

ADOPTION OF METHYL BROMIDE ALTERNATIVES IN TOMATO AND VEGETABLE PRODUCTION IN SARDINIA

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Introduction

- **Tomato monoculture and the increased presence of highly virulent telluric pathogens rendered MB use essential; initially on greenhouse horticultural crops, subsequently, at a lesser degree, on intensively cropped open field vegetables.**
- **The certainty that, within a short time, the use of such product would be forbidden or strongly limited represented an important stimulus for the search of technical alternative solutions.**



Fig. 1- Evolution of greenhouse crops area in Sardinia (Italy) over the last 50 years

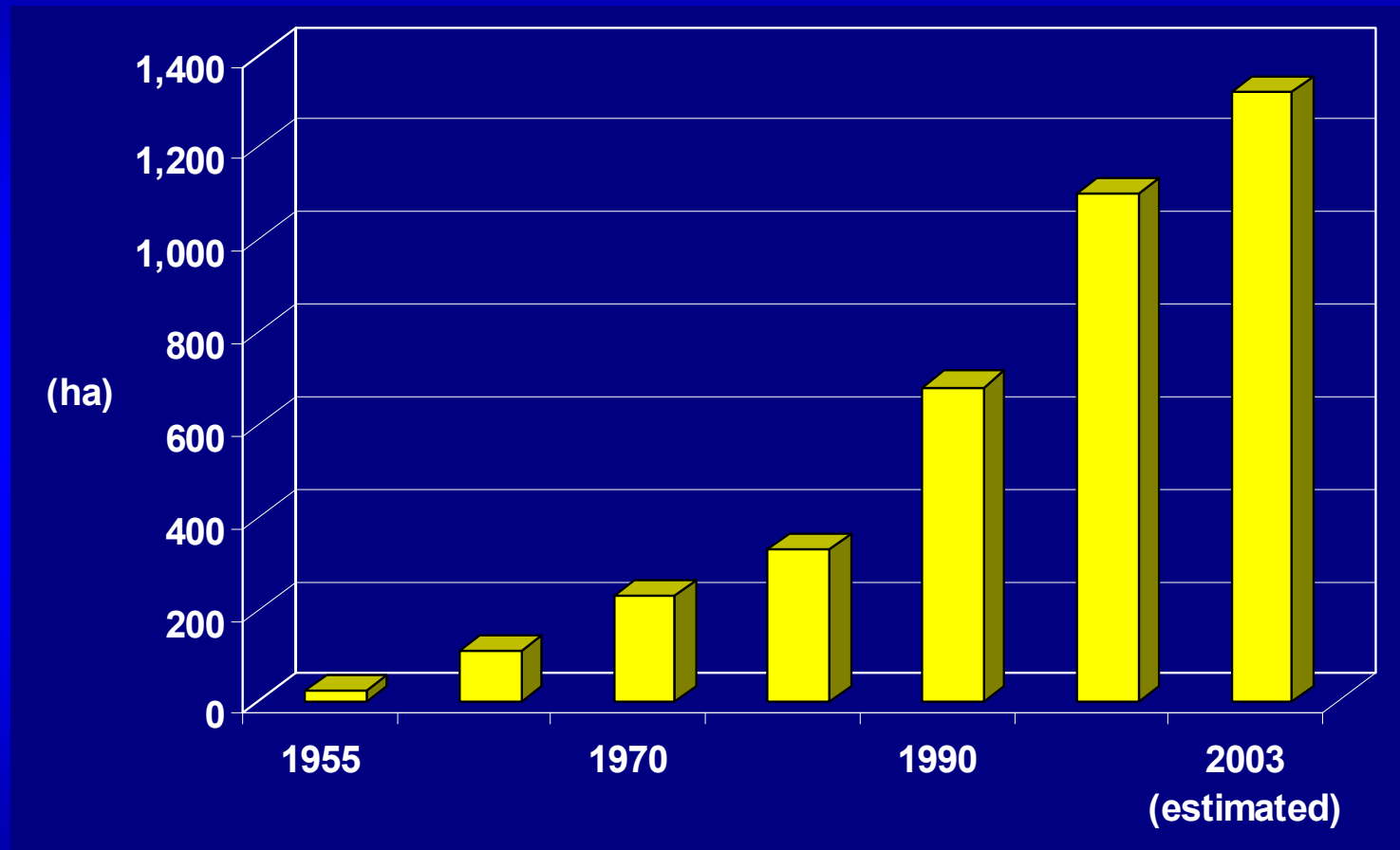
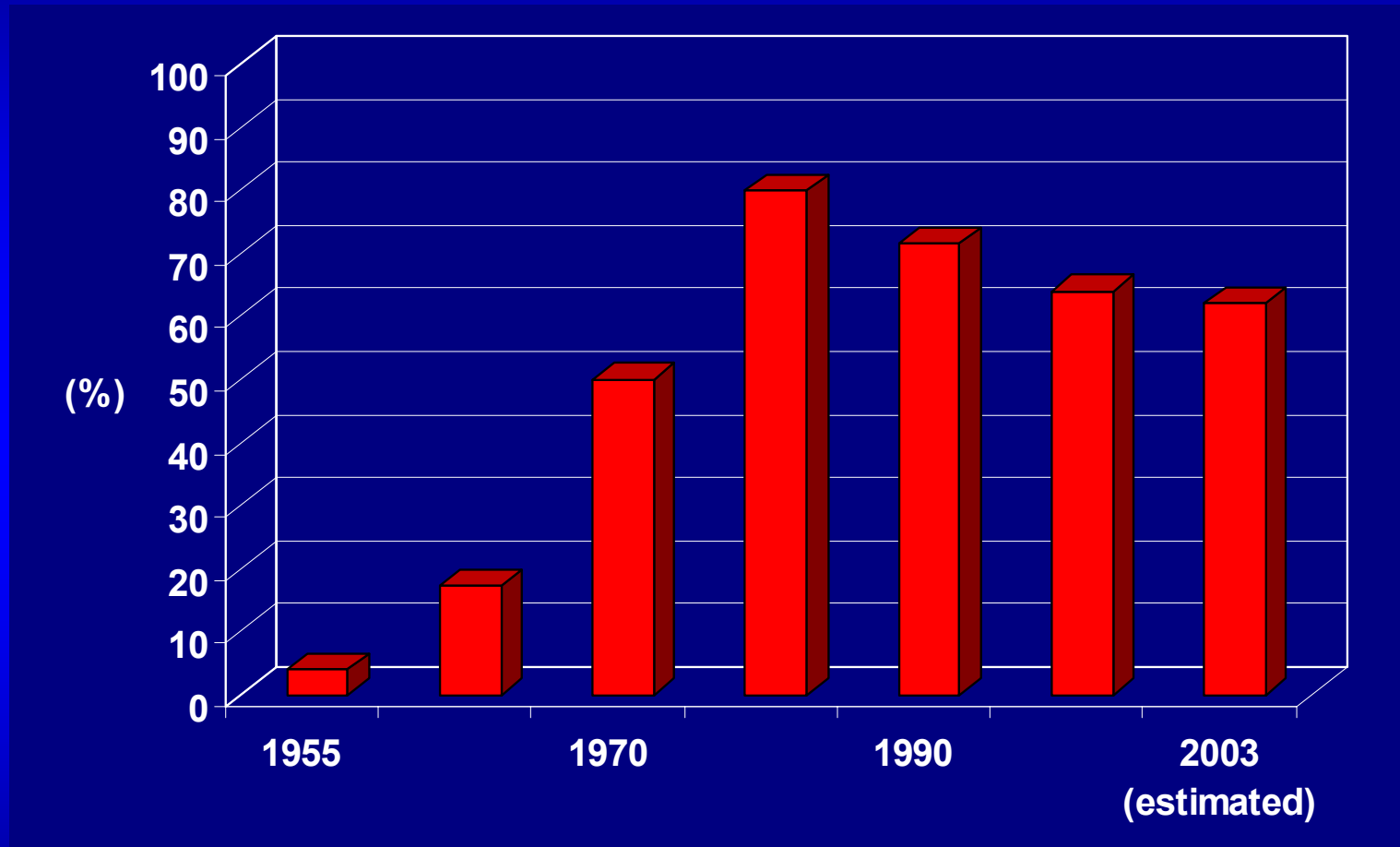


Fig. 2 - Tomato percentage on total greenhouse area in Sardinia (Italy)



Tomato monoculture and MB fumigations

- Methyl bromide use has increased together with tomato expansion.
- The surfaces annually fumigated reached a maximum in 1992, with around 250 ha in greenhouse and 15 ha in open air; it derives that the MB fumigation concerned about 50% of the total greenhouse area.



The start of the researches

- In Italy Sardinia has been one of the first regions to carry out an intense experimentation and research activity to set up and promote cultivation techniques, suited to the Sardinian environment, able to reduce greenhouse MB use.
- The activities were stimulated by the results of a long term research, previously carried out, to monitor brome residues on tomato berries produced in fumigated greenhouses.



Research and experimentation of alternative techniques

- From 1984-85 research and experimentation programs on soilless cultures were then set up and their results greatly affected the greenhouse horticultural sector, both in Sardinia and in other Italian regions.
- The winning idea was to adapt cultivation techniques, set up and broadly used in Northern Europe, to the climatic conditions and the technical and economic constraints typical of Southern Italy.

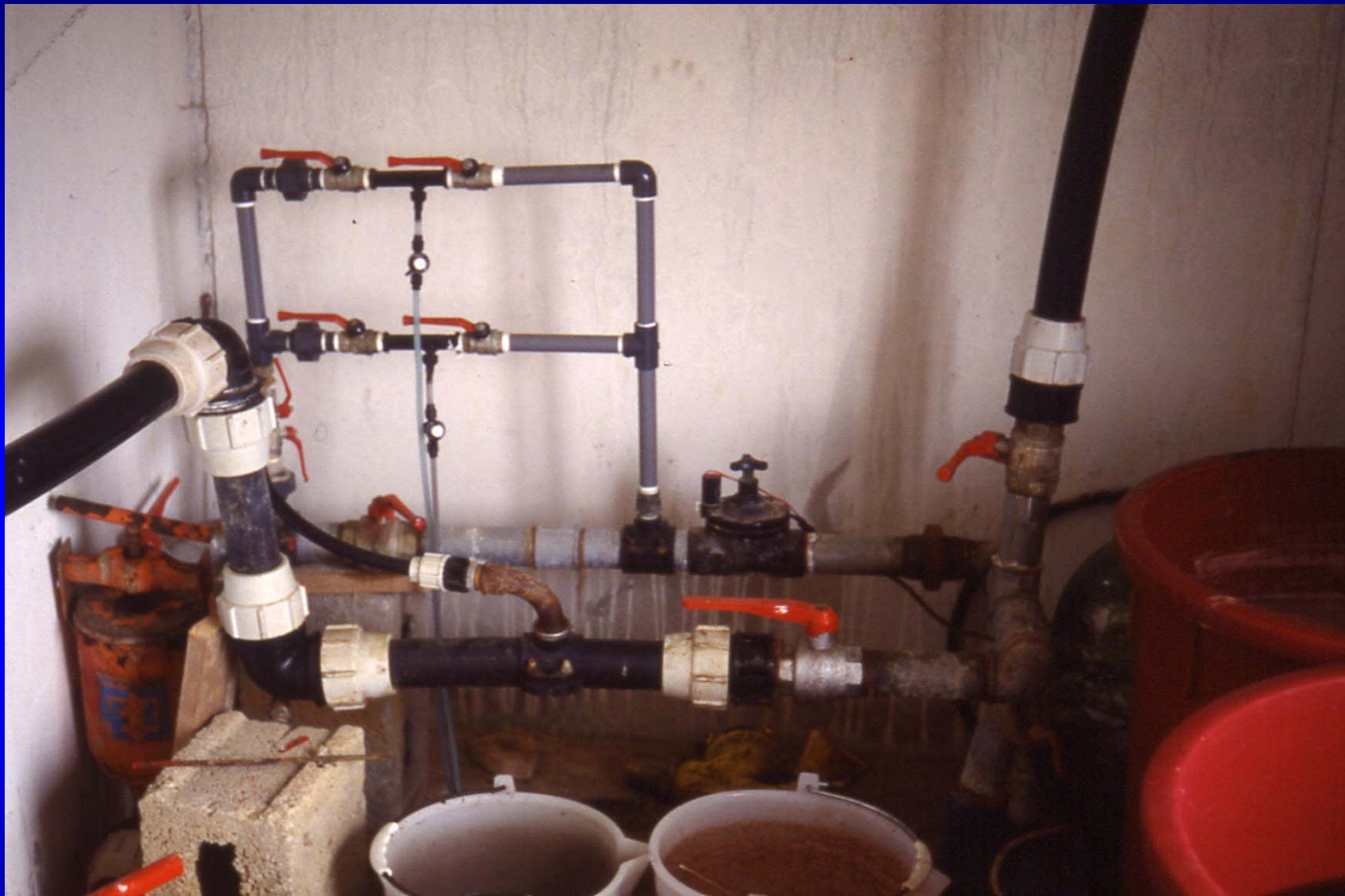


Research and experimentation of alternative techniques

The most important research and experimentation results were:

- a) preparation and solution distribution equipments simplification:
 - the use of venturimeters or other low cost equipments for solution dosage;





Venturi mixer, a low cost device

Research and experimentation of alternative techniques

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a) preparation and solution distribution equipments simplification:

- the use of venturimeters or other low cost equipments for solution dosage;
- the automation of the device for dosing the nutritive solution by using the same control unit, distributor and pipes already employees in greenhouse ordinary crops;
- the understanding of the relationships between elements, salts concentrations, time and volumes of irrigation and leaching volumes in greenhouses with none or minimum heating;

b) substrate selection:

- the use of distillery marc, sea straw (*Posidonia oceanica* L. Delille) volcanic lapillus and perlite, as an alternative to the more expensive imported substrate.





Tomato on *Posidonia oceanica*

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Tomato on distillery marc



Melon on perlite

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- b) substrate selection:
 - the use of distillery marc, sea straw (*Posidonia oceanica* L. Delille) volcanic lapillus and perlite, as an alternative to the more expensive imported substrate.
- c) choice of cultivation system:
 - the open cycle, Nutrient Film Technique and high-density aeroponic cultivation systems calibration for the Mediterranean environment.





Watermelon on perlite



Tomato on distillery marc and volcanic lapillus

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Tomato on nutrient film technique (NFT)

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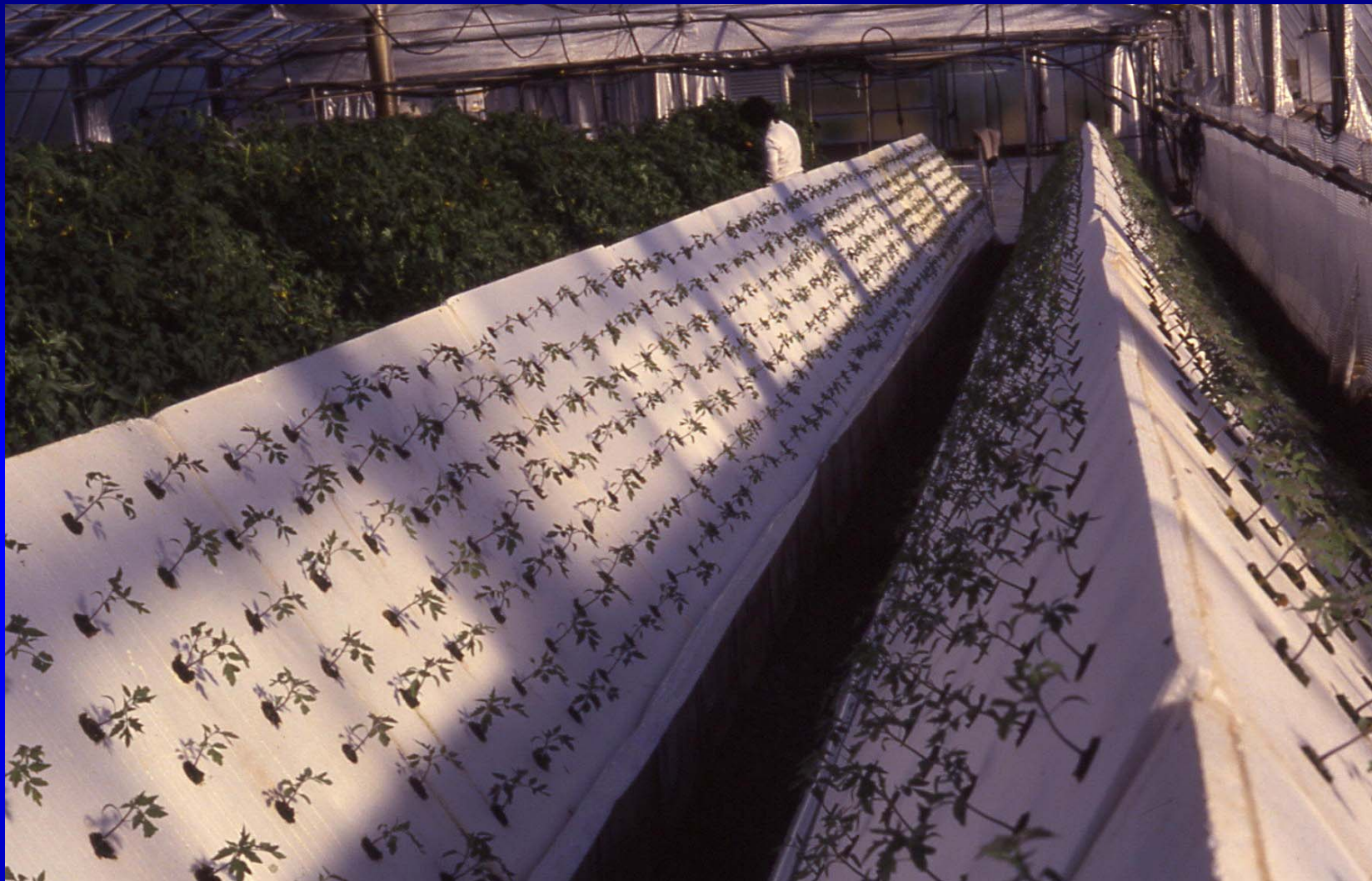




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High-density aeroponic culture for tomato production

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High-density aeroponic culture for tomato production

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High-density aeroponic culture for tomato at the harvest

Soiless culture expansion

- From 1989, after verifying the results through 3.000 m² trials, the technique quickly spread in several farms, also favoured by the massive increase of *Fusarium Oxisporum* var. *radicis lycopersici* attacks in traditionally cultivated crops.
- The soiless culture area increased from 3.000 m² in 1989 to around 35 ha in 1993, to reach around 90 ha a few years later.



Grafting

- The introduction and diffusion of grafting occurred in Sardinia since 1996-97;
- Initially it concerned melon and watermelon only, and in the following, increasingly tomato.



Grafting expansion

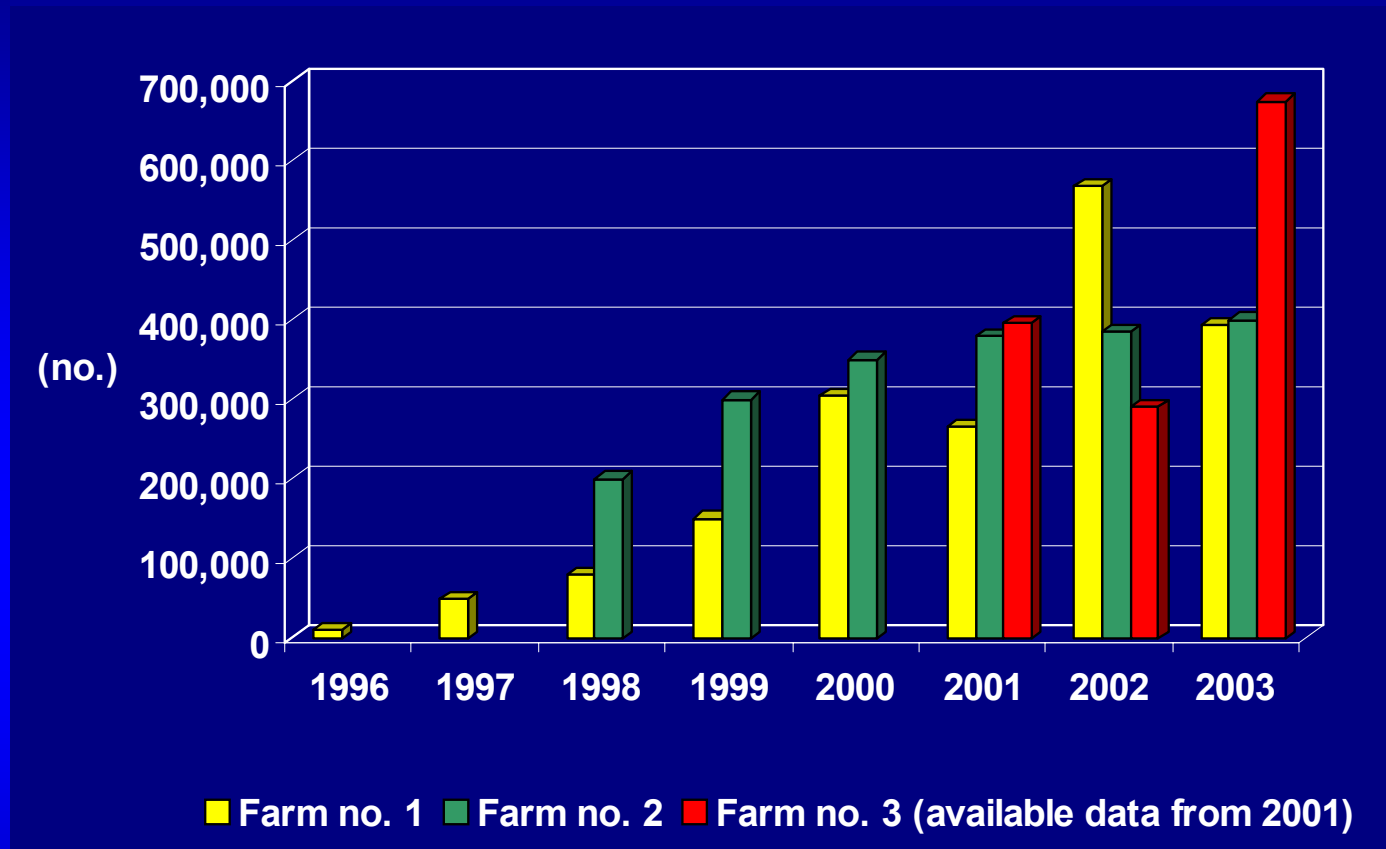


Fig. 3 Production on resistant foot trend sold by the three most important specialized farms of the sector in Sardinia

Grafting

- The further development in the sector will be highly dependant on consumers preferences on tomato fruit typology.
- If markets will develop towards traditional horticulture products, an expansion of grafting will certainly follow. On these cultivars, characterized by the absence of genetic resistances, grafting on resistant foot will be essential.
- Vice versa, grafting will decline if consumers will turn towards less typical market-scale products.



The role of tolerant hybrids and solarization

- The increasing virulence of pathogens and ineffectiveness of MB fumigations stimulated multinational seed production companies to intensify research efforts to find hybrid varieties with acceptable levels of genetic resistance or tolerance to *Fusarium Oxisporum* var. *radicis lycopersici*.
- Since 1995-96, farmers have planted these new hybrids, where possible, as an alternative to those traditionally cultivated.
- The choice was favoured by the increasing consumers' product innovation demand.
- The significant change in the selection of the variety was facilitated by solarisation, which became a common practice in 70-80% of the farms.
- Solarisation reduced telluric pathogens that attacked new hybrids, as they had lower levels of tolerance to the most aggressive pathogens.



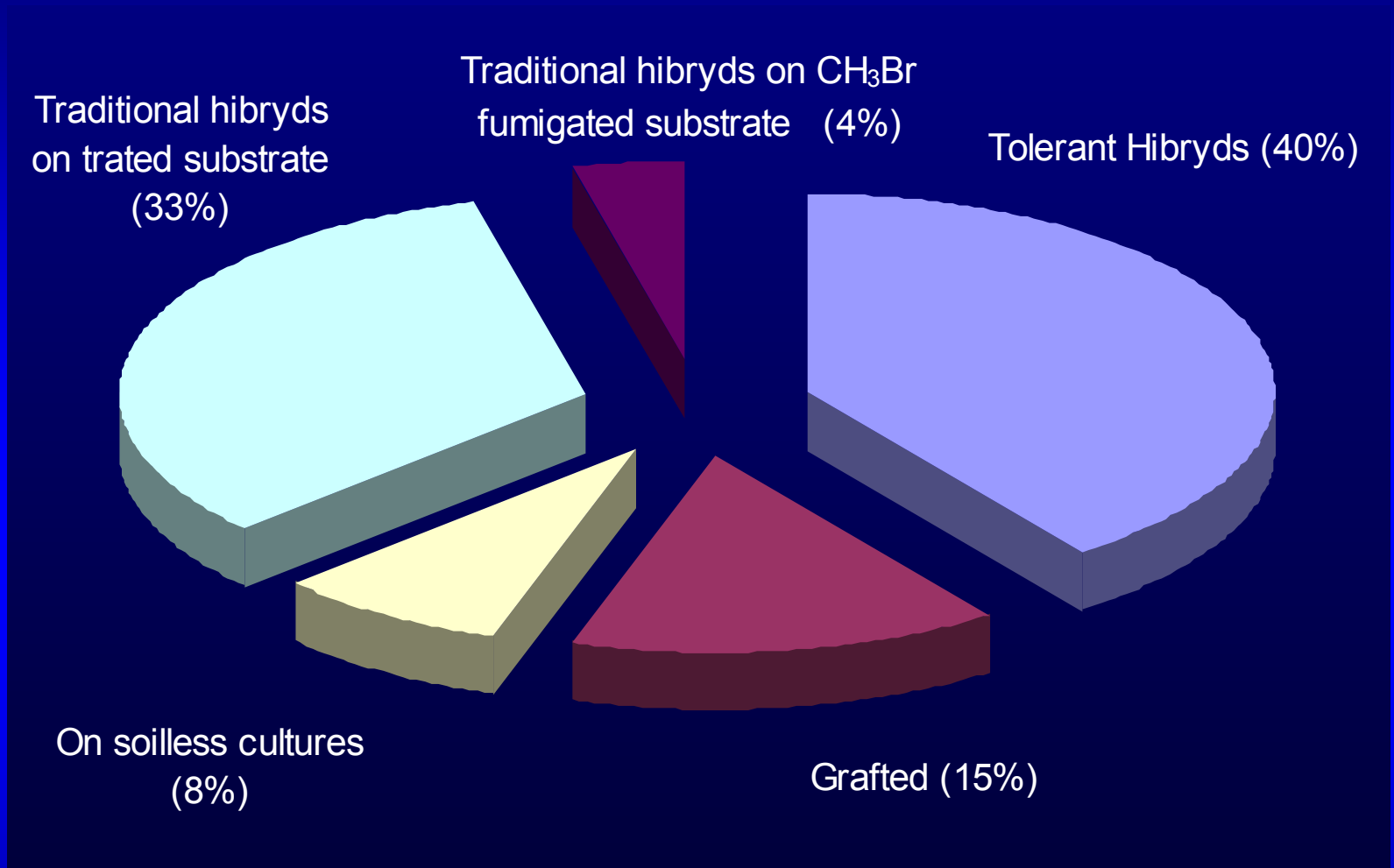


Fig. 4. Greenhouse horticulture in Sardinia (2004, estimated data)

Plants and substrate average costs

Table 1- Average costs in Sardinia (Italy)

Type	Costs (Euros)
MB fumigation, per m ²	0.67 - 0.70
Grafted tomato, per plant	0.77 - 0.85
Tomato ibryds, per plant	0.25 - 0.35
Tomato varieties, per plant	0.16 - 0.19
Grafted melon, per plant	0.77 - 0.80
Distillery marc, in long life p.e. bags (40 l)	1.8
<i>Posidonia oceanica</i> L, in long life p.e. bags (40 l)	2.0
Volcanic lapillus, , in long life p.e. bags (40 l)	2.2
Perlite, in long life p.e. bags (32 l)	3.3



Problems and future perspectives

- MB use has decreased from 50% of the tomato production area treated in 1992 to just 4% today.
- The innovative techniques adopted during the last years have reduced the problems related to the presence of telluric pathogens but have not solved the problem.



Problems and future perspectives

Remaining challenges are:

- The employment of root stocks and hybrids resistant to *Fusarium Oxisporum* var. *radicis lycopersici*, has evidenced that such resistance has weakened considerably by elevated pathogen infestations in the substrate or by relevant nematode attacks.
- An increase in *Corynebacterium Michiganense* J. attacks which was recently observed, such as an increase in the frequency of *Pyrenocheta lycopersici* S., pathogens to which the hybrids and the most common root stocks do not seem to be particularly resistant.
- The high costs of grafted seedlings, higher than to those sustainable for soilless cultivation.
- The re-emergence of such pathogens and the planting over vast areas of the cultivar “Beef” has resulted in a renewed interest towards the adoption of soilless cultivation technique. In fact, tomato has recently been more widely grown on *Posidonia* and perlite.



Problems and future perspectives

- A limit to the large scale adoption of soilless culture is the result of unjustified resistance of some big food distribution companies towards soilless productions.
- However, the greatest problem presently affecting tomato production in Sardinia is represented by the extreme virulence and spread of Tomato Yellow Leaf Curl Virus (TYLCV). In some southern areas of the island the virus currently represents a real threat to crop survival.
- Grafting as an alternative to MB use is essential for long term monoculture production and especially when *Fusarium* attacks are evident.
- Unfortunately, *Corynebacterium michiganense* J. and *Pyrenocheta lycopersici* S. also attack grafted plants.
- In this respect, cultivation on *Posidonia* is greatly expanding in Sardinia.
- Promising results have also been obtained on distillery marc and volcanic lapillus.



Conclusions

- The 1960's expansion of tomato monoculture combined with an increase in highly virulent pathogens in more intensive cultivation area stimulated, in Sardinia as in other region of the country, MB use on vast areas.
- The limitations on the use of MB in the future have contributed significantly to changes in pathogen control and tomato production.
- The problems that have emerged in this field have stimulated research and experimentation effort.
- The results of this research have totally modified greenhouse horticulture in Sardinia.
- The ability to adapt to changing cultivation conditions and market demand represents an extremely positive and encouraging aspect for the future of the sector.

