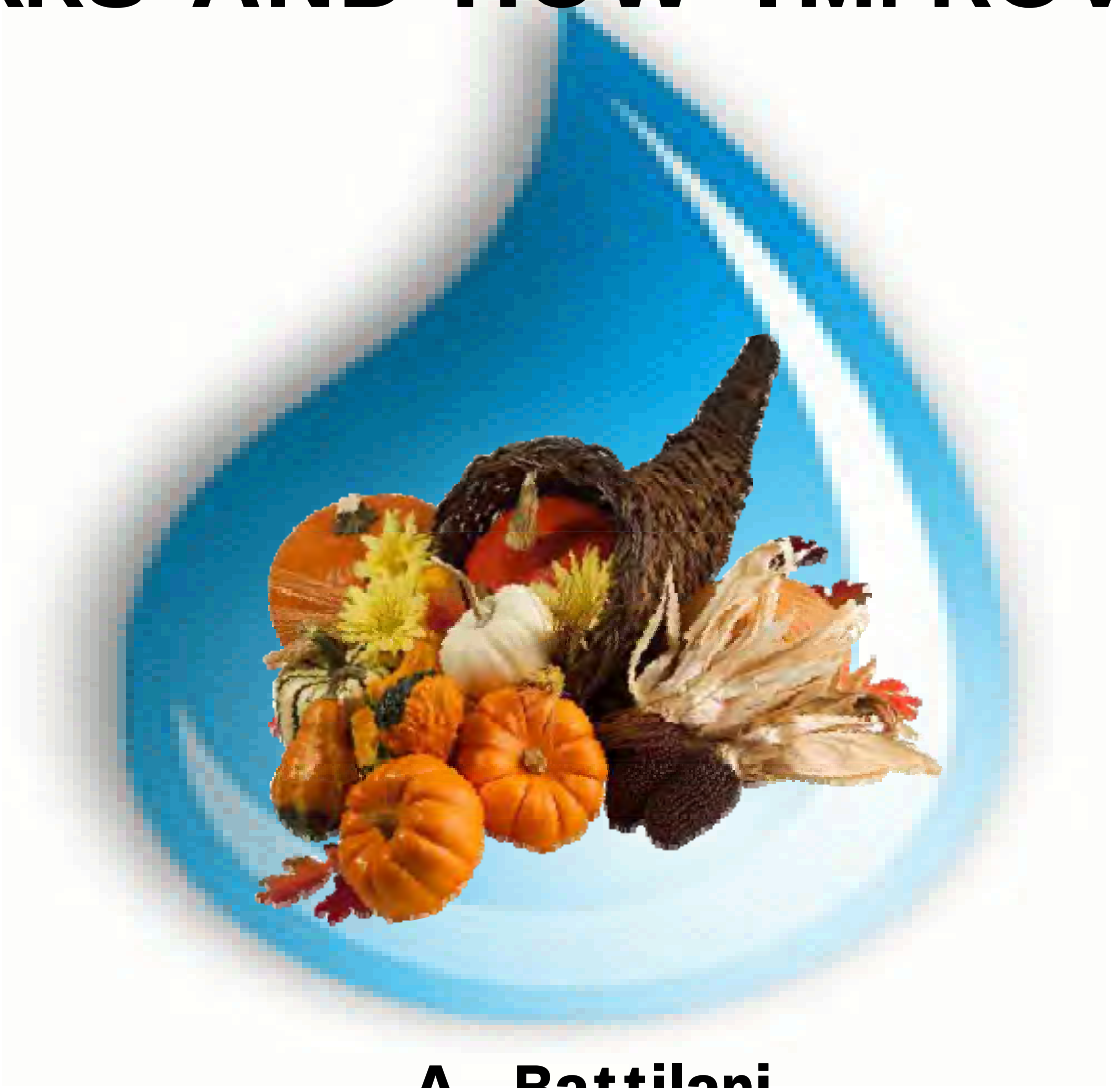
CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

WATER PRODUCTIVITY: HOW IT WORKS AND HOW IMPROVE IT



A. Battilani

CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

BULLET POINTS

1) The report "Toward a water efficient Europe" (EEA, Jan.2012) underline the need to **INCREASE WATER PRODUCTIVITY** in order to effectively support the EU Green Economy and Agriculture

2) DG Agriculture reports are claiming that we must **DOUBLE BIOMASS PRODUCTION** in the next 5 to 10 years in order to give a chance to the EU Green Economy

3) FAO's scenario analysis for year 2050 have shown an **increase of 74% of global food demand** (up to 100% in LDC) while **pro capita arable land will drop of -20%**. The expected arable land expansion is of 5 and will produce 12% more food. **Yield increase and higher crop intensity are expected to contribute to fill respectively 74% and 14% of the gap. Irrigated land will increase of 7%**, while **irrigation use will be more intense and diffuse** even in northern countries. **"MORE CROP PER DROP"**

CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

WATER PRODUCTIVITY: HOW IT WORKS

Still there is not a common agreement on the use of WATER PRODUCTIVITY as indicator.

The WATER PRODUCTIVITY index may only express a physical ratio between yields, or its value, and the water used to produce it.

$$\text{Water productivity} = \frac{\text{Actual Yield}}{\text{Actual water use}}$$

CONSORZIO DI BONIFICA DI SECONDO GRADO PER IL CANALE EMILIANO ROMAGNOLO

WATER PRODUCTIVITY: HOW IT WORKS

ACTUAL YIELD: produced fresh matter biomasses (total or commercial)

ACTUAL WATER USE:

as Outflow: Plant Transpiration, Salinity Leaching Factor, Percolation, Runoff, Soil Evaporation

as Inflow: Rainfall, Capillary Rise, Soil Water consumption, Irrigation

$$\text{Max WP} = \frac{\text{Max Yield}}{\text{Opt. Beneficial Water Uses + Min NOT BWU}}$$

CONSORZIO DI BONIFICA DI SECONDO GRADO PER IL CANALE EMILIANO ROMAGNOLO

WATER PRODUCTIVITY: HOW IT WORKS

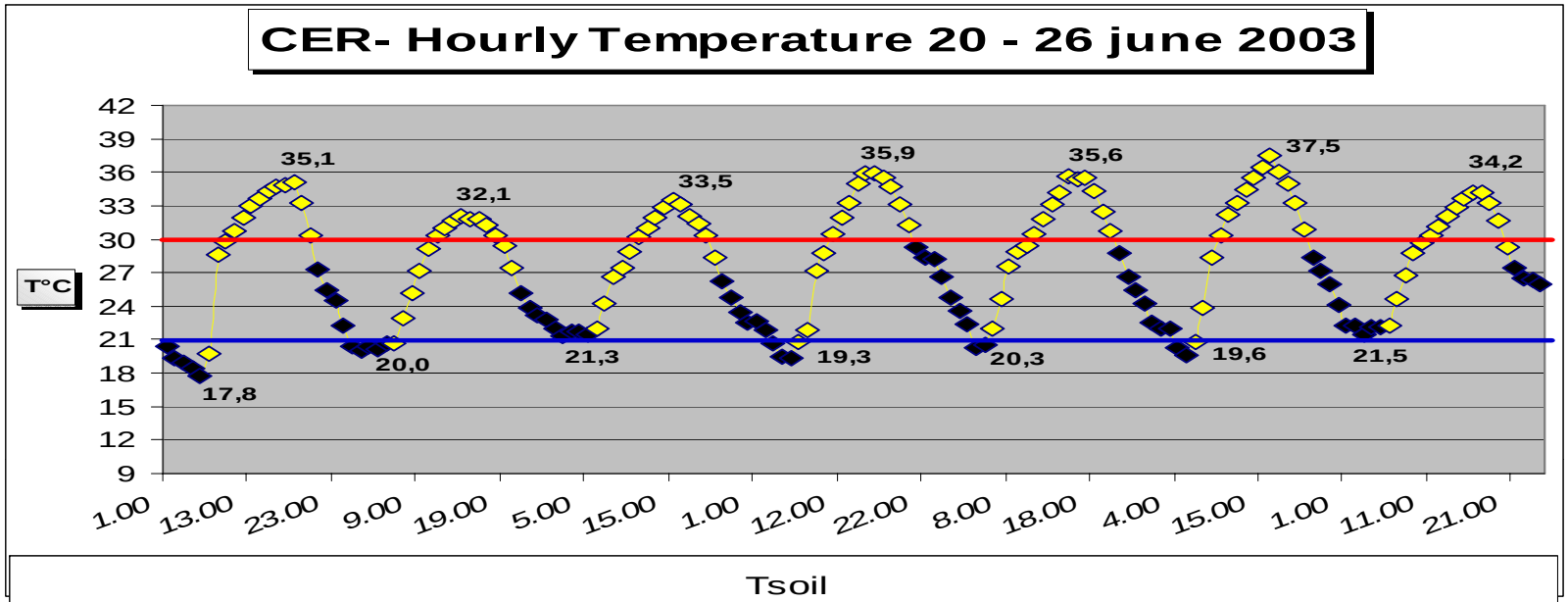
Water productivities are lower under very high climatic demand because crop water requirements are then the highest.

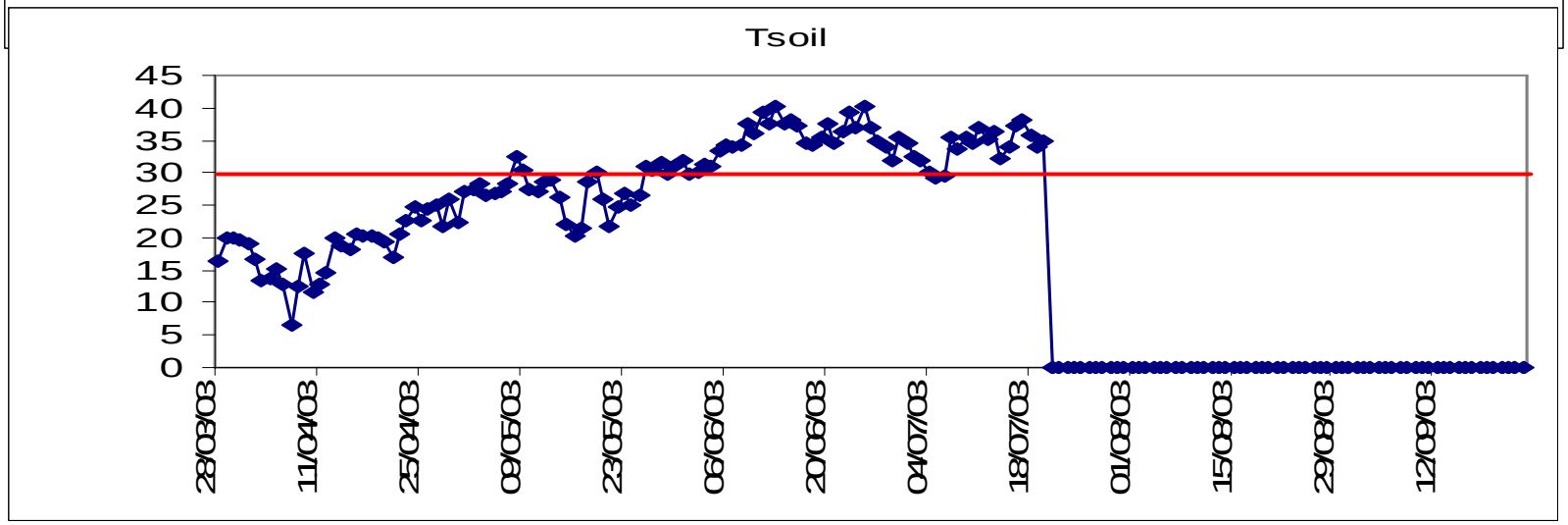
Are all the parameters correctly estimated under these conditions??

Under stress reduction in yields could be not fully recovered by Irrigation supply, thus the dividend (Yield) decrease while the divisor (Water Use) increase, resulting in a decrease in WP.

CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

WATER PRODUCTIVITY





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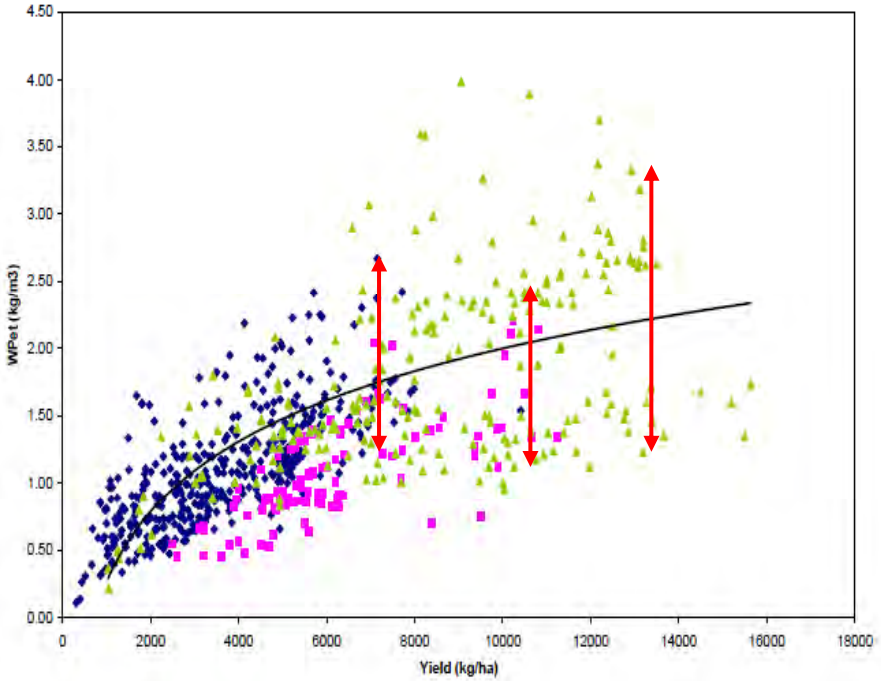
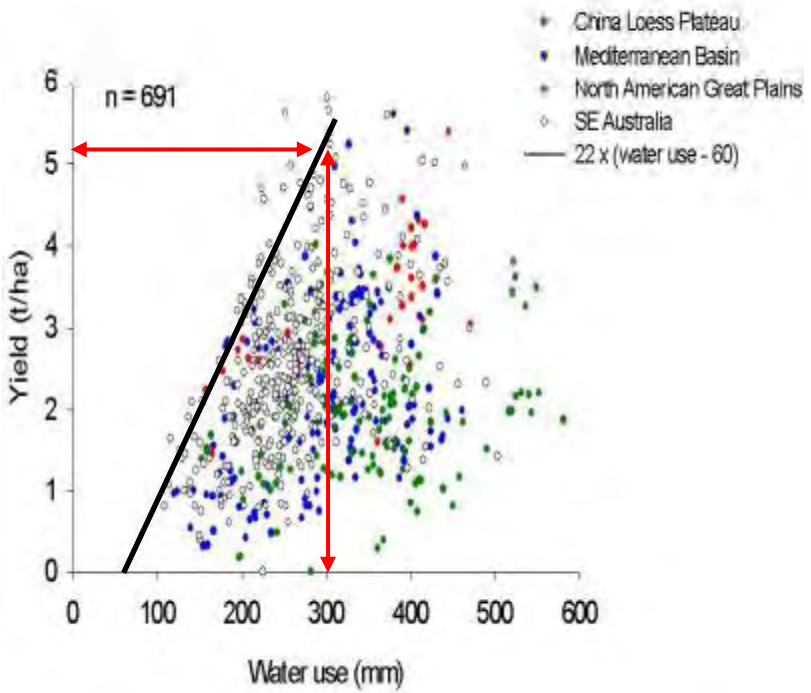
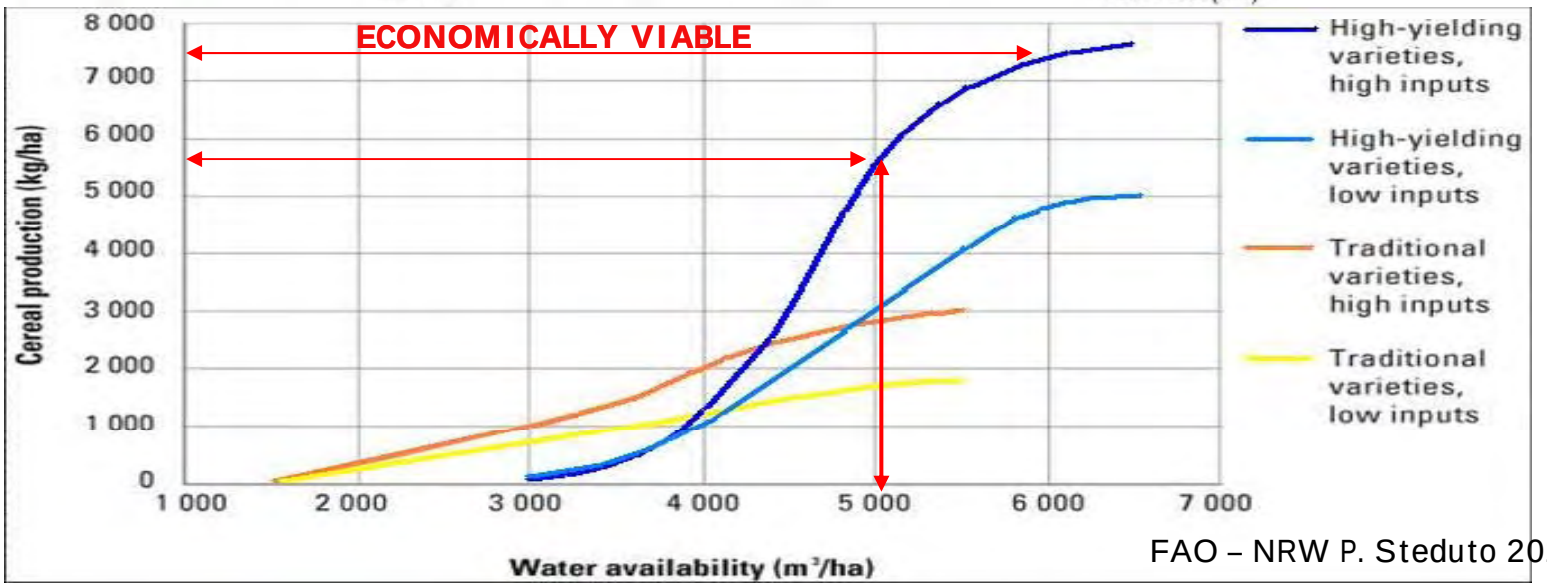
CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

WATER PRODUCTIVITY

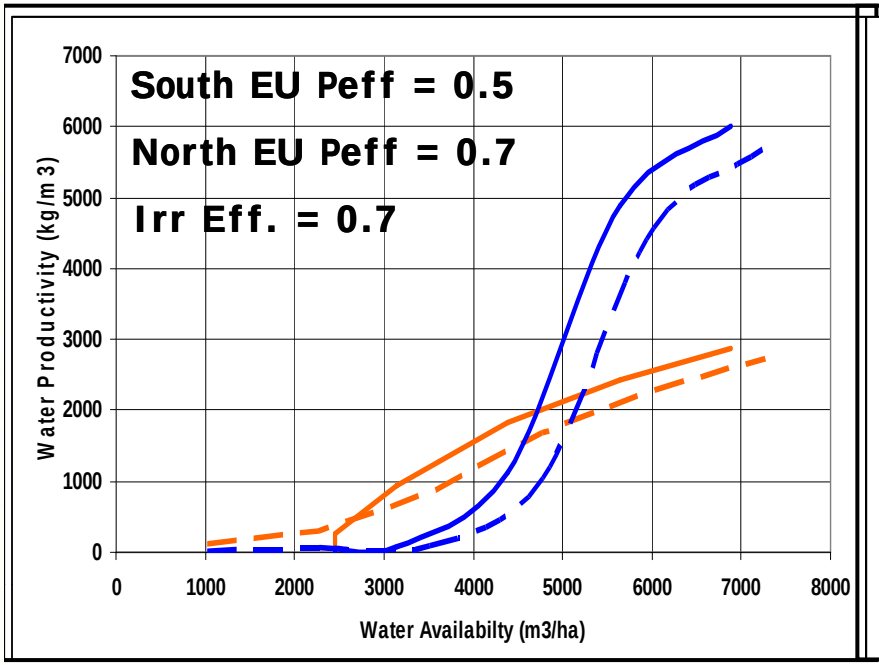


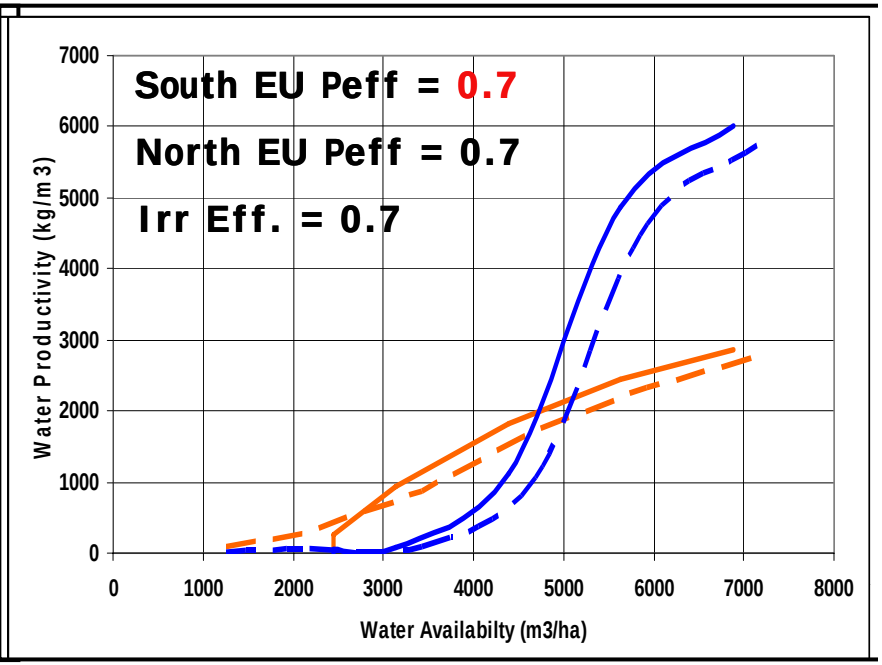


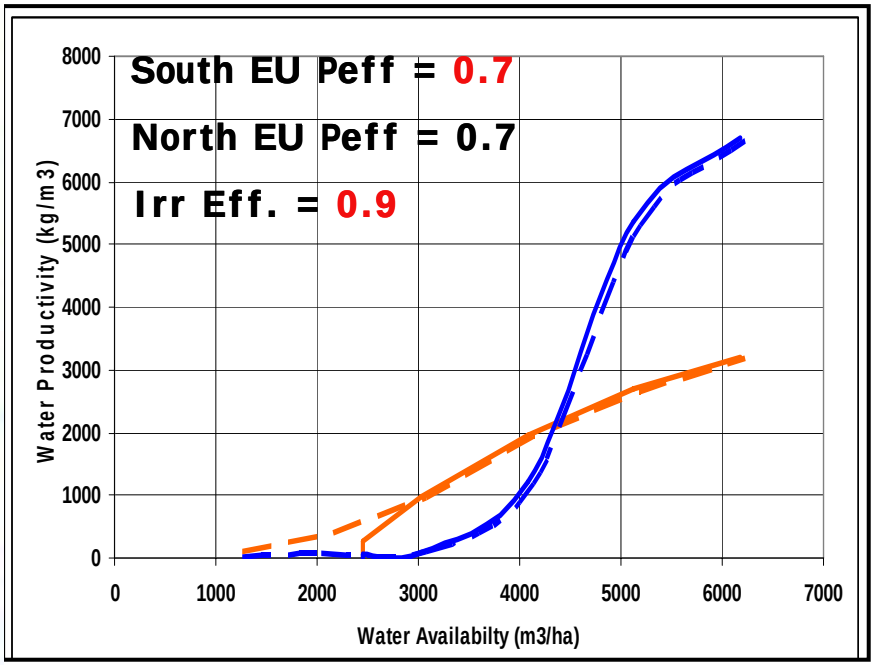


FAO – NRW P. Steduto 2011

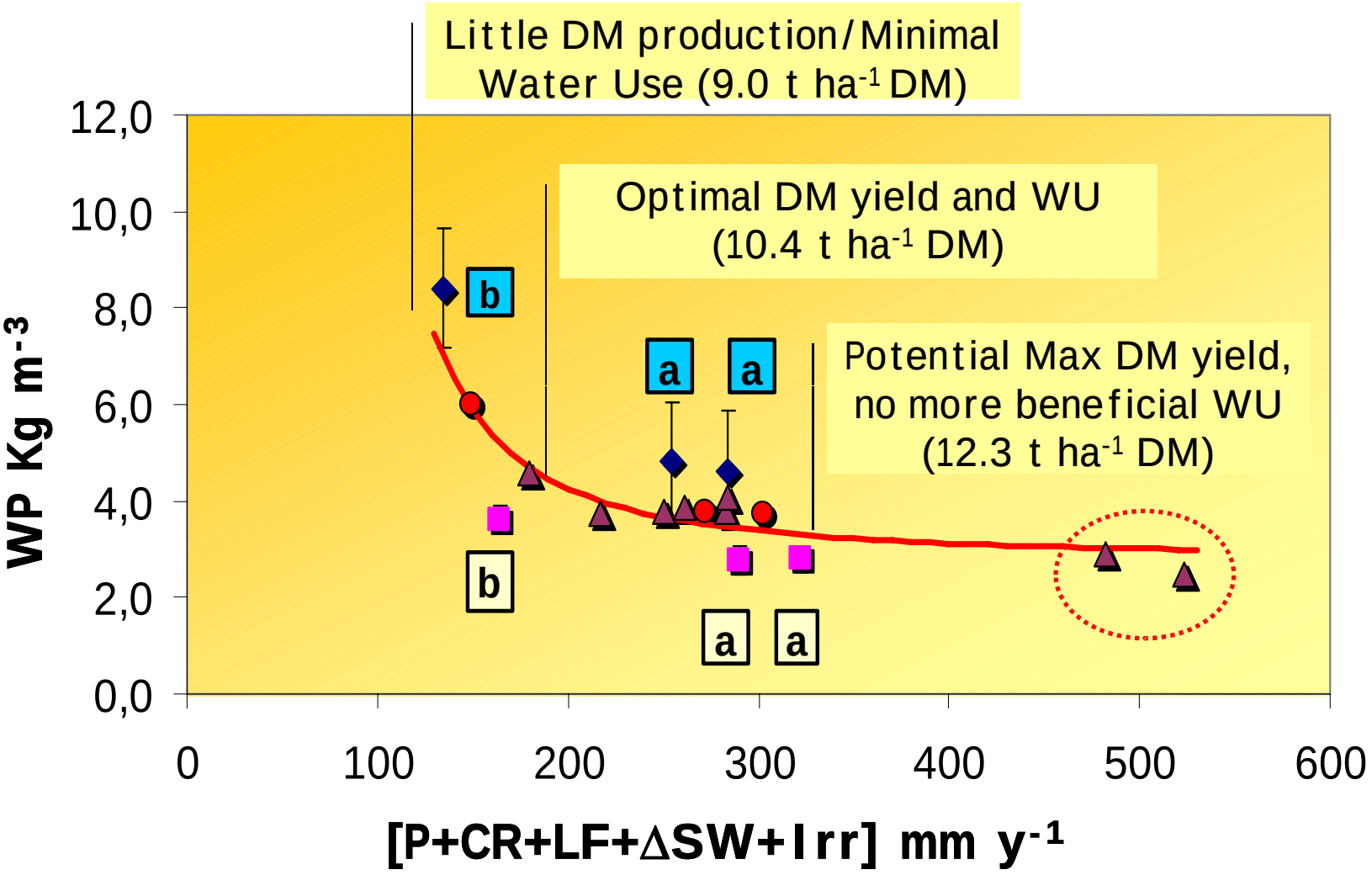
CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO







Water Productivity



Battilani, Dalla Costa Lovatti, 2002

CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

WATER PRODUCTIVITY: HOW INPROVE IT

a) TECHNOLOGICAL INNOVATION

b) BETTER GOVERNANCE AND MANAGEMENT

c) DEFICIT IRRIGATION STRATEGIES

d) DECREASE SOIL EVAPORATION

e) IRRIGATION SCHEDULING

f) REDUCE RUNOFF (AND PERCOLATION)

g) CONSIDER ALL THE INPUTS (I.E WATER TABLE)

h) WATER REUSE

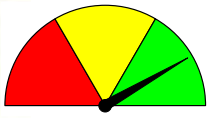
i) CROPPING SYSTEM IMPROVEMENT

(BioIntelligence reports -EU ENV 2012)

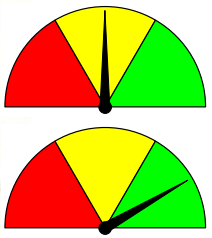
e) *TRADE AND CONSUMERS RESPONSABILITY*

CONSORZIO DI BONIFICA DI SECONDO GRADO PER IL CANALE EMILIANO ROMAGNOLO

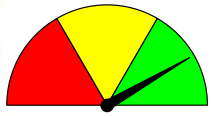
TECHNOLOGICAL INNOVATION



Improvement of Surface Irrigation: don't requires new infrastructure such energy supply, changes in conveyance systems or relevant investments by the farmer. **Up to 50-60% potential water saving**.



Convert surface to Sprinkler irrigation: labour and energy cost will significantly weight upon the irrigation costs. Water conveyance will be positively affected by reduction of irrigation volumes and instant flow. **Up to 40% potential water saving**.



Drip irrigation: less energy, initial investments and labour costs. The impact on the water conveyance systems could be very high (up to 24 hours a day of irrigation). **Up to 60% of water with respect to Surface Irrigation and up to 25% with respect to Sprinkler Irrigation.**

CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

TECHNOLOGICAL INNOVATION

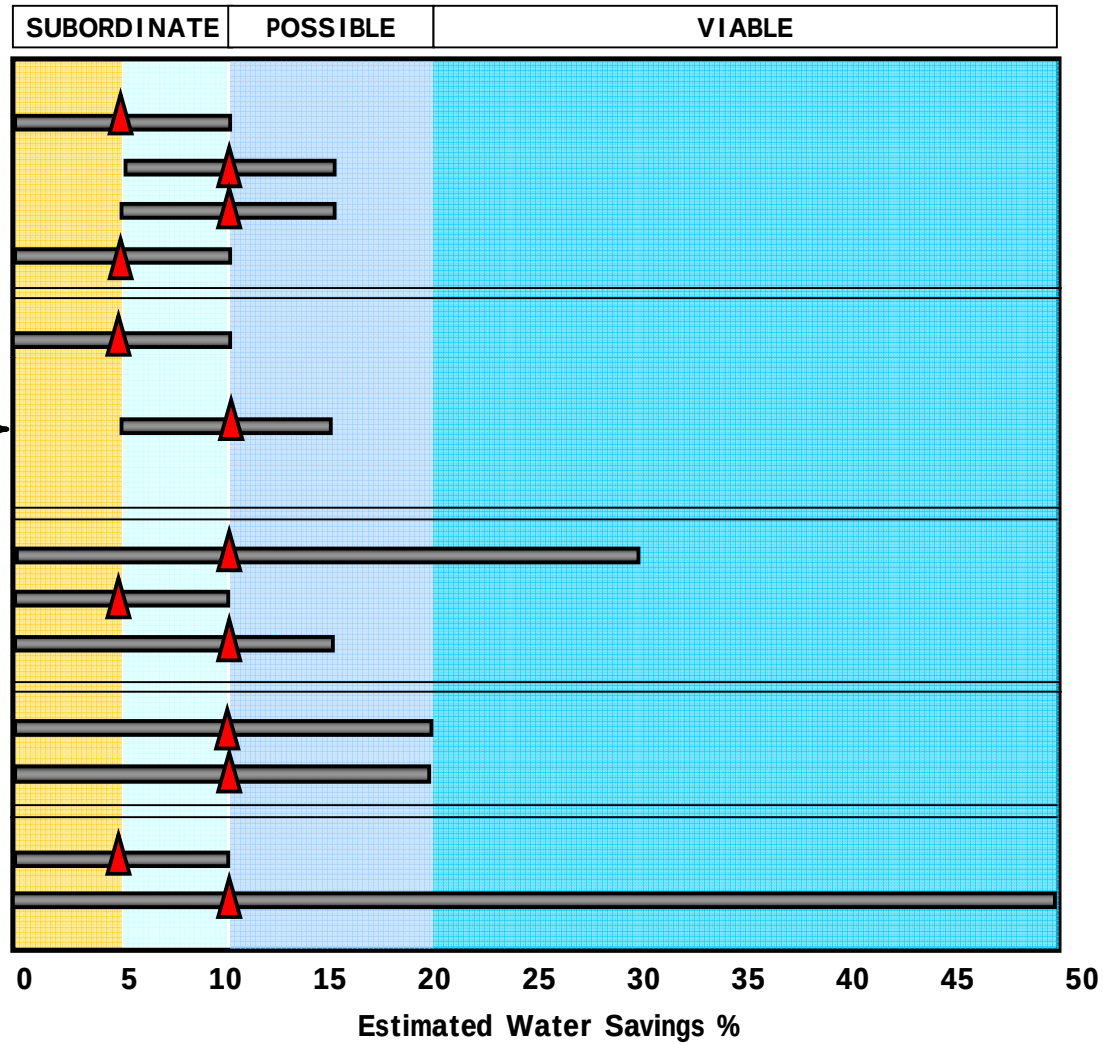
SPRINKLER
Increase uniformity >80%
Reduce angle impact
Lower pressure (-0.7/1.5 bar)
LEPA

DRIP
Better pressure control
Compensating pressure/CNL emitters,
buried driplines, pressure control devices,
operating maintenace

TRAVELING SYSTEMS/REEL MACHINES
Speed compensation
Low angle gun (18°)
Adequate operating pressure and maintenance

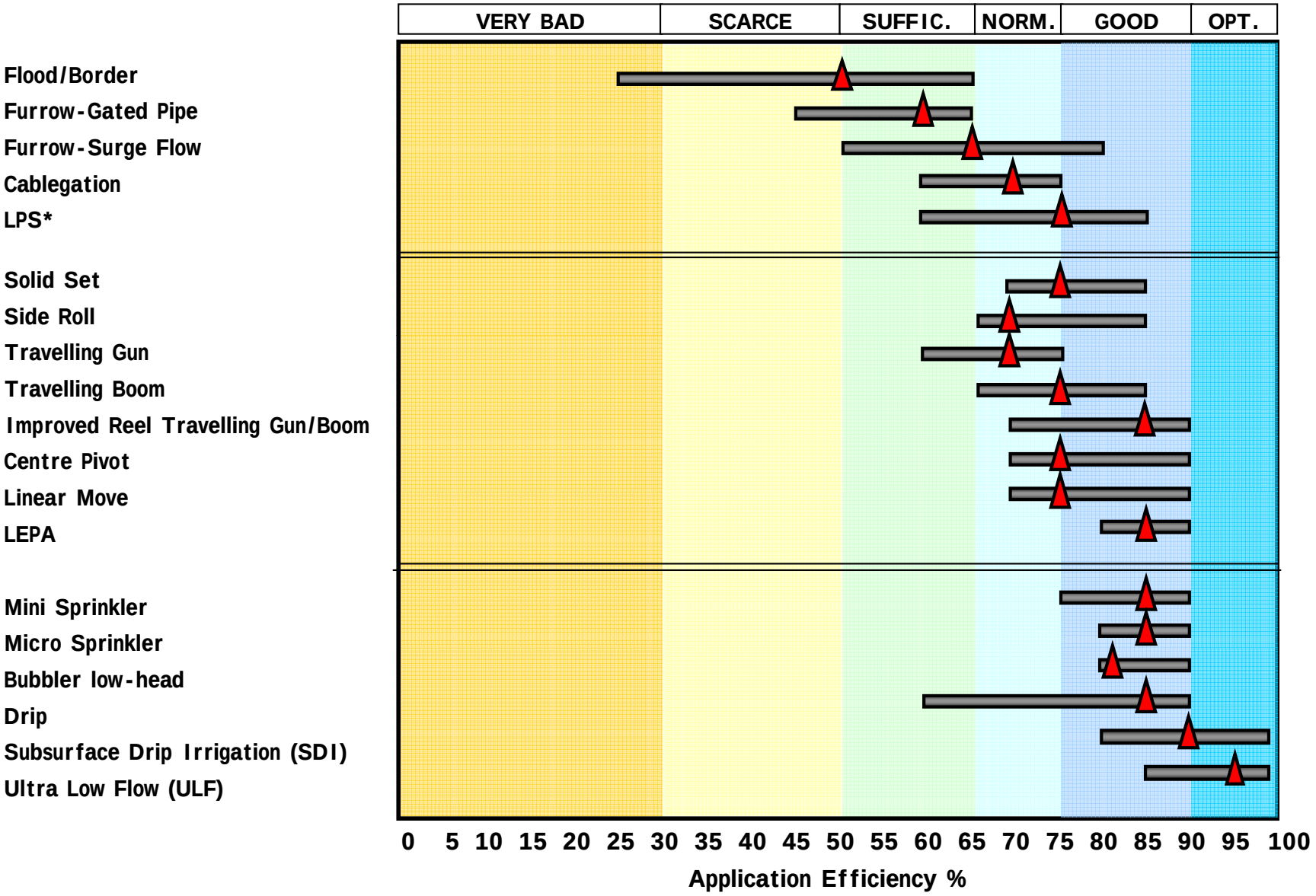
SOLID SETS
Proper sprinklers spacing, pressure, uniformity
Proper sprinkler angle

OVERALL
Uniformity test (5 year period)
Irrigation Audit



CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

TECHNOLOGICAL INNOVATION



CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

NEW TECHNOLOGIES ARE NOT A PANACEA

In order to *improve the productivity of water in irrigated agricultural systems* a single step improvement of the irrigation technologies can be not sufficient.

Technological innovation by itself cannot produce the expected results while, when not correctly applied, can cause losses arising on investments made by Farmers, thus decrease the Economic Water Productivity Index.

CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

BETTER GOVERNANCE AND MANAGEMENT

Rainwater Harvesting and Storage: Macro Catchment

Micro Catchment

On the spot Catchment

CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

BETTER GOVERNANCE AND MANAGEMENT

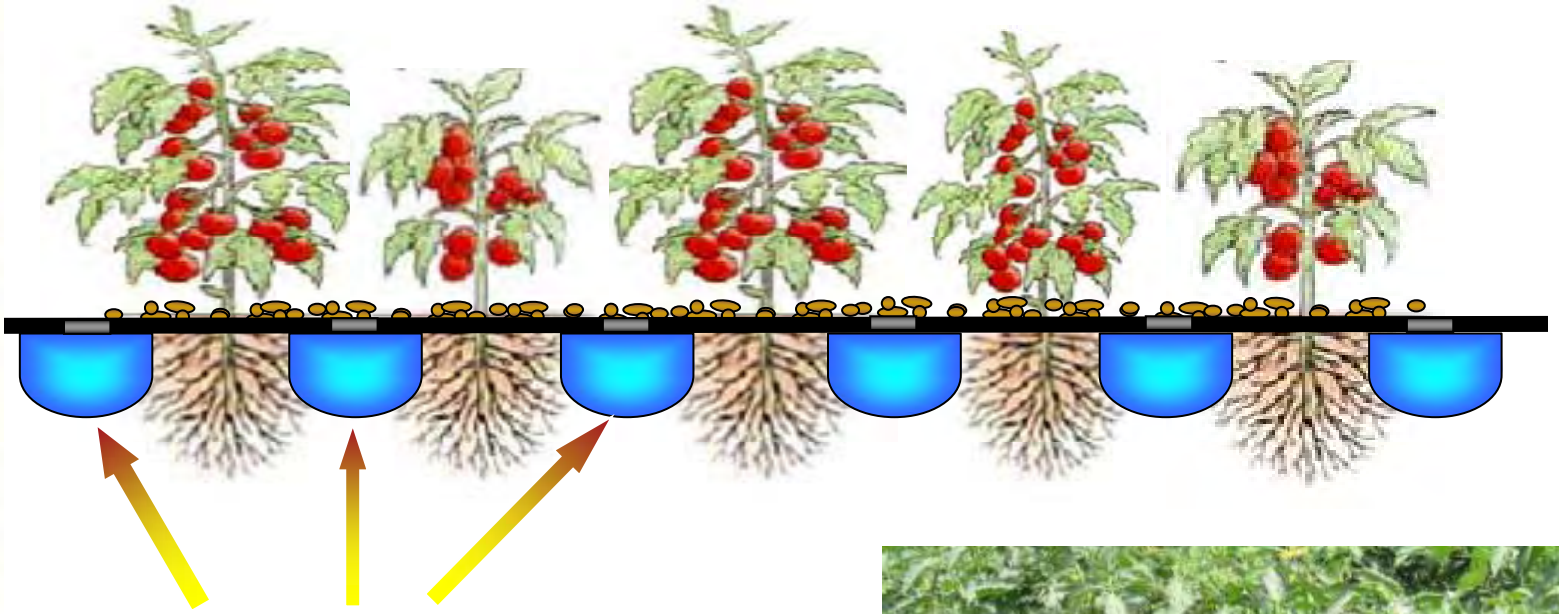
Canal Lining

Irrigation Aqueduct (pressurized)

Intelligent Water Meters

CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

DEFICIT IRRIGATION

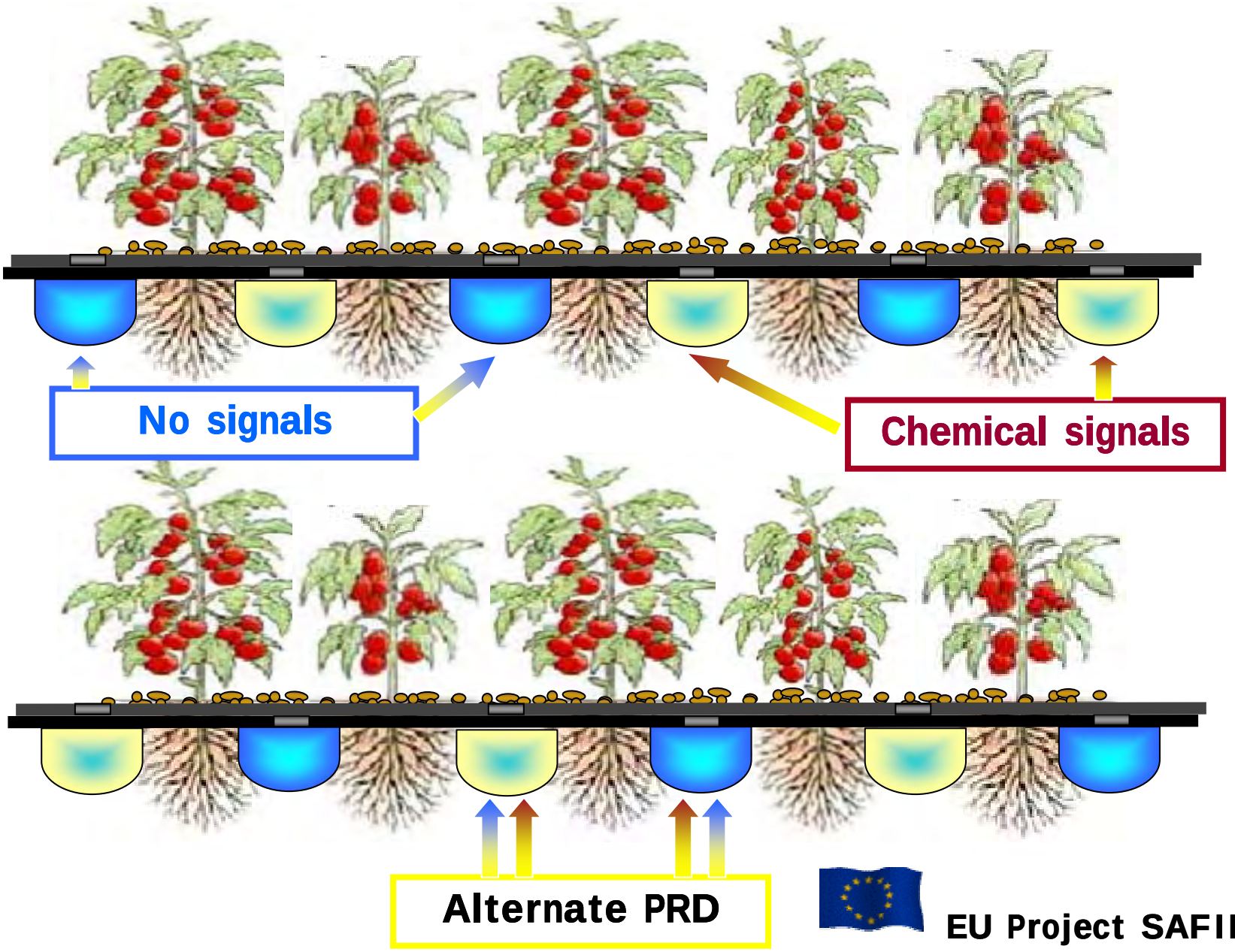


Hydraulic signals to control and reduce evapotranspiration

Deficit (DI) and Regulated Deficit Irrigation (RDI)

CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

DEFICIT IRRIGATION



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CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

DEFICIT IRRIGATION

POTATO

		2006	
		Full Irrigated	*PRD*
WUE Total	DW kg m^{-3}	*1.14 b*	*1.34 a*
WUE Marketable	DW kg m^{-3}	*0.97 b*	*1.21 a*

Avg Water Saving %	
PRD vs FI	PRD vs RDI
15.55	**12.98**

PROCESSING TOMATO

		2006	
		Full Irrigated	PRD
WUE Total	DW kg m^{-3}	1.22 b	1.41 a
WUE Marketable	DW kg m^{-3}	1.00 b	1.13 a

Avg Water Saving %	
PRD vs FI	PRD vs RDI
19.66	**9.18**

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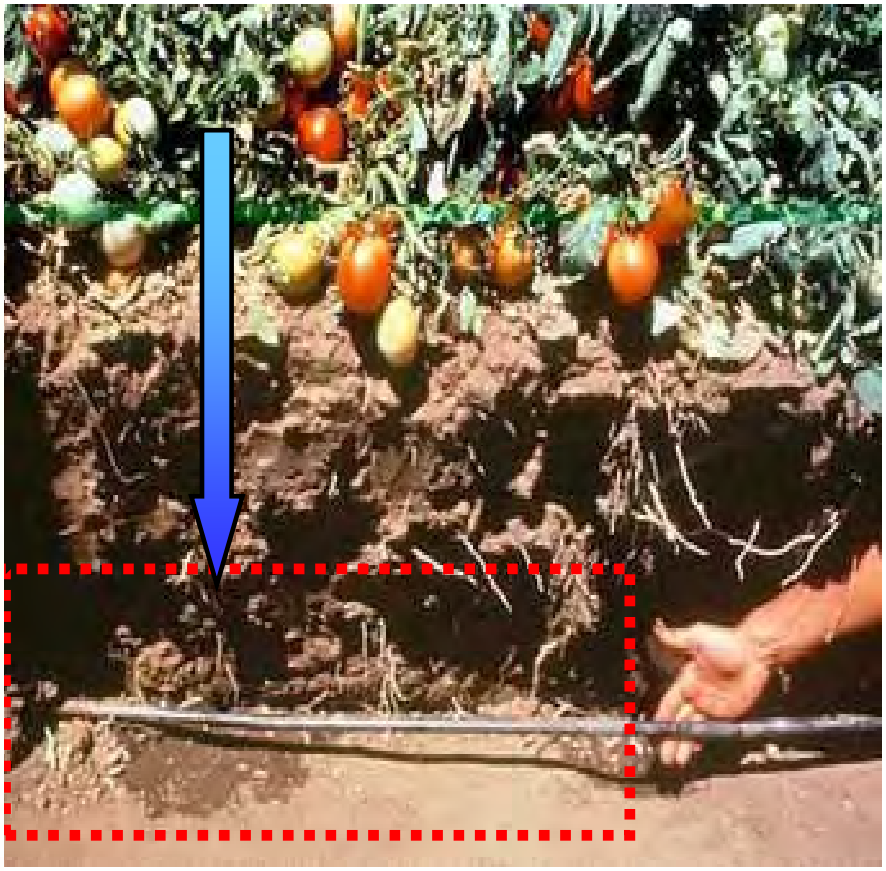
CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

DECREASE SOIL EVAPORATION



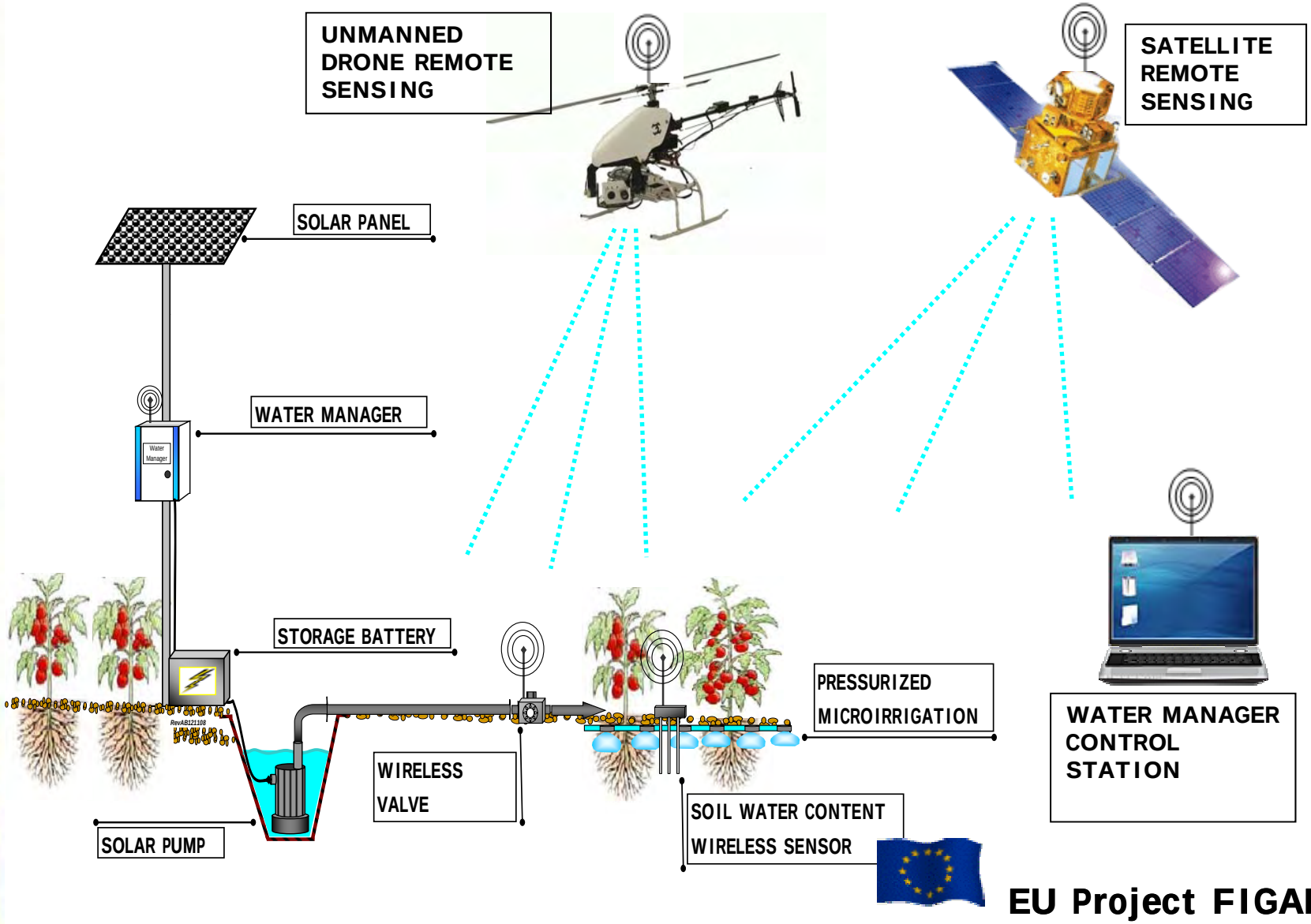
Subsurface Drip Irrigation is worldwide recognized as the most efficient irrigation system, it can virtually eliminate soil evaporation.

CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

IRRIGATION SCHEDULING: PILOT MONITORING STATION

CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

IRRIGATION SCHEDULING: PRECISE IRRIGATION



EU Project FIGARO

CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

MODEL AND DSS APPLICATION

Complex technological/technical systems can not be properly managed without model/DSS support.

TEXT MESSAGE

Involves more than 9000 farms, covering about 33% of the irrigated area in the Emilia Romagna region. More than 50 million m^3 of water saved per year thanks to the application.

CONSORZIO DI BONIFICA DI SECONDO GRADO PER IL CANALE EMILIANO ROMAGNOLO

MODEL AND DSS APPLICATION

Countless studies underline the relevance of irrigation strategies, mainly when coupled with advanced irrigation technologies and crop husbandry practices.

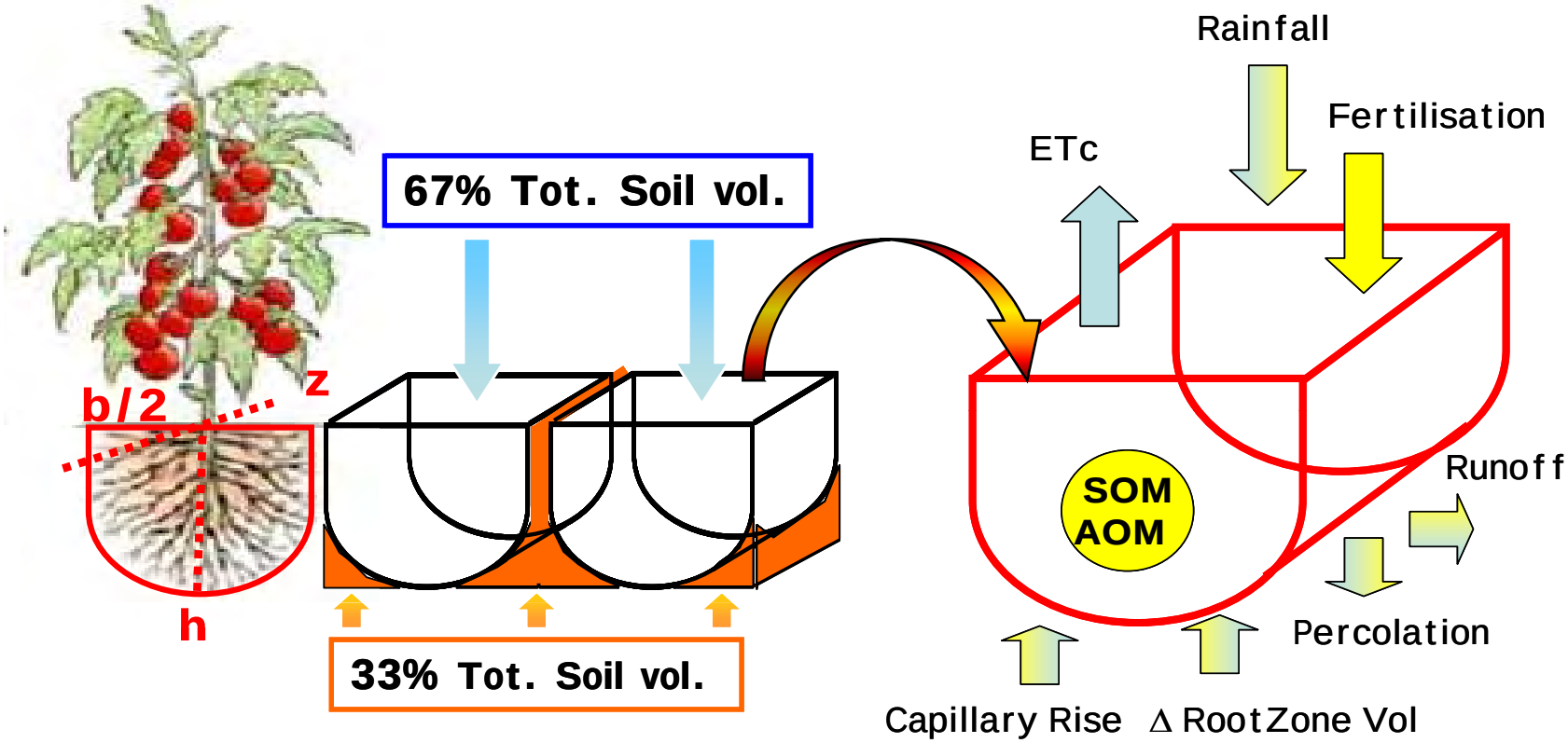
	FERTIRRIGERE		TRADITIONAL		*t-Student*
	Average	Standard Error	Average	Standard Error	
Yield (t/ha)	**90.94**	1.85	**84.94**	2.39	**
Soluble Solids (°Brix)	**5.04**	0.051	**4.52**	0.046	**
Quality Index	**8.35**	0.27	**11.40**	0.81	**
WUE (t/m^3)	**4.7**	0.1	**2.0**	0.1	**
NUE (t/kg)	**1.17**	0.09	**0.48**	0.01	**
Fertigation Costs (€/ha)	**322.00**	5.00	**673.00**	23.00	**

Processing Tomato, 56 Farms,5 year survey

C. Pennucci, A. Battilani - Conserve Italia

CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

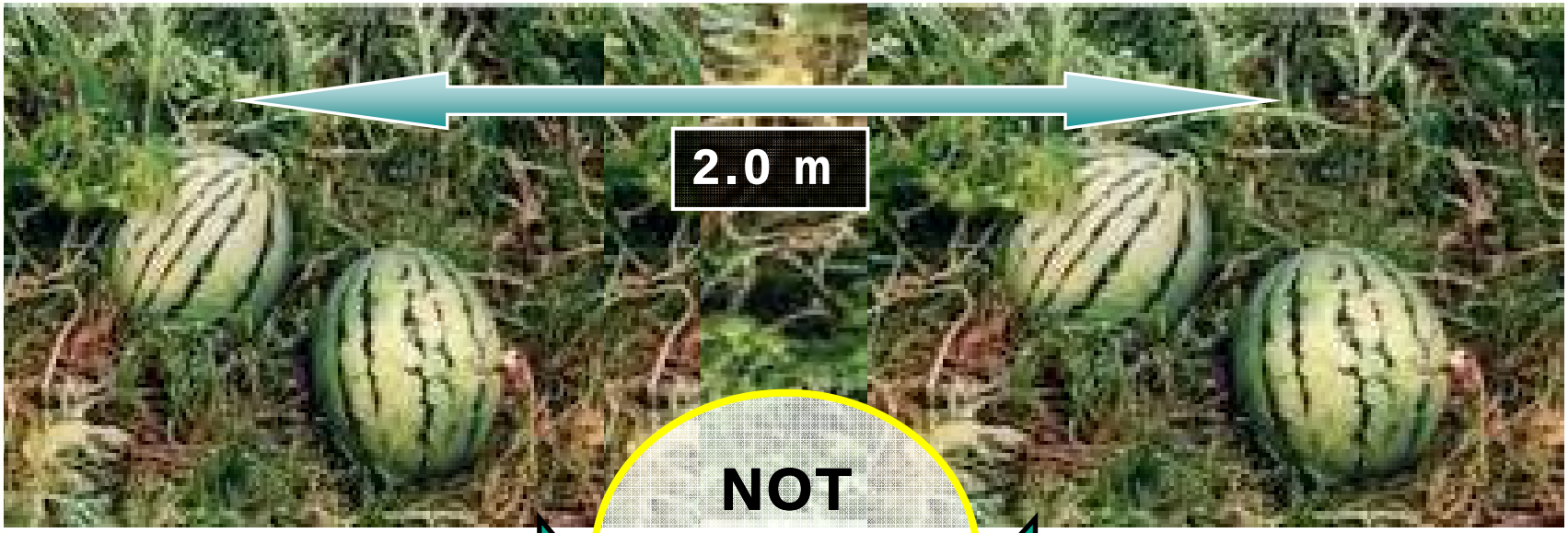
REDUCE RUNOFF AND PERCOLATION



Estimate precisely the Root Zone Volume is crucial to correctly manage irrigation supplies avoiding percolation and runoff.

CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

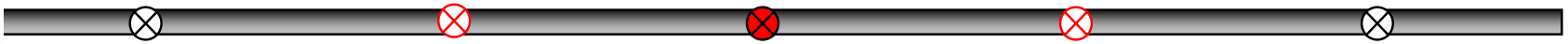
REDUCE RUNOFF AND PERCOLATION



$RZ_{L,MAX}$ = ≤ 0.70 m

NOT COLONISED VOLUME

$RZ_{L,MAX}$ = ≤ 0.70 m



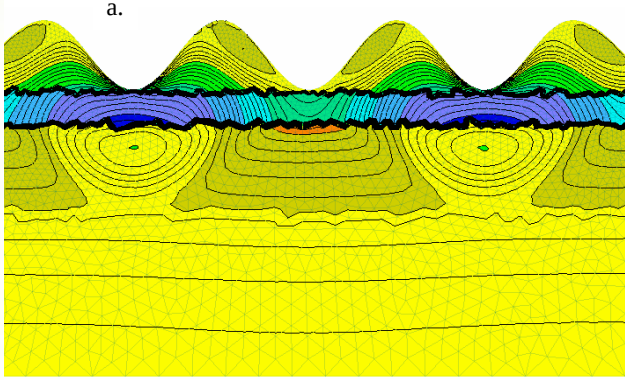
$$RZ_{VOL,MAX} = 0.506\ m^3$$

$$RZ_{VOL,MAX} \ / \ SOIL_{VOL,MAX} = 0.211$$

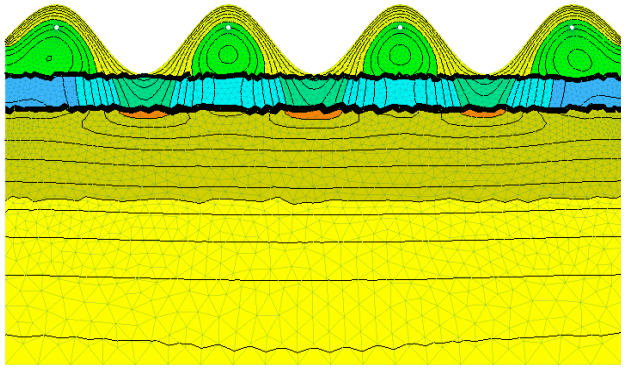
CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

REDUCE RUNOFF AND PERCOLATION

a.



b.

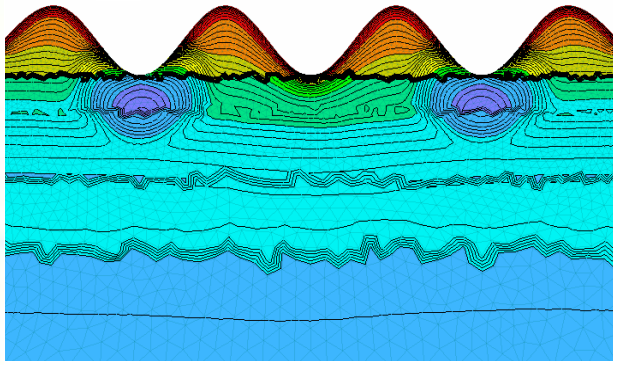


SANDY SOIL

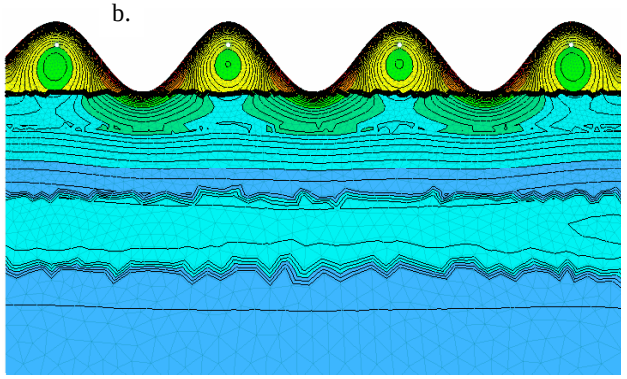
Dripline in the valley every other ridge

Dripline on each ridge top

a.



b.



SILTY CLAYEY SOIL

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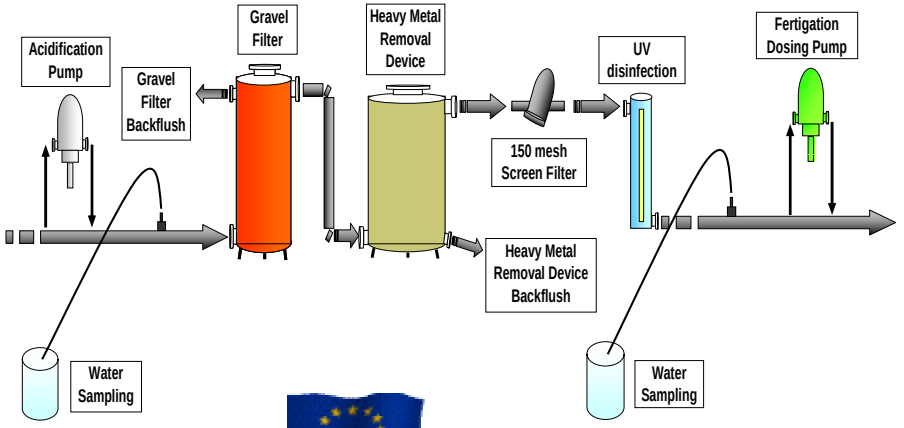
CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

WATER REUSE

Water Reuse can contribute up to 10-15% of irrigation supply, even more with decentralised treatments



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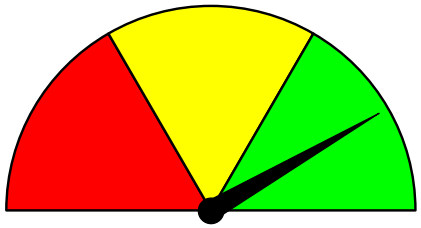
CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

CROPPING SYSTEMS IMPROVEMENT

Action	Impact					
	Costless	Investments Required	Extension Services	Farmer's Training	Effect on Rural Society	Changes in Water Governance
Crop Selection						
Drought/saline tolerant varieties	X		X	X		
Use of more suited Crops	X		X	X		X
Higher Harvest Index crops	X					
Changes in crop rotation		X	X	X		X
Cropping Pattern						
Sowing earlier	X					
Soil moisture conserving tillage		X		X		
Adjust timing of field operations	X					
Increase soil organic matter		X				

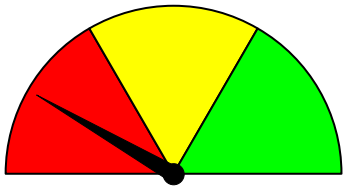


CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

TRADE AND CONSUMERS RESPONSABILITY

Fruit and Vegetable size and aestethic get happy customers but farmers are forced to oversize products and standardize their aesthetic using more water and nutrients

From 5 to 40% of the food produced is not even harvested because of its "non standard" size and aesthetical characteristics



CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

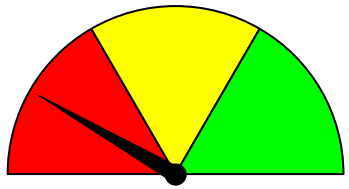
TRADE AND CONSUMERS RESPONSABILITY

1400 M Overweight

400 M OBESE

SUSTAINABLE AND RESPONSIBLE DIET

REDUCE WASTES

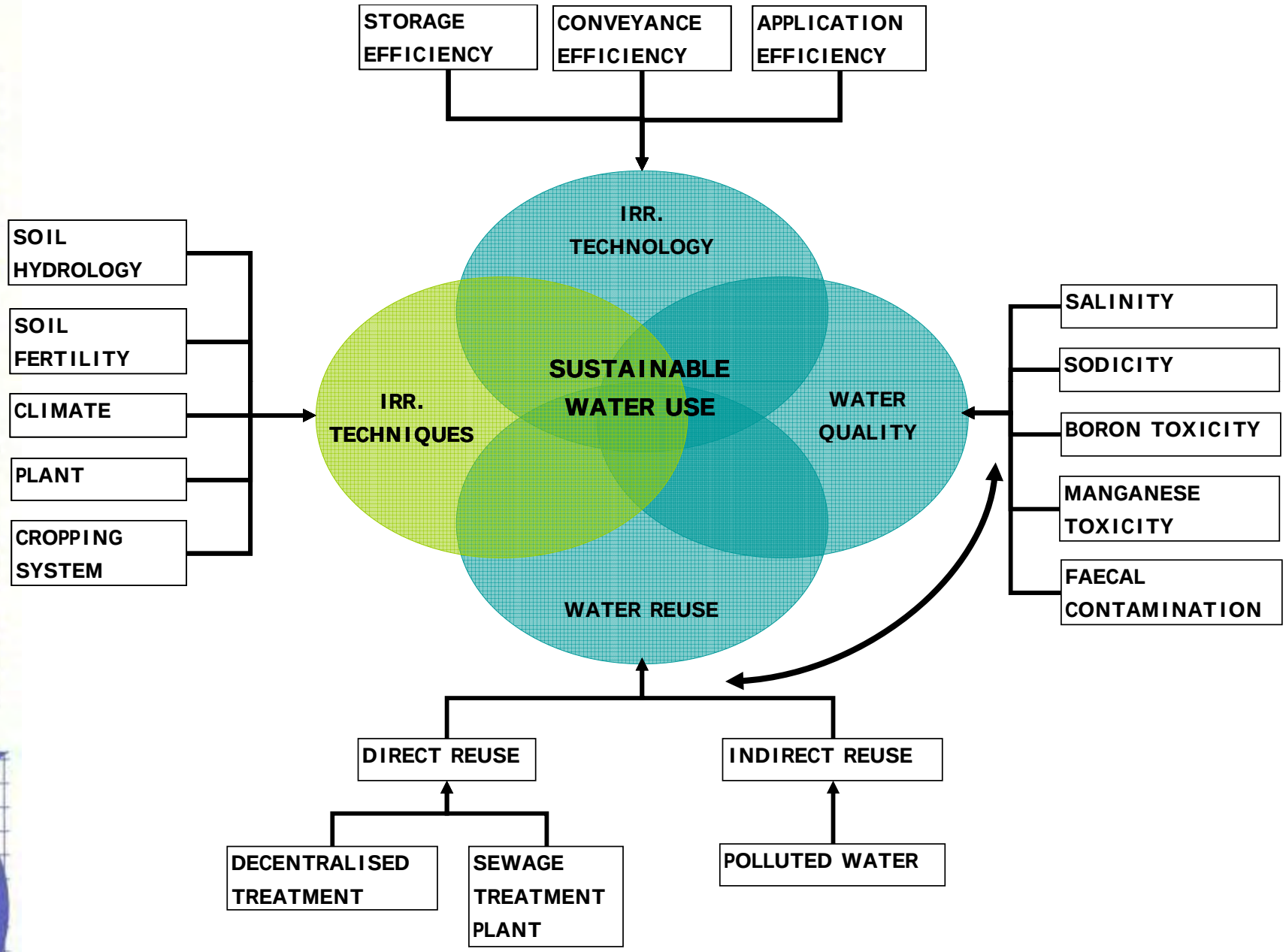


EU, Average Food Waste 179 kg p^{-1} y^{-1}

A. Battilani – CEPS – Which economic model for a water efficient Europe?, Brussels 27 March 2012

SUSTAINABLE WATER USE IN AGRICULTURE

CONSORZIO DI BONIFICA DI SECONDO GRADO PER IL CANALE EMILIANO ROMAGNOLO



CONSORZIO DI BONIFICA DI SECONDO GRADO
PER IL CANALE EMILIANO ROMAGNOLO

WATER PRODUCTIVITY: PROBLEM SOLVED ??