Drought & Water Deficiency

FROM RESEARCH TO POLICY MAKING

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WATER MANAGEMENT AND AGRICULTURAL PRACTICES ON MEDITERRANEAN ISLANDS

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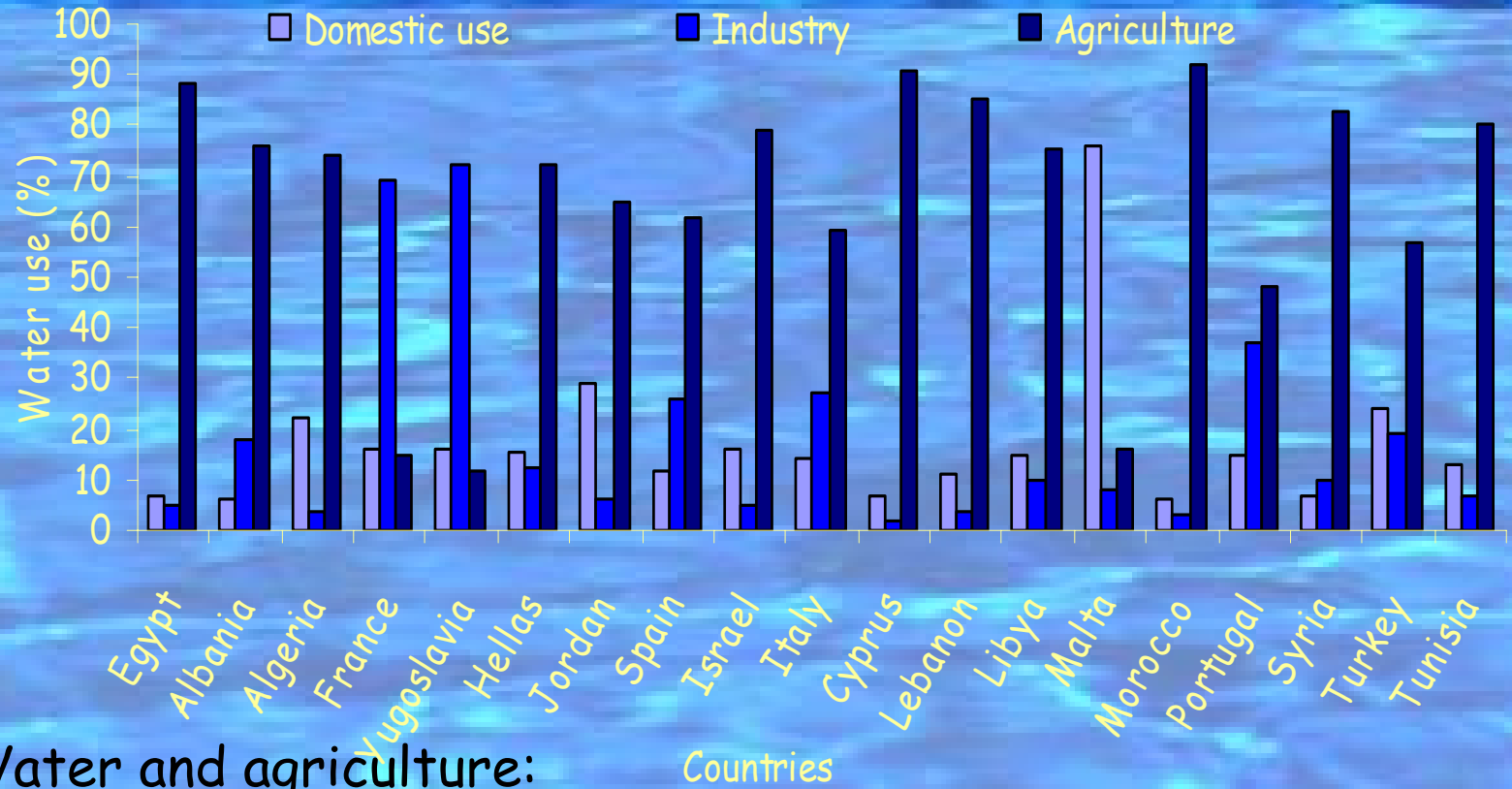
Introduction

- Water: - the most critical resource for sustainable development
  - essential for agricultural, industrial and economic growth
- Water resources under stress due to:
  - rapid growth of population
  - extension of irrigation
  - industrial development
- Water and agriculture:
  - agriculture accounts for 70% of water used
  - irrigated area increased more than 6 fold since 1900
  - today 40% of the worlds' food comes from the 18% of irrigated agriculture

Water use in agriculture



- Water and agriculture:
  - irrigation water demand will increase by 14% by 2025
  - 8-15% of fresh water supplies will be diverted from agriculture to meet the domestic and industry demands
- To overcome the shortage in agriculture:
  - Increase the water use efficiency
  - Use of marginal waters (brackish, reclaimed, drainage)

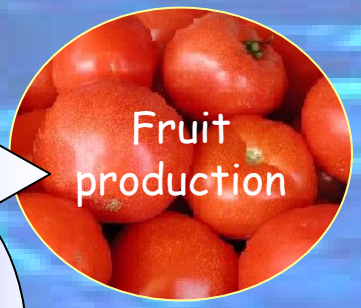
Water use by the crop

Agricultural production needs high water consumption

Water required for production of 1 kg dry matter	m^3 water
Potatoes	0.5
Tomatoes	0.6 – 1.0
Wheat	0.9
Rice	1.9

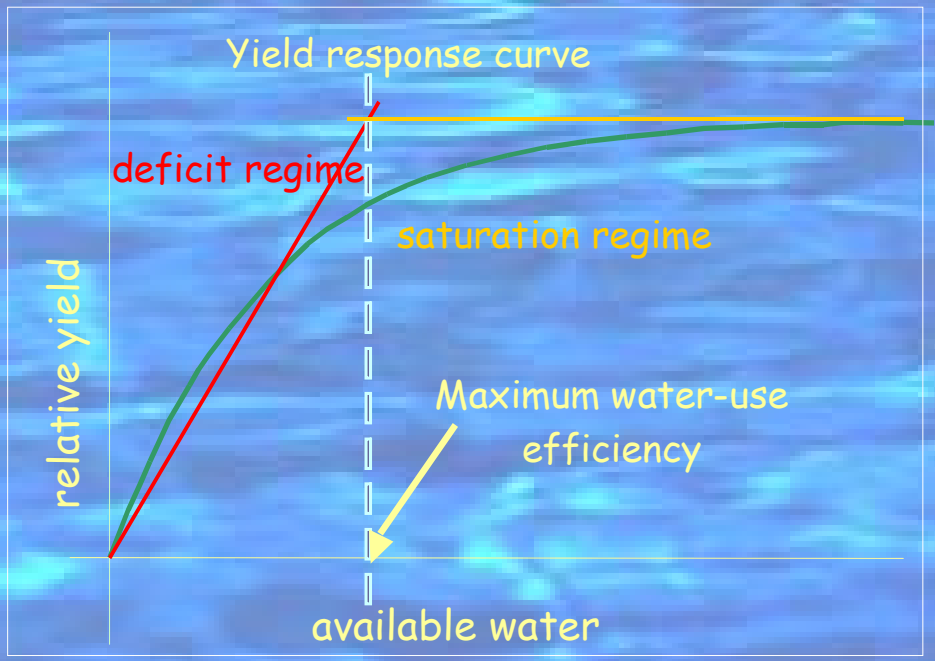
Evapotranspiration
60 - 90%

Biomass ≈ 10%



Water use by the crop

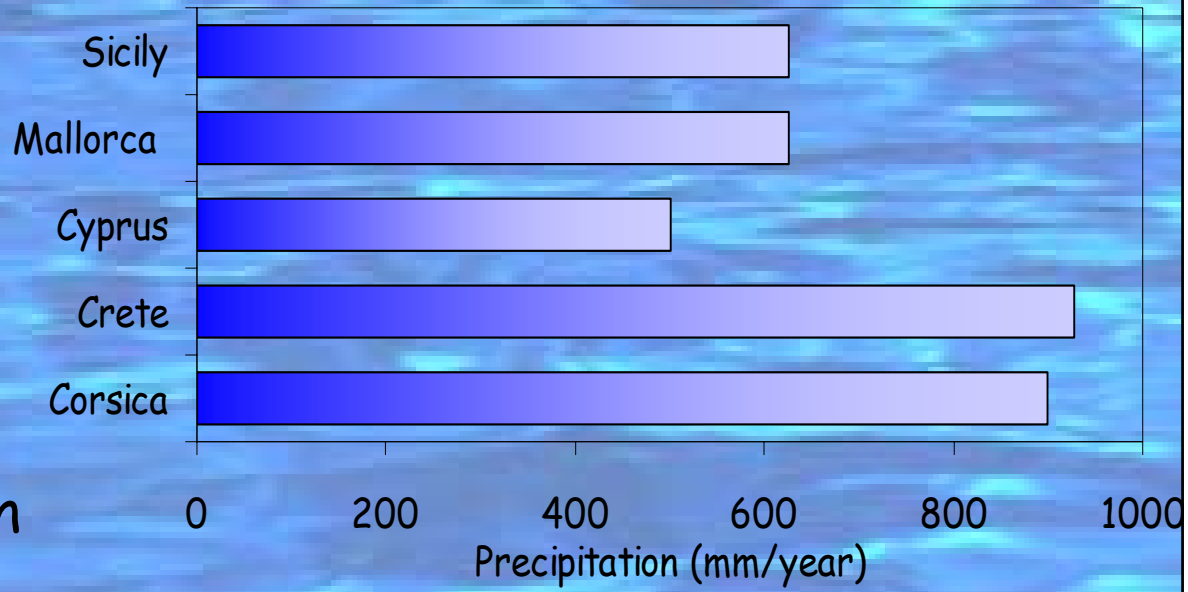
- Crop yields increase with water availability in root zone until saturation level.

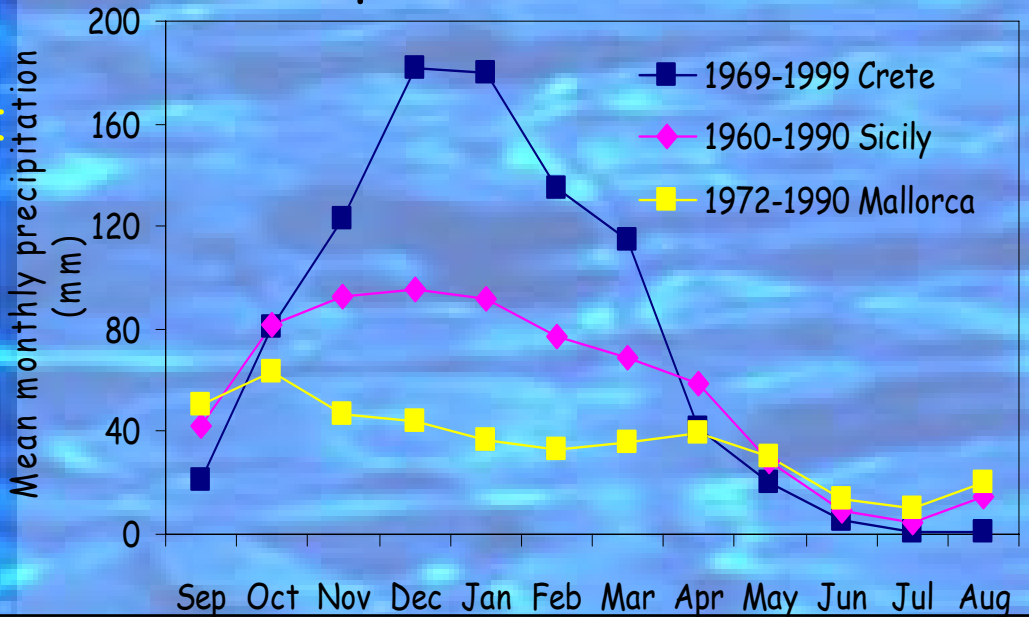


- Yield response curve depends on:
  - weather conditions
  - soil type
  - agricultural inputs
- Difficult for a farmer to know at any moment, if there is a deficit or not.
- Farmers usually tend to «play safe» increasing the irrigation amount, especially when it is associated with low cost.

Water resources

- Mean average rainfall ranges from 500 mm/yr in Cyprus, up to 900 mm/yr in Crete and Corsica
- Precipitation is uneven distributed in time and space





- Crete – Cyprus: 70-80% of total rainfall occurs in three to four months (November to February)

Water resources

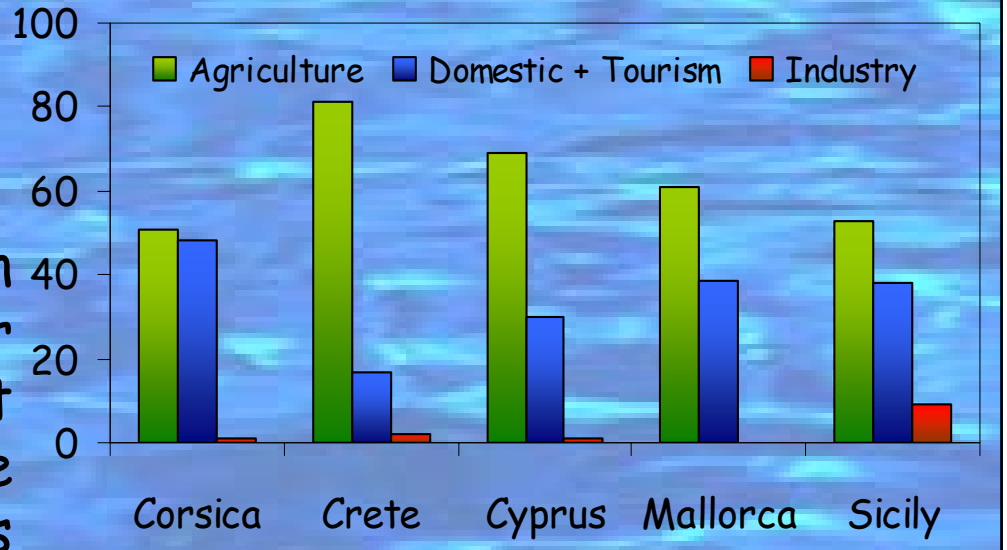
- Total water used in Mediterranean islands and origin of the water in Mm^3 (data 2000)

	Total water used	Origin of water (% of water used)			
		Groundwater	Surface water	Recycled water	Desalinated water
Corsica	86	21	79	-	-
Crete	372	93	7	-	-
Cyprus	266	48	38	1	13
Mallorca	246	90	3	7	-
Sicily	1875	78	21	-	1

Groundwater is the main source of water in most Mediterranean islands. Exception: Corsica where most of the water comes from surface reservoirs

Water resources

- Agriculture is by far the main water user (55% in Corsica up to 82% in Crete)
- Groundwater is the main source of irrigation water in most islands except Corsica where all the irrigation water comes from surface reservoirs



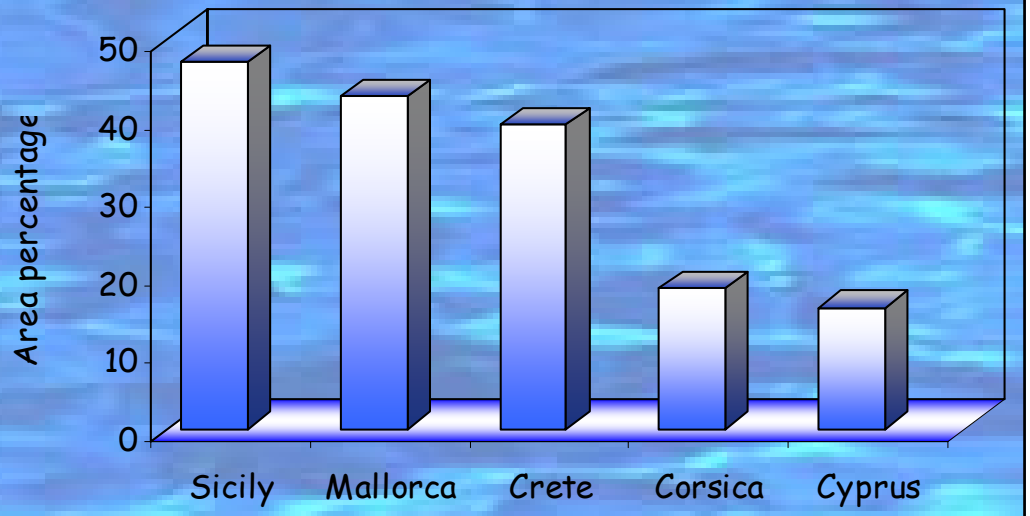
- Treated wastewater, although a valuable irrigation water resource, its use is limited for crop irrigation (Cyprus 1%). In Mallorca treated wastewater is used for golf courses irrigation

	Cyprus	Mallorca	Crete	Corsica	Sicily
Groundwater	55 %	91 %	93 %	-	68 %
Surface water	44 %	-	7 %	100 %	32 %
Recycled water	1 %	9 %	-	-	-

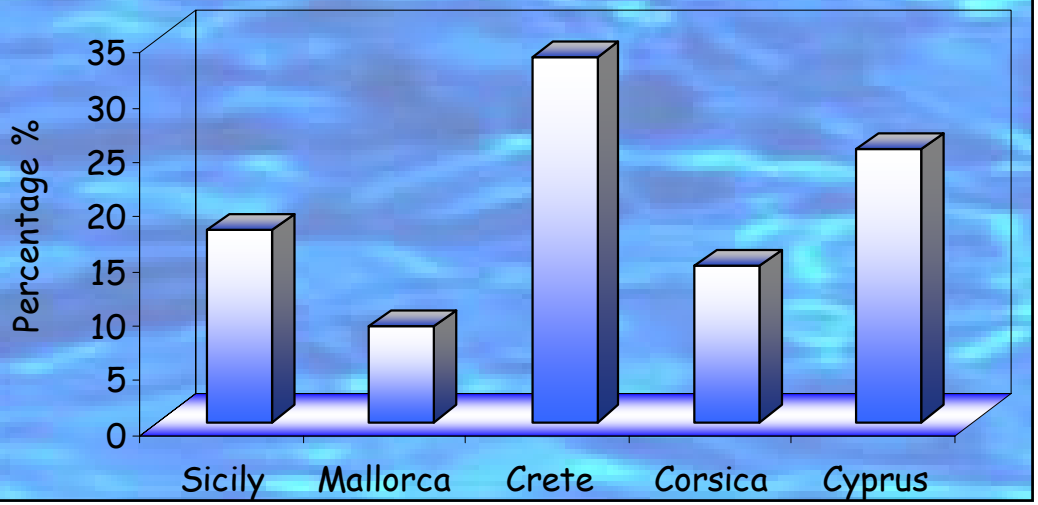
Agriculture and crops

- Area used for agriculture varies a lot among the islands, ranging from 16% in Cyprus up to 47% in Sicily. There is a trend for reduction of agricultural land in most islands.
- Crete has the highest % of irrigated land (33%)
- Although Mallorca has the lower % of irrigated land (8.8%), the total water allocated to agriculture is more than 60% indicating that cultivated crops (row crops) are high water demanding crops

Percentage of cultivated land

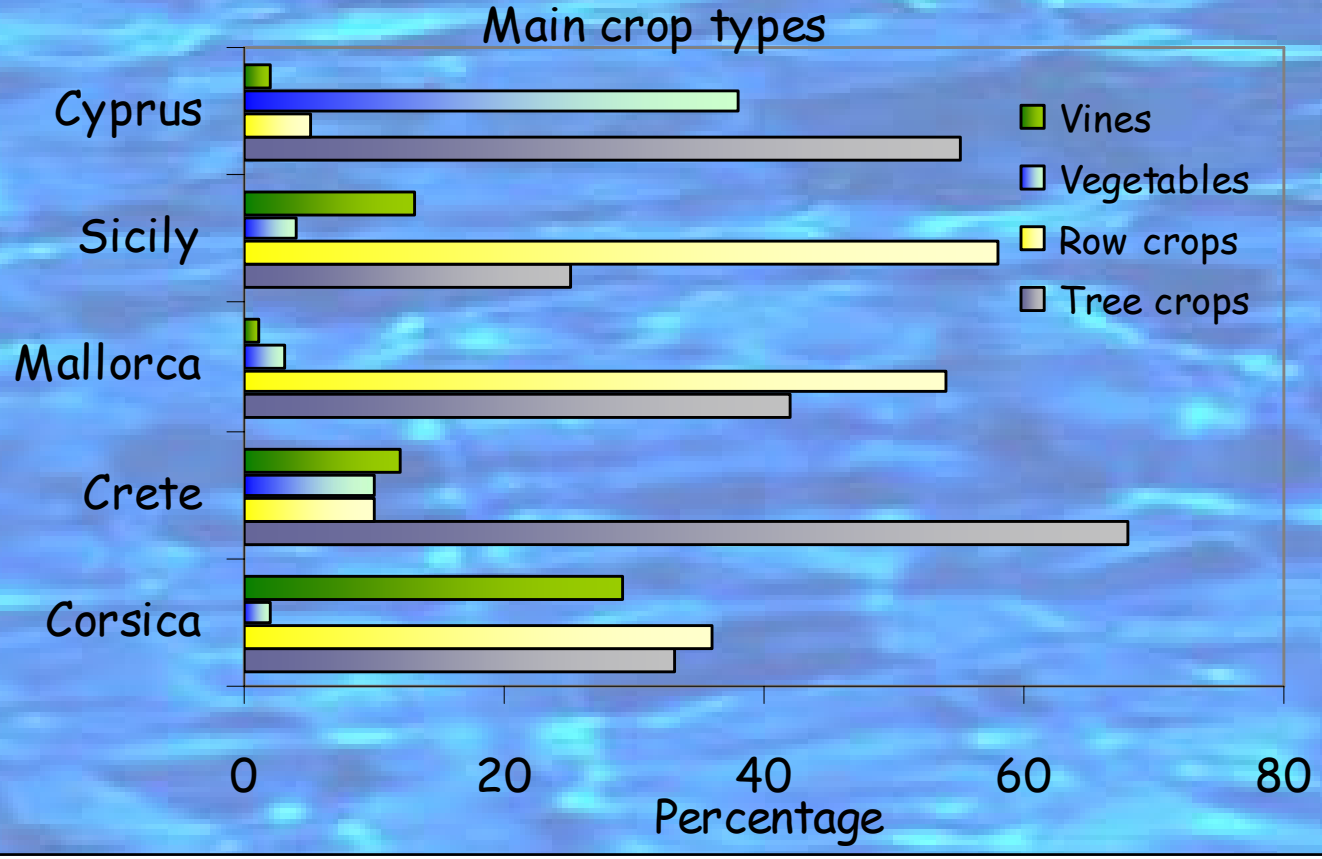


Irrigated agricultural land

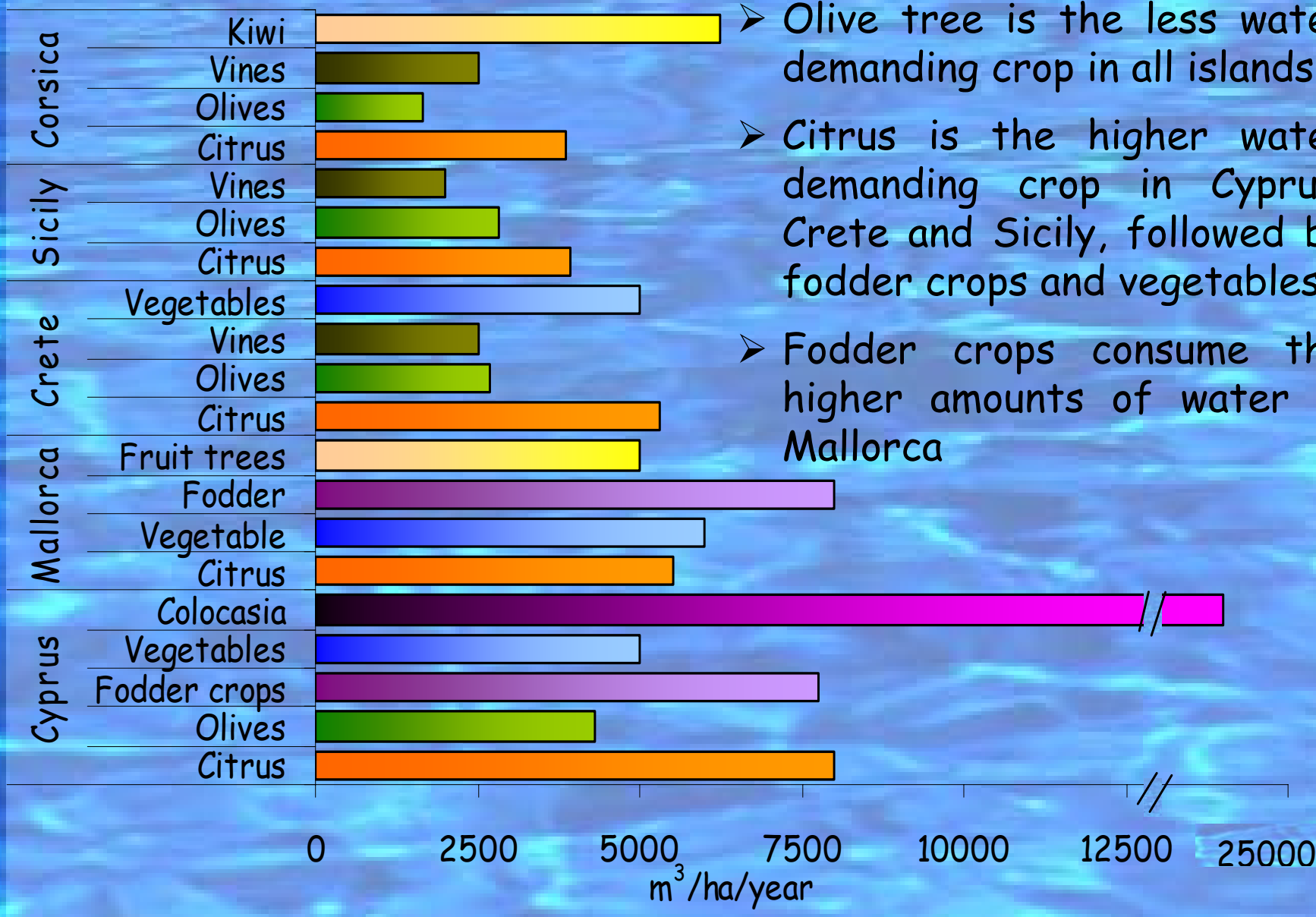


Agriculture and crops

- Crops grown in Mediterranean islands, are mainly the same due to similar climatic conditions, but there are significant differences in the importance of each crop among the islands
- Main groups of crops in Mediterranean islands



Crop water requirements



- Olive tree is the less water demanding crop in all islands
- Citrus is the higher water demanding crop in Cyprus, Crete and Sicily, followed by fodder crops and vegetables
- Fodder crops consume the higher amounts of water in Mallorca

Irrigation systems

Irrigation systems

- In all islands modern irrigation systems have been used (drip, sprinkler, micro-irrigation)
- Localized irrigation systems (drip or mini-sprinklers) are used for tree crops irrigation
- Sprinkler irrigation is mostly used for fodder crops and some vegetables (potatoes in Mallorca and Cyprus)
- Vegetable and greenhouse crops are irrigated with advanced irrigation systems, which support simultaneously fertilizer application
- Traditional surface irrigation methods (furrows, basins, flooding) are rarely used in some areas

Irrigation scheduling

- Is an irrigation aspect of utmost importance for the appropriate irrigation of horticultural crops
- It consists of methods and procedures which allow for a given crop the estimation of the time and amount of irrigation
- Irrigation scheduling is done empirically by the farmers and only few of them use meteorological parameters (like class A pan evaporation) for tree crops or soil moisture monitoring for greenhouses
- Constrains for efficient irrigation scheduling:
  - lack of flexibility → rigid schedules
  - lack of flexibility → system limitations
  - non-economic pricing of water →covers less than 30% of its cost
  - cost of irrigation scheduling
  - lack of education and training → technology
  - lack of education and training → labour
  - institutional problems
  - behavioral adaptation

Price of irrigation water

- Price of irrigation water varies greatly among the islands due to different pricing structure and policies
- Water prices often differentiate among areas in the same island or even among catchments
- Crete: the price is determining by the managing agency of each area. In large publicly operated irrigation projects the price ranges from 0.007 - 0.008 €/m^3, in community or municipality operated projects it reaches 0.10 - 0.15 €/m^3 whereas in some private projects it reaches 0.23 - 0.35 €/m^3
- Cyprus: the price is on average 0.10 €/m^3
- Mallorca: the price ranges from 0.18 - 2.4 €/m^3
- Corsica: the average price is 0.50 €/m^3

Agricultural practices

- Agricultural practices, such as soil management, fertilizer application, disease and pest control are related with the sustainable water management in agriculture and protection of the environment.
- Agriculture practiced in Mediterranean islands is characterized by the abuse of fertilizers.Farmers very rarely carry out soil and leaf analyses in order to clarify the proper quantity and type of fertilizer needed for each crop and they apply them empirically.
- This practice increases considerably the cost of agricultural production and is potentially critical for the deterioration of the groundwater quality and the environment. The fertilizers for tree and row crops are mainly applied by spreading on the soil during winter, while fertigation -the application of the fertilizers through the irrigation system- is practiced mainly for vegetable and greenhouse crops.
- Agrochemicals (herbicides and pesticides) are also excessively used, endangering the quality of the surface water and negatively affect the environment. Plant-protection products (pesticides) are often used preventively, even when there is not real threat in the area.

Recommendations for irrigation water management and agricultural practices

- Sustainable water management in agriculture aims to match water availability and water needs in quantity and quality, in space and time, at reasonable cost and with acceptable environmental impact.

- Its adoption involves:

  - technological problems
  - social behavior of rural communities
  - economic constrains
  - legal and institutional framework
  - agricultural practices

Sustainable water management in agriculture can be achieved by:

Sustainable water management in agriculture

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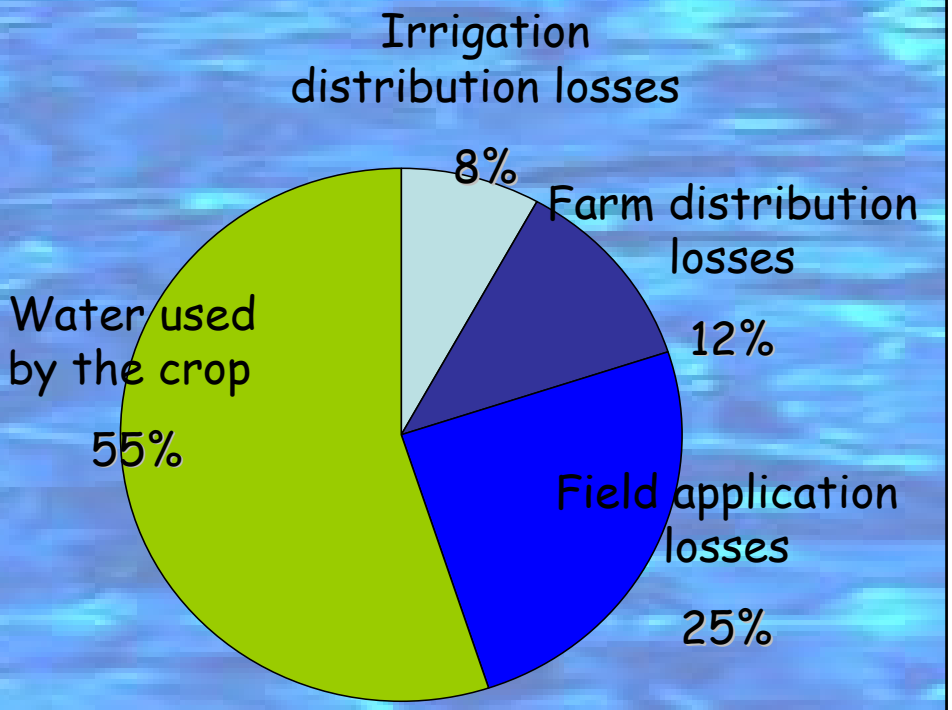
Adoption of best irrigation practices



- Reduction of water losses
  - detect and eliminate any water leakages
- Improve the efficiency or irrigation systems used
  - surface irrigation systems: land leveling and use of short length furrows and basins
  - sprinkler irrigation systems: use pressure regulators in sloping fields, monitor and adjust pressure, good system maintenance
  - localized irrigation systems: use a single drip line for a double row crop, control of pressure, adjust the amount and the duration of irrigation according to soil characteristics

Sustainable water management in agriculture

- Increase water use efficiency
  - obligatory use of localized irrigation systems
  - establish an advisory system for advising the farmers for irrigation
  - apply proper irrigation scheduling
- Adopt innovative irrigation techniques
  - adopt new techniques which require reduced amount of water like regulated deficit irrigation (RDI) and partial root drying (PRD) in water scarce regions
  - apply fertigation (fertilizers applied though the irrigation system)

Sustainable water management in agriculture

b) Adoption of best soil and crop management practices

- Soil management

  - soil surface tillage
  - contour tillage where soil cultivation is made along the land contour
  - conservation tillage, including no-tillage and reduced tillage, in order to maintain high levels of organic matter in the soil
  - mulching with crop residues on soil surface
  - increasing or maintaining the amount of organic matter in the upper soil layers
  - control the acidity by liming
  - adopt the appropriate weed control techniques

Sustainable water management in agriculture

- Crop management
  - selection of crop patterns taking into consideration seasonal rainfall, crop variety and water productivity of the crop
  - adoption of water stress resistant crop varieties
  - use of short cycle crops or varieties
  - rational use of fertilizers

c) <u>Water pricing</u>

- irrigation water tariffs must cover the O&M cost of water use and services
- volumetric water metering must be obligatory
- progressive, seasonal and over-consumption water tariffs (quotas) should be promoted
- an increasing block tariff charging system, for those exceeding crops' critical water requirements, must be established

Sustainable water management in agriculture

d) Reuse of marginal waters (reclaimed or brackish) for irrigation.

- Use of reclaimed waters (under some restriction) for irrigation of tree, row and fodder crops
- The tariff for this source of water should be lower than the tariff of the primary sources
- When using low quality water (brackish or reclaimed), an integrated approach for water, crop (salt tolerant varieties), field management (suitable tillage) and irrigation system (adequate leaching, suitable devices) should be considered

Sustainable water management in agriculture

e) Wider and more effective participation of farmers in water management. It will ensure:

- better preparation of the plans and decision-making
- monitoring implementation of water management
- safeguard the acceptability of the plans by the general public
- raise support from political administrative authorities
- promote easier resolutions in possible conflicts

Sustainable water management in agriculture

f) Strengthening capacity

- Education and training of professionals, technical staff and decision makers on subjects related to sustainable water management
- Manpower build up. Institutions to be staffed with qualified manpower (managers, engineers, technicians, social scientists)
- Facilities and procedures. Water authorities at all levels of management should be equipped with technologically advanced devices and programs e.g. computers and software for the application of new techniques such as GIS, remote sensing etc.
- Legislative changes. Should be conducive to water directive WFD60/2000


THANK YOU!