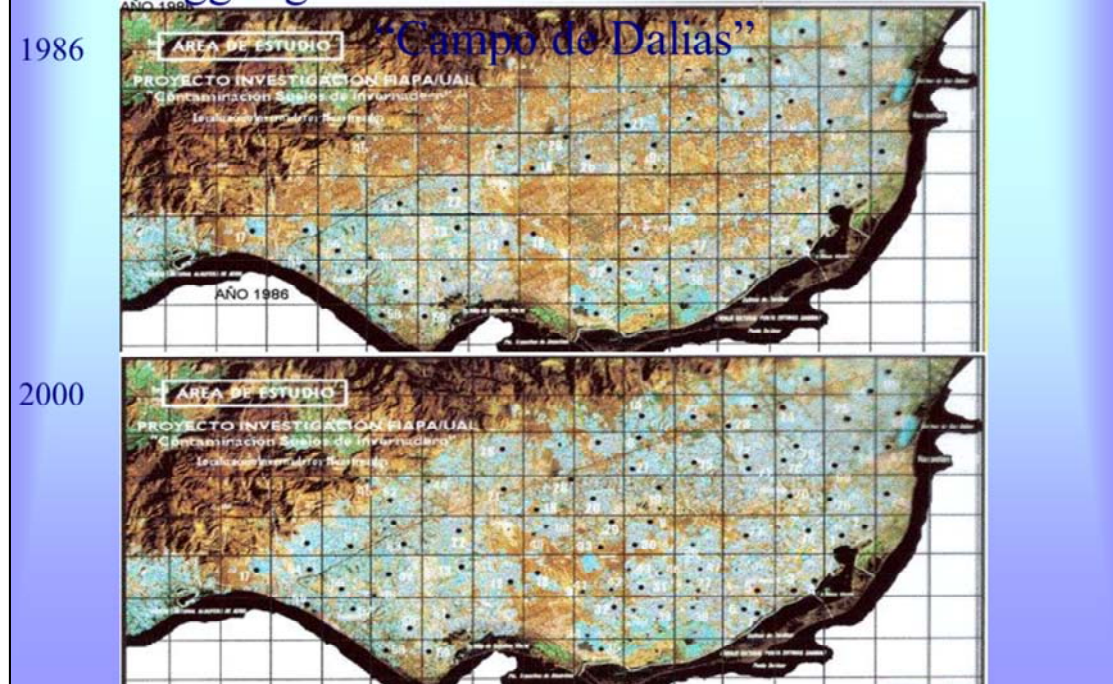
According to the latest estimated, They are more that 54,000 has of greenhouses in Spain.

75% of this greenhouses areas are in Murcia with near 9,000 has and Andalucía Region. With more than 41,000 has.

Almería Is the Andalusia province with the bigger area of greenhouse with more than 28,000 has. The average occupancy rate index is 1,6. This mean that more than 45,000 has composed the productive area.

The good climatic conditions for this area, together with the rise of essential ground water, the “parral” greenhouse, the application of the “sanding” techniques, and the development of plastic material, are the conditions that give rise to the so called “Almería miracle”

The bigger greenhouses concentration in the world:

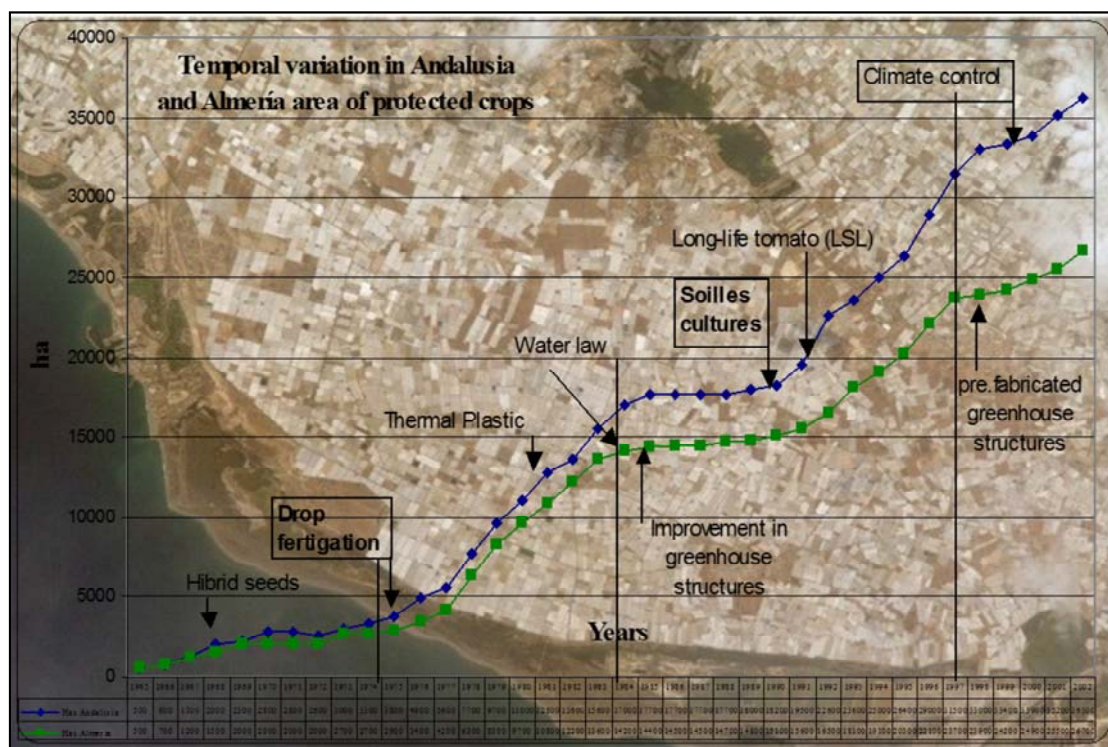


We say: “one image is better than thousand words”

The two satellite photographs are made in 1986 and 2000. The blue colours are due to polietilene film which covers the greenhouses.

The protected surface increase in this area and expanded to the bordering area between 17,000 has in 1986 to near 30,000 has actually.

More than 60% of these area has belong to the coastal area of “Campo de Dalias - El Ejido” and inspires the metaphor of “The sea of Plastic” when seen this area from the air. The other 40% are located in neibord areas that are actually increasing their importance.



The constant incorporation of technological advances into vegetable production, lead to the continuous increase in protected area. We can summarise the evolution of the agricultural system of Almería in the following phases:

a) First stage: based on family farms (no bigger than 1 ha each)

In 1965 there are only 500 has of protected crops in Almería.

The increase between 1965 and 1977 was slow (300 has/year).

b) The Second stage is characterised for the introduction of hybrids vegetable material, generalisation of drip irrigation and introduction of fertigation techniques, and thermal plastics. That led to higher greenhouses (higher than 1 ha)

Between 1977 and 1985, the increase was more intensified (1250 has /year) and lead to 14,000 has of greenhouses.

In 1985, the overexploitation of the aquifers of “Campo de Dalías” led to the forthwithen “prohibition” to increasing the irrigated area and the construction of new greenhouses. Only 200 has/year. During this years, the increase of protected surfaces take place in other bordering areas, whereas in this the main innovation was made in the improvement of greenhouse structures.

c) During the Third phase: After 1989 the immigrant labour help to change from the family farm to the commercial one, with clear increased production areas and with the introduction of open substrates systems.

During 1990-92, the translated water from “Sierra Nevada” and the use of more efficient fertigation systems, alleviated the overexploited aquifers, reduces the problem and promotes a new increase of covered surfaces in these and other bordering areas .

d) Present stage: (1995 until now): The high land price, the new model of market, and the economic situation of European countries, promote technological innovation in structural changes and climatic control of greenhouses, in order to improve the productivity by surface unit. Parallely lead to a new increase in the protected surface not only in this area but in the whole region, which reach the 1600 has/year.

e) Global Crisis

Actually the protected crops in the “Campo de Dalias” and “El Ejido” constitutes the bigger greenhouses concentration in the world.

Spanish and Almería Production and yield of fresh vegetables (11/12)

Main Veg. Crops	Has (*1000)			Tm (*1000)			Tm/Ha	
	Spain	Alm.	%	Spain	Alm.	%	Spain	Alm.
Common beans	77	5,2	7	560	73	13	7.3	14.0
Tomatoes	55	8,3*	15	2,790	754	27	50.7	90.8
Melon	50	6,1	12	905	250	28	18.1	41
Lettuce	32	4,5	14	935	112	12	29.2	24.9
Bell Pepper	25	7,9*	32	742	458	62	29.7	57.9
Water melon	23	6,9*	30	593	442	75	25.8	64.1
Aubergine	12	1,1	9	136	68	50	11.3	74.8
Cucumbers	7	3,2	46	314	273	87	44.9	85.3

In the European context, Spain is the first country in the production of:

Onion and garlic with 1 Millions tons, lettuce with 935,000 tons, melon with 905.000 tons; Bell pepper with 742.000 tons; watermelon with 593,000 tons, Pumpkins with 250,000 tons and 83,000 tons of asparagus

Is the second country in the production of tomato with 2.8 Millions tons, zucchini with 150.000 tons aubergine (eggplant) with 136.000 tons and 91,000 tons of celery after Italy, and Cucumber with 314.000 tons after Netherlands. And in fresh green beans with 56.000 tons we are after UK, Italy and Greece

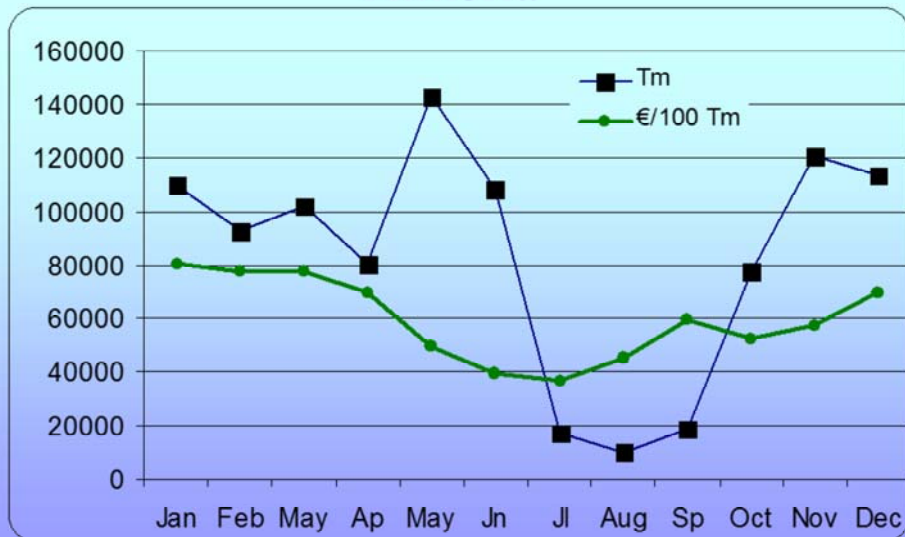
In the Spanish context, Almería and Murcia provinces balance their economy by exploiting vast amounts of horticultural and fruit products:

Almería is the first province in the production of bell pepper with 742.000 tons; water melon with 442.000 tons; cucumbers with 273.000 tons, zucchini with 100.000 tons and aubergine with 68.000 tons which represent more than 50% of the total Spanish production.

The tomato with 754.000 tons and the 250.000 tons of melon production are the 30 % of the total. In fresh bean and lettuce Almería production is only 12 - 14 % of total Spanish production.

The yield in Almería is at least double than the rest of the Spain yield, for every represented crops, except for lettuce..

Annual Vegetables Production and yield from Almería



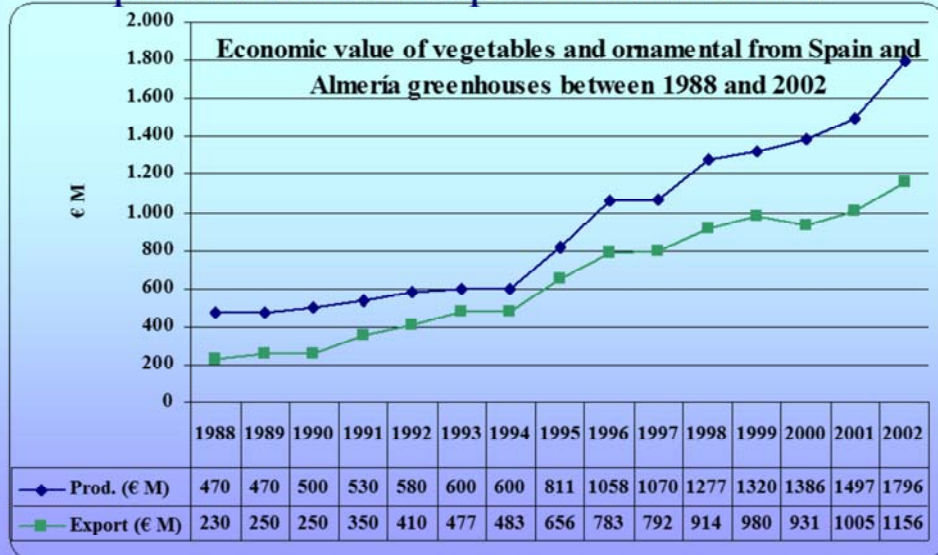
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The strongest profits and highest production in Almería are in winter vegetable production season (between the last and the first month of the year), with an average production of 110,000 tons by month.

During the spring season, the productions is less important, (20,000 tons for month) and the profits yield (€/mT) is half than during the winter season.

Economic value of fresh vegetables and fruit production and export from Almería



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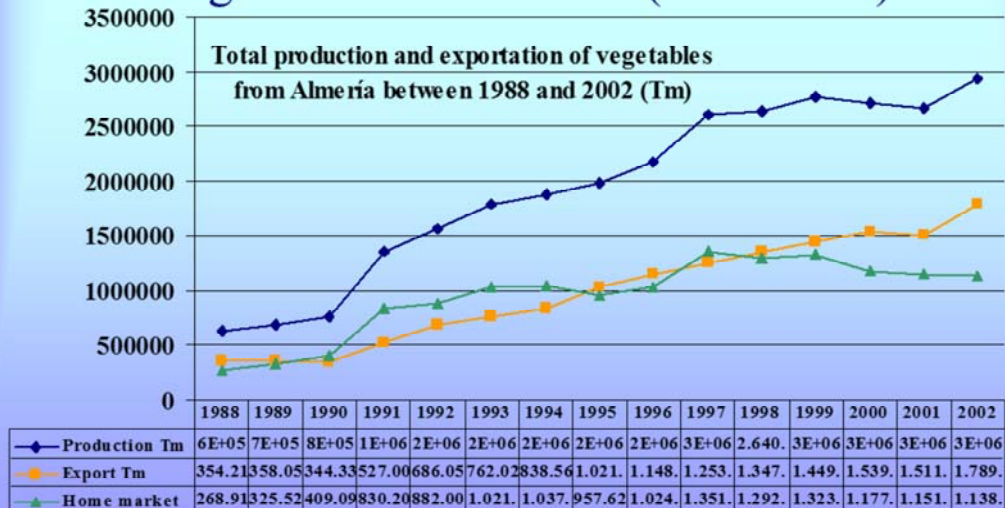
Vegetable intensive greenhouses farming are the main force in Almería and Murcia economy and the largest part of the population direct or indirectly depend on it.

During the last thirty years, the economic value of Almería production of vegetables double each five years and actually round 2,000 Million Euros.

In the last five years more than half of this production is exported to other European countries (mainly to German, French Dutch and UK market). The rest of the total production is consumed in the Spanish market.

The actual value of the Almería vegetable exportation is rounding 1,200 Million Euros (1.2 billion American dollars) (based on the parity: 1 Euro = 1 US\$).

Production, home market and exportation of vegetable from Almería (1988-2002)



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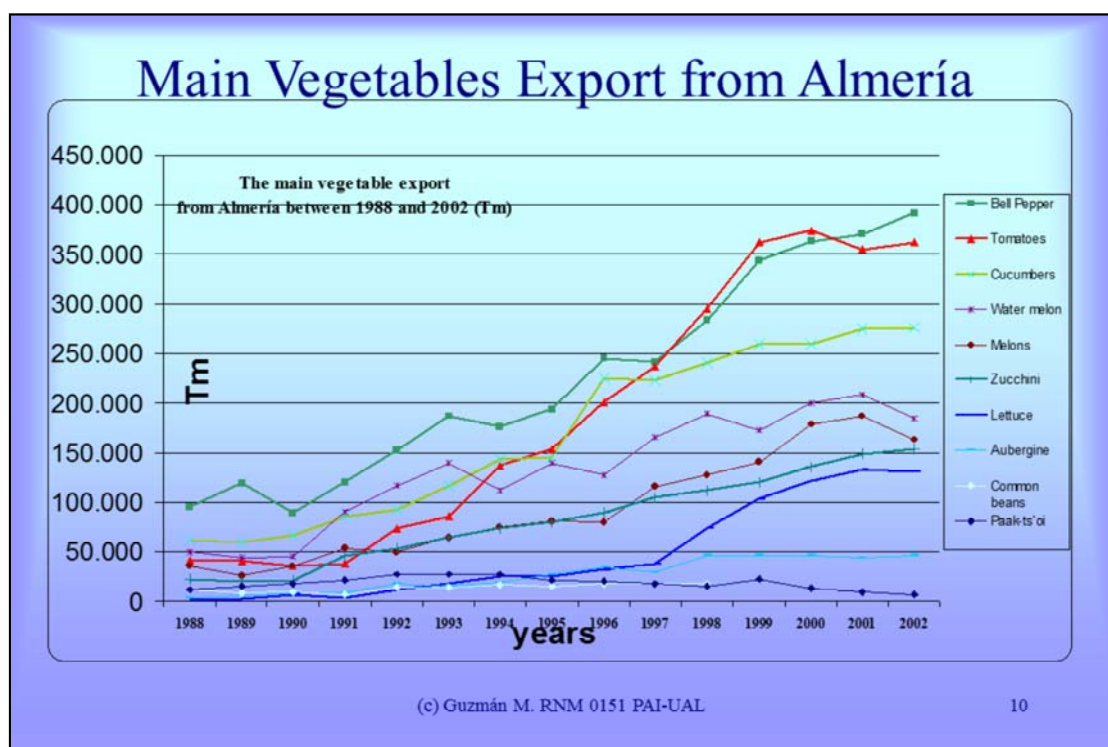
I remember reading an article many years ago which said that Spain could produce virtually all of the horticultural vegetables required in Europe. I believe this prophecy was largely accurate.

The production and export rates from Almería greenhouses have a marked increase between 1990 and 2012 and a less important but constant increase in the last five years.

The 1988 value of production (623,000 T) was increased four times in the subsequent ten years to near 2 Millions T in 2000 with an average annual increase rate of 15% /year. Actually the total amount is more than 2.5 MT.

The export variation is less pronounced in 90 – 92, but they represent during the last ten years, between 45 and 60 % of the total vegetable production.

The big increase in production after 90 is partially absorbed by the increase of home market in vegetables greenhouses consumption, but after 93 this is stabilised and in last five years, the exportation clearly surpasses home consume.



More important export vegetable crops in Almería are:

Autumn-winter season crops are bell pepper, tomato and cucumber, they have the better increasing production and yield in the last years.

Half of the bell pepper and tomato, 25% of cucumber consumed in Europe are from Almería. Actually we are exporting tomato and pepper to North America (US and Canada).

The second important group of spring season crops are watermelon, melon and zucchini. On the other hand, lettuce suffered the most relative increase, reaching the importance of this second group.

Half of the melons and 30% of the watermelon and zucchini consumed in Europe are from Spain

Finally other minor crops as, aubergine, green beans and pe-tsai (*Brasica pekinensis*) are less important.

40 % of lettuce, 30% of aubergine, and only 10% of green beans and pe-tsai consumed in Europe are from Spain.

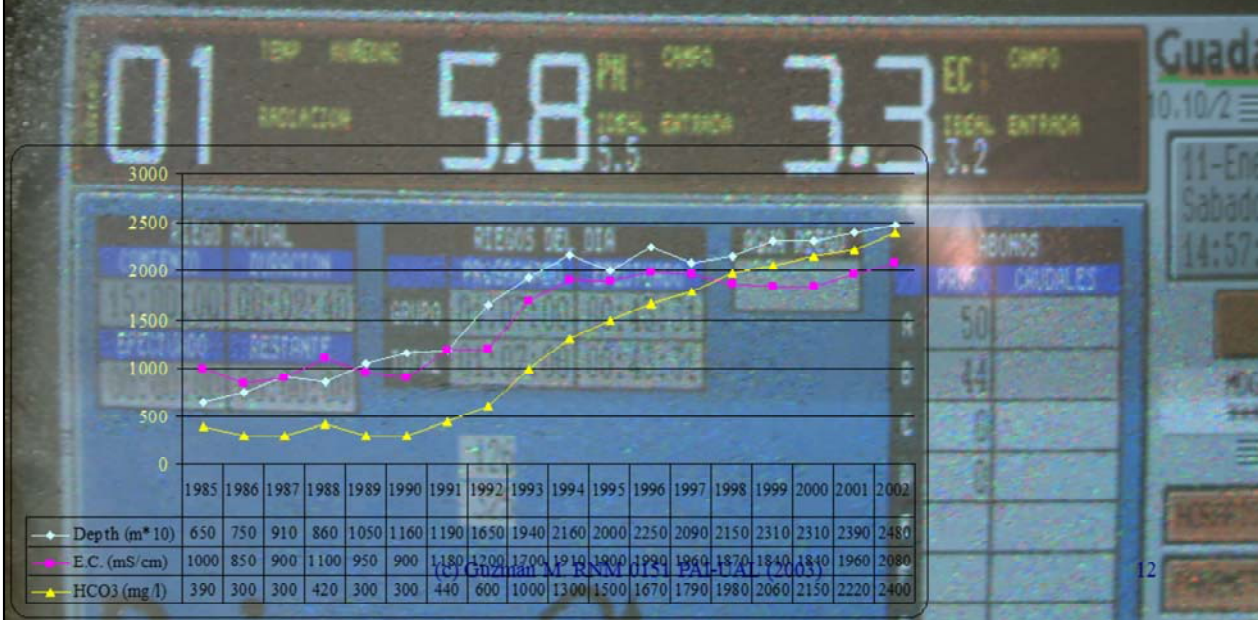
Water and fertiliser problems and policy

Water quantity and quality.
Use efficiencies
Soilless system as a solution

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The second part of this presentation focused on main problems in water and fertiliser management. Who are the most usual substrates used in our area. I consider very interesting make a overview of ecological and economical problems in this highly concentrated intensive production areas.

Time course of piezometric level and water quality in “Campo De Dalias” aquifer



In Spain 72 % of water is mostly used for irrigation.

Irrigated area in Spain increases by 80% during the period 1960 –2000.

In South-eastern Spain, groundwater is the leading source of irrigation water.

The piezometric level of the groundwater extracted in the Campo de Dalias are progressively descended with the time of extraction. The average depth level increases between 65 m in 1985, 180 m in 1998 and more than 200m currently.

The overexploitation of groundwater are related to marine intrusion, which determine high conductivity and high Chloride and Sodium concentration values. Also the Calcium and Magnesium facies causes problems resulting from carbonate and sulphate concentration.

The direct effect on crops irrigated with theses waters, lead to a quick response, of highly sensible crops to salinity, reducing yield. But the most important effect is the slow salinization and alkalinisation of soil witch have a negative effect on crop systems. This leads to an abandonment of some greenhouses or to reconversion to soilless system .

Currently, 10% of the greenhouses area are growth under soilless system.

Water and fertiliser policy

- Regional, National and European Directives

- European directives
- National directives
- Local directives

- Planning and management practices

- Drip irrigation (100% in Southeast greenhouses)
- Fertigation, automated and computerised
- Desalinated through inverse osmosis.

- Economic tools:

- Taxes on fertiliser and pesticides contamination;
- Water price

- Soilles culture (closed system)

(,Gubys, 2003), 0151 PAI-UAL (2003)

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There are different level of actuation in water an fertiliser policy:

DIRECTIVES: Are Actions taken at Local, Regional, National and European levels with the final aim of protect soil and groundwater from overexploitation and contamination.

As a example, in the current year, have to be used closed systems or to re-circulate the nutrient solution in 100% of the cultivation area of Holland obligated by law. In the rest of the European Union countries, laws like this one are being prepared

MANAGEMENT PRACTICES: Consumers are demanding a consistent supply of high quality products (fruit, vegetables and ornamental) regardless of season and local conditions. Fertigation gives the grower a practical method to achieve these quality standards, ever in conjunction with other Good Practices Codes.

Fertigation is a well established technique of adding value to irrigation water by inclusion of the nutrients required by plants. This technique has had some spectacular successes as in the Almería and Murcia regions of Spain and in North Africa.

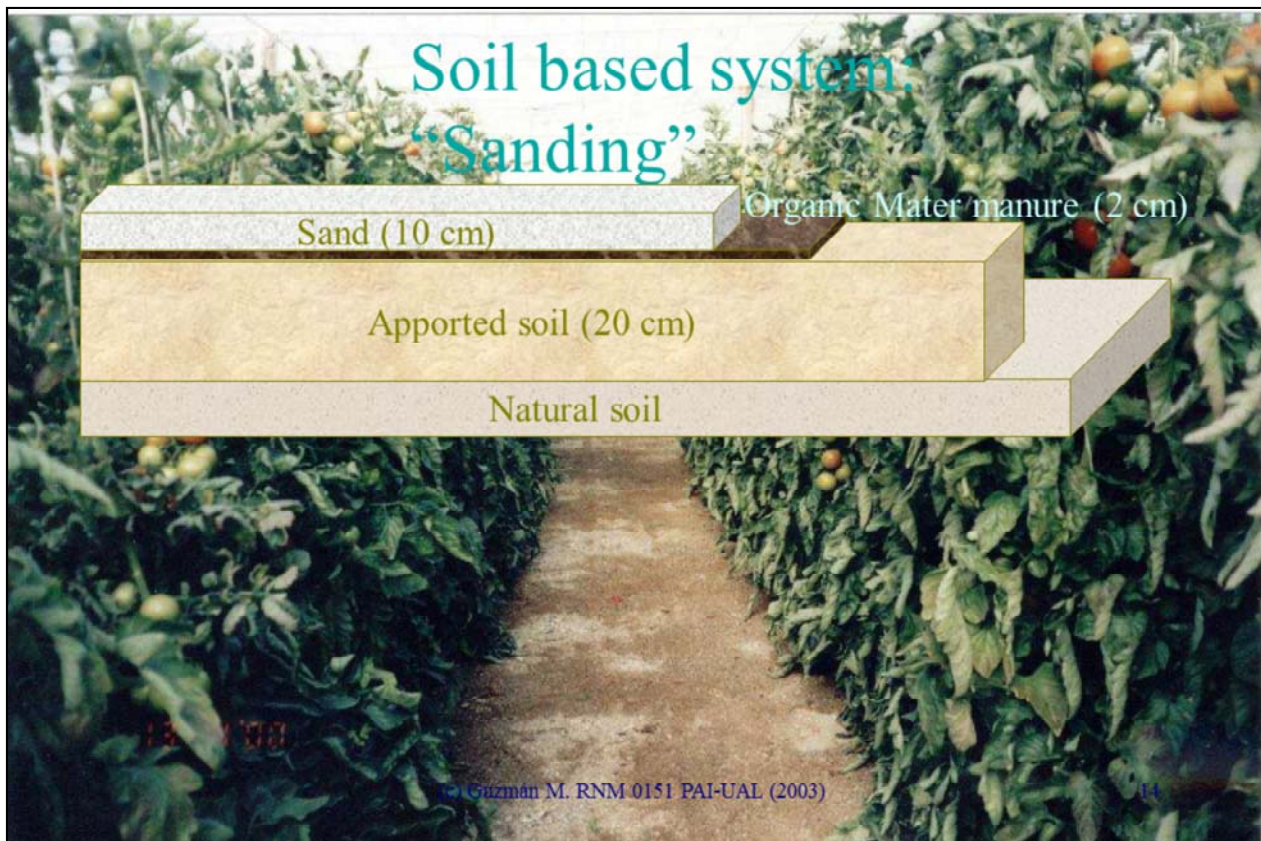
Automation of fertigation is just a consequence of generalised automation of horticultural systems. Automatic fertigation opens new possibilities in crop management because it can be extended from traditional techniques on soil, to one automatic fertigation which control the plant-environment system.

ECONOMIC TOOLS: The use of taxes and subsidies to modify the conduct of growers as regard a more efficient use of fertiliser and water. Tax on pesticides, fertiliser and pollutants already exist in European Union countries.

The introduction of water prices reflecting the true cost of water is other actuation to take into account .The price of irrigation water reach now between 0.1 - 0.3 €/m³. The price of desalinate water through inverse osmosis may be in Almería = 1 €/m³

SOILLES SYSTEM: The necessity of increasing revenues in horticultural production and use-restrictions of some agricultural soils has resulted in an increased use of hydroponic and

soilless techniques in South-eastern Spain.

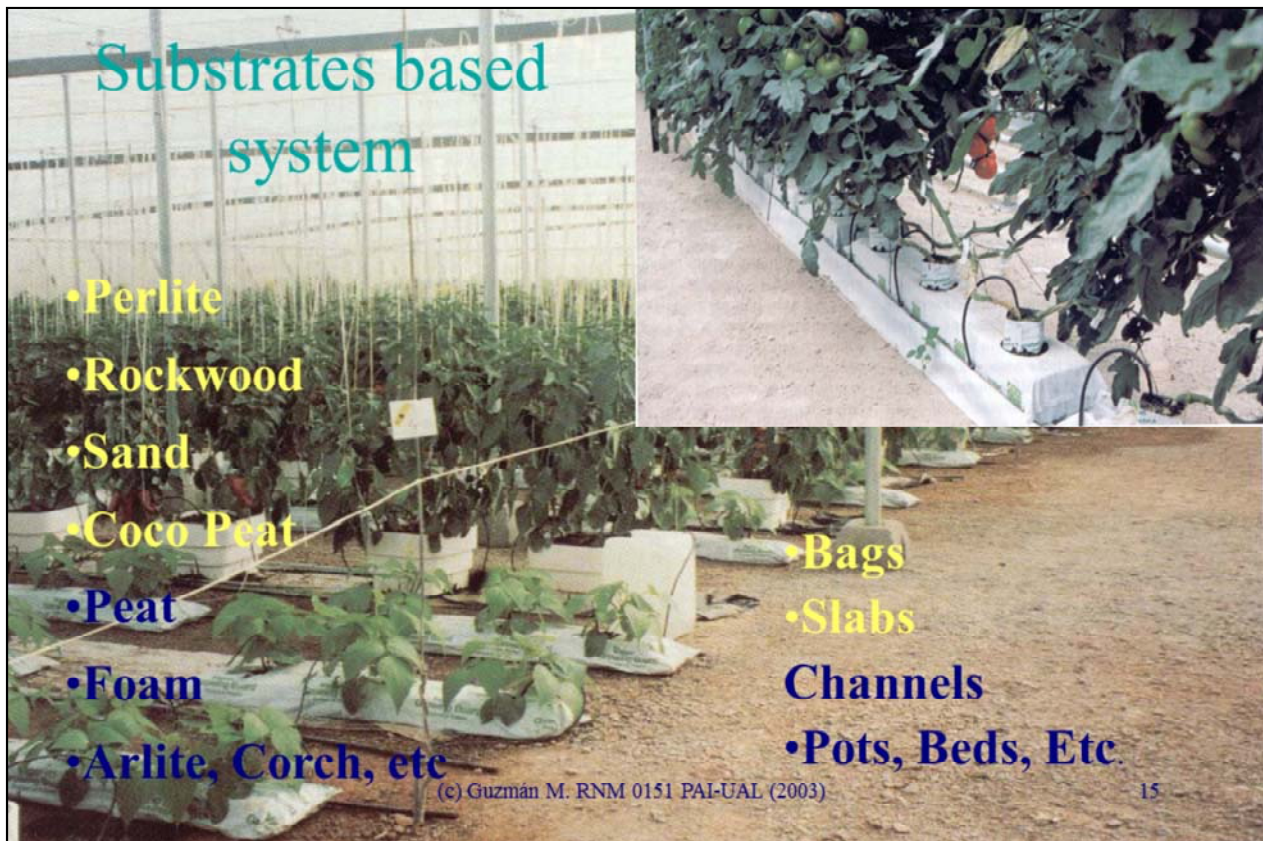


We can consider the “sanding” as an artificial crop system, because the plant growth outside a natural soil. The “enarenado” (sanded soil) was constructed providing three layers of materials on the original ground:

- 20 cm of apported “soil” which in reality is a clay material with, in some cases, are more than 40% of clay mineral.
- 2 - 3 cm of organic matter manure (This layer need be re-located every 3 to 4 year) .
- 0 - 12 cm of sand of determinate granulometry (rice size)

With an automatic fertigation systems (often called drip or trickle irrigation by a wide variety of emitters) water and nutrient will be applied directly to the feeding system of the plants. This situation lead to a very reduced and located root system. (90% of root are in the interface between the top of the soil and the bottom of sand layer)

75% of the Almería greenhouses production are in this artificial growing system. 15% uses natural soil and 10% are soilless system.



They are several substrates used in south east area (peat, rockwool, Perlite (mainly in Almería), sand, coco peat and coco fibber, (mainly in Murcia) foam, cork, etc.)

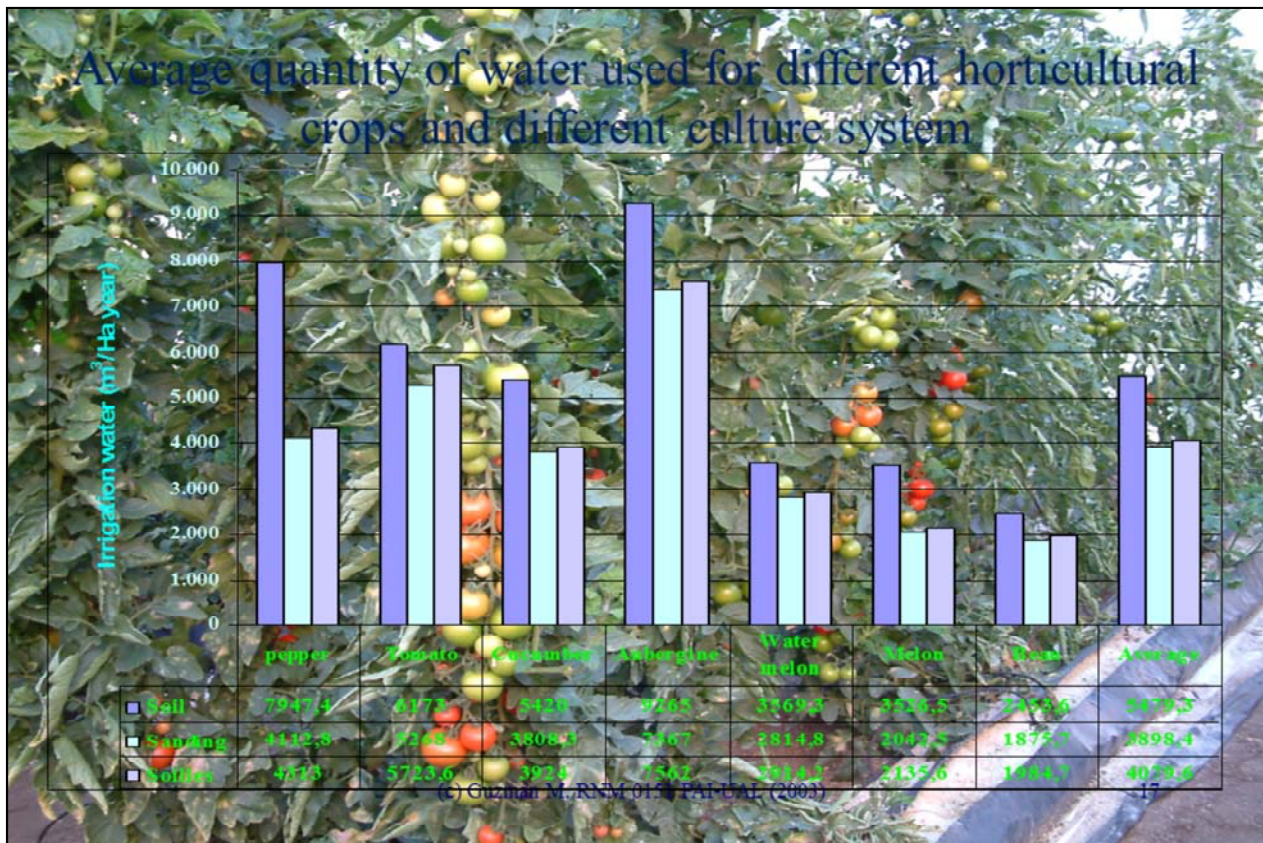
They are several substrates based system too: (Bags, Slabs, Pots, Channels,, multiblocks, jiffy, plug, etc)

10% (3,500 has) of the total greenhouses production area of Almería and Murcia are in theses substrates system



There are a interesting business activity related with the transplant production in the area. All our vegetables start their developmental growth in nurseries which uses specialised and sophisticated greenhouses. Constitute an special soilless seedbed system for seedling plant in a multiblock container (whit peat, perlite and vermiculite mix substrates) designed to provide a plant adequately conditions of development in order to reduce the period between transplant and harvest.

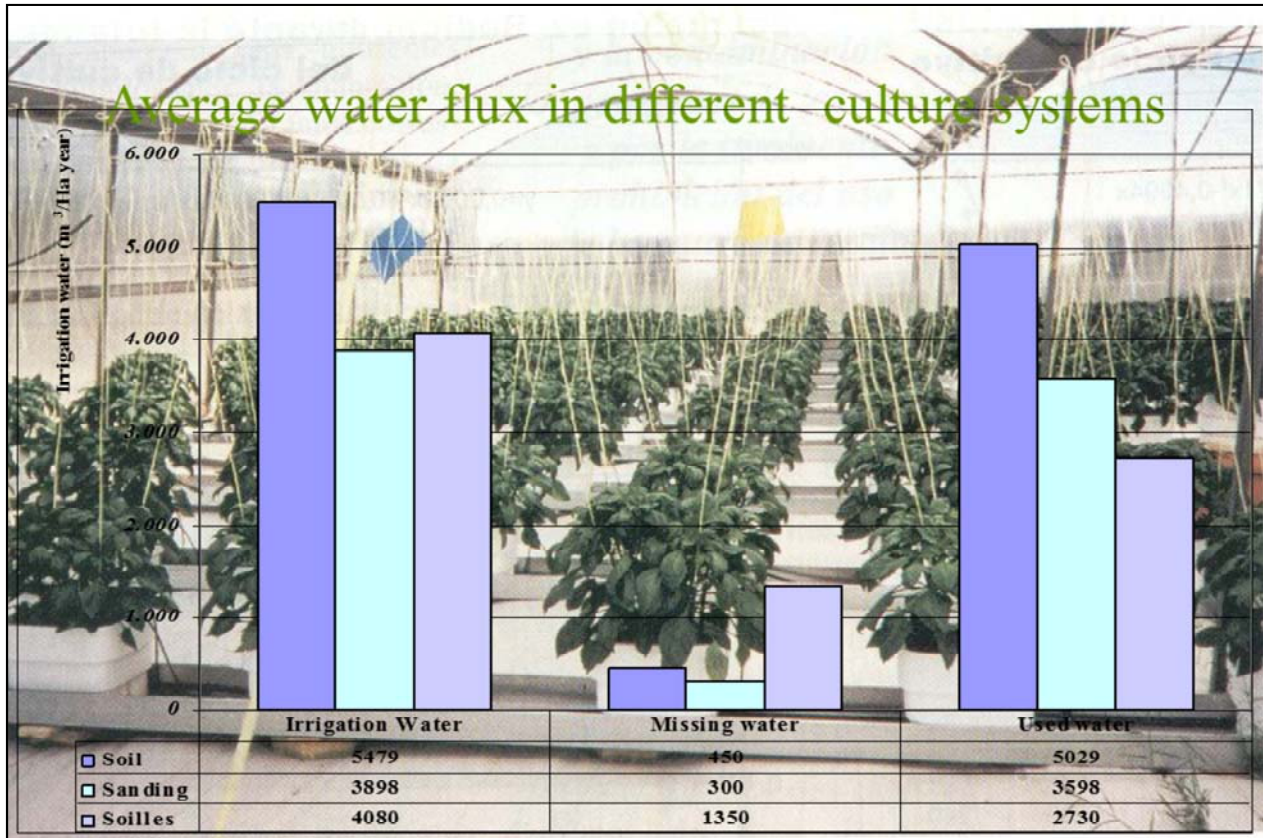
1% of the total area of Almería and Murcia is occupied for this specific culture system which account 450 H. Produce more than 2,000 millions of transplant /years, including grafting of desired varieties over resistant rootstock. The estimated importance of the nursery transplant industry round 35 M €



Actually 100% of greenhouses vegetables crops of the area are under drip fertigation systems.

The quantity of water used for irrigation depends on various factors, such as climate, soil or substrate characteristics, water quality, irrigation methods, cultivation practices, and crop types. The water applied is very different for different crops with different management practices: Can be differences as big as from 9000 m³/Ha·year (eggplant in soil) to 1800 m³/Ha·year (green beans in sanded system).

The average quantity of water applied is bigger in soil based system (5,700 cubic meter /ha year), and less in “sanding” (3,900 cubic meter) and similar in soilless system. (4,000 cubic meter).



Automatic fertigation allows control of the plant-environment system

In this way we can control external inputs to the system (water and fertilisers applied) as well as outputs from the system to the environment (water and fertiliser runoff or lixiviate). Knowing these facts we will calculate the use (water and fertiliser used) by the crops

In this slide we represent the average water applied to the crops in three different systems (soil, sanding and soilless) the inputs and the outputs (lixivated produced for each), are different and lead to different amount of water used by the crops.

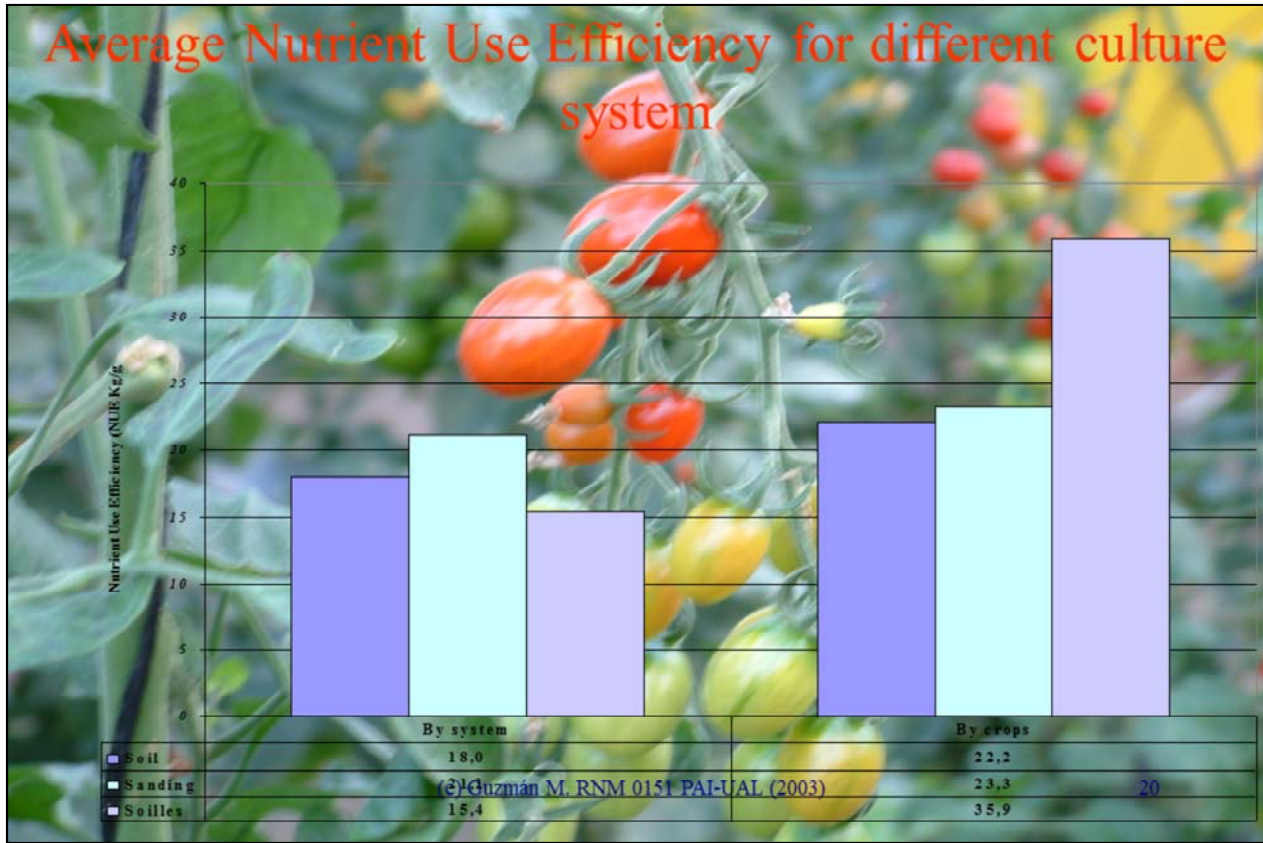
For a similar amount of water in sanding and soilless system, the bigger lixiviates amount in soilless lead to a less water use in soilless systems.



When we compare the Water Use Efficiency (WUE) of the system (gr. produced /Litres (L) of water applied to the system) with the water use efficiency by the crops (gr. Produced/L water consumed by the crops),

The Water Use Efficiency (WUE) by the systems of sanding and soilless is the same and bigger than in soil.

Whereas the Water Use Efficiency by the crops is bigger in soilless than in the other system.



In the same way, The Nutrient Use Efficiency (NUE) for the soilless open system is less than in soil or sanded. But these Nutrient Use Efficiency increase considerably in soilless system when we consider only the nutrient used by the crops.

If we can reuse the lixivates, we can increase the Use Efficiency of water and fertiliser by the system, generating a closed-system.



Thank

- NASA for the satellite images
- And everybody for yours attention

Thank you very much



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
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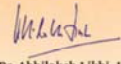
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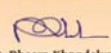
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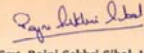
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