Irrigation Technologies and the Limits of Water Productivity

Elias Fereres

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Irrigation Technologies and the Limits of Water Productivity

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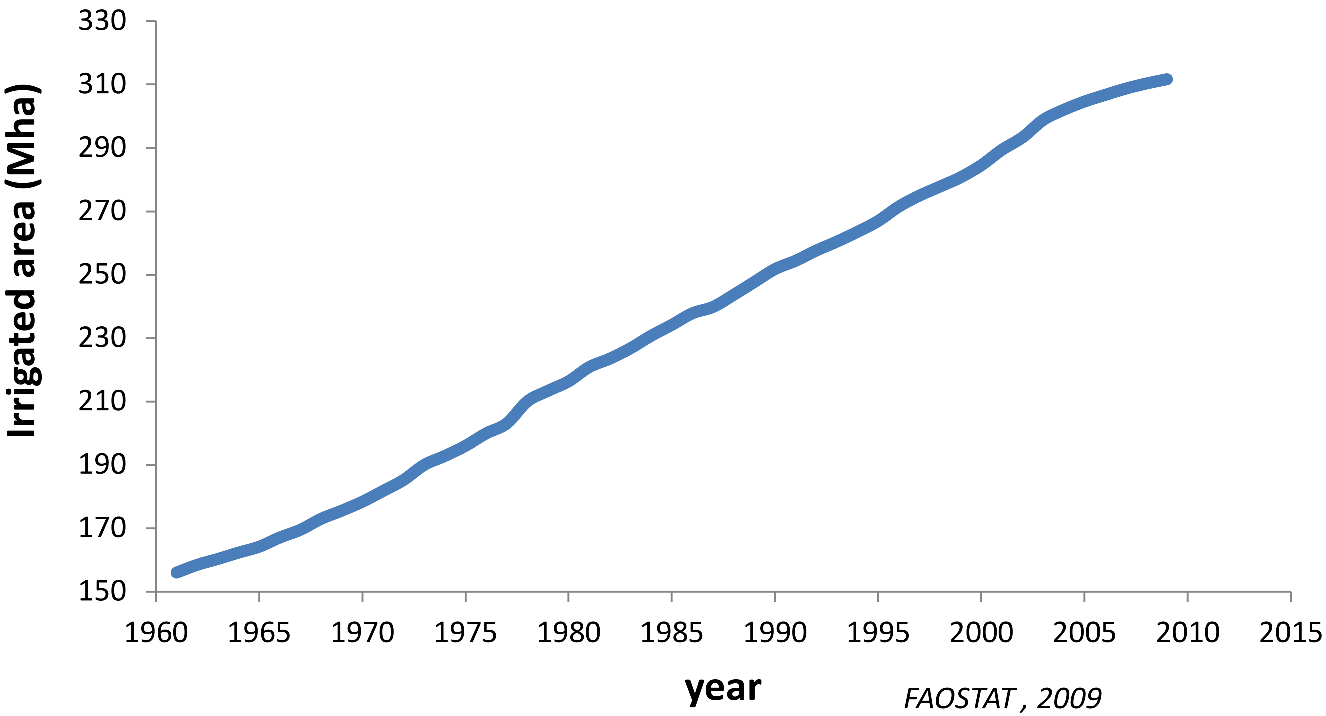
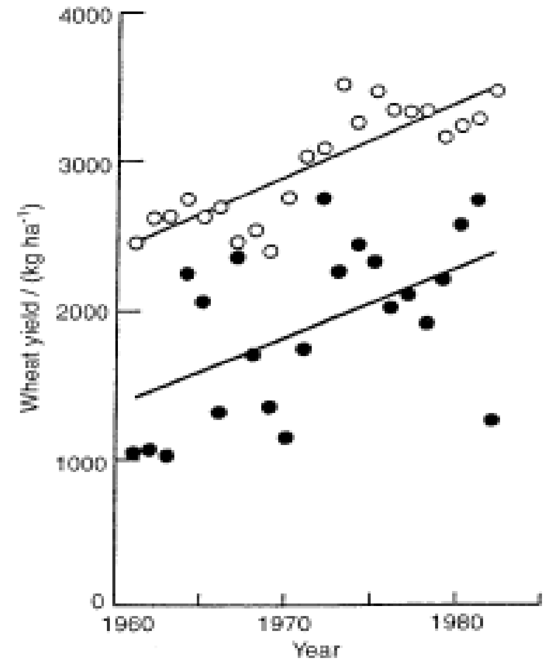
THE RECENT EXPANSION OF WORLD IRRIGATED AREA

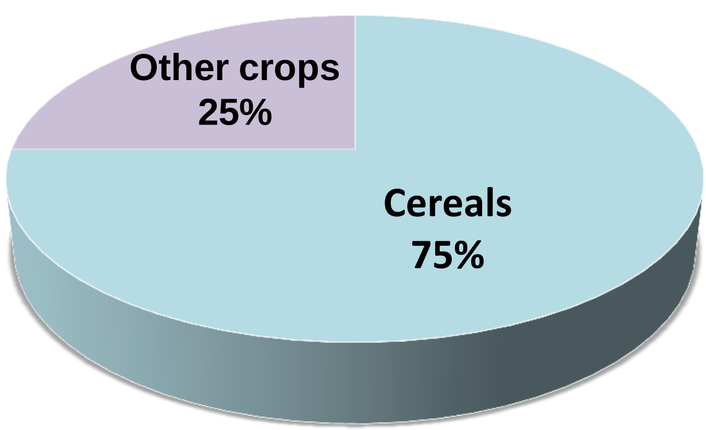


FAOSTAT , 2009

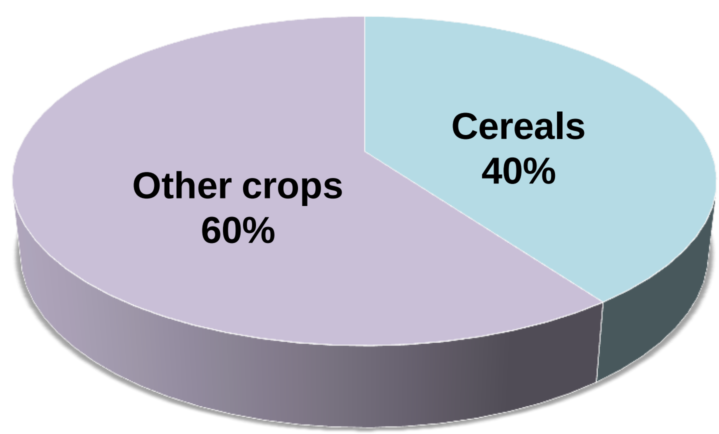


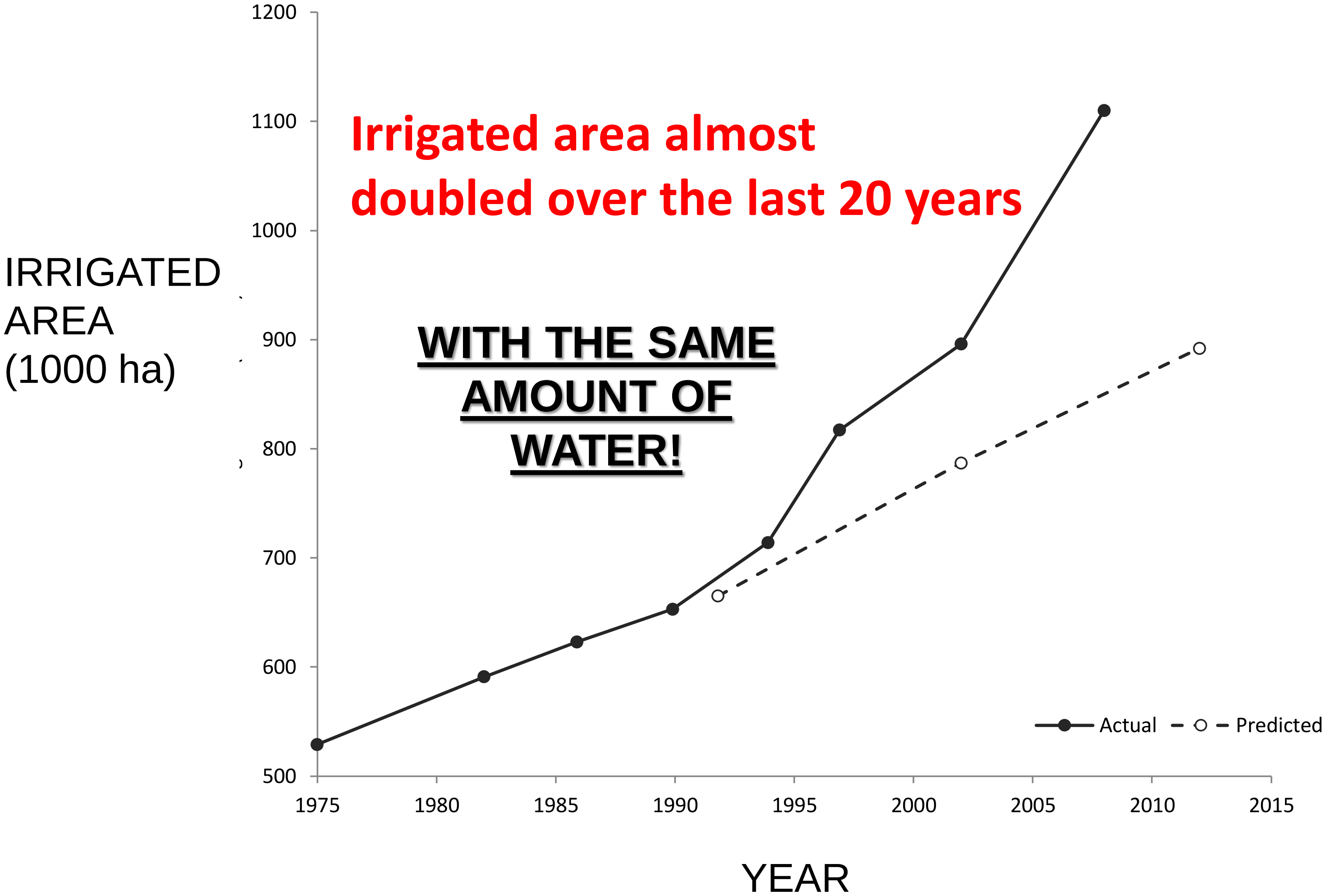
(Stanhill, 1986)

Crops distribution (area)



Relative Water Productivity ($/m³)

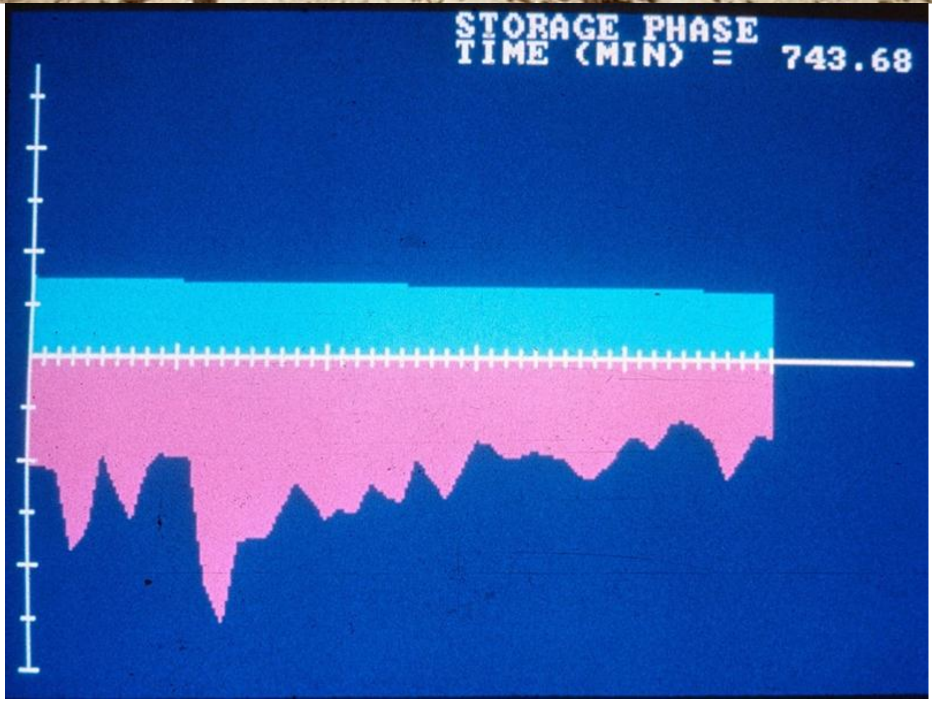




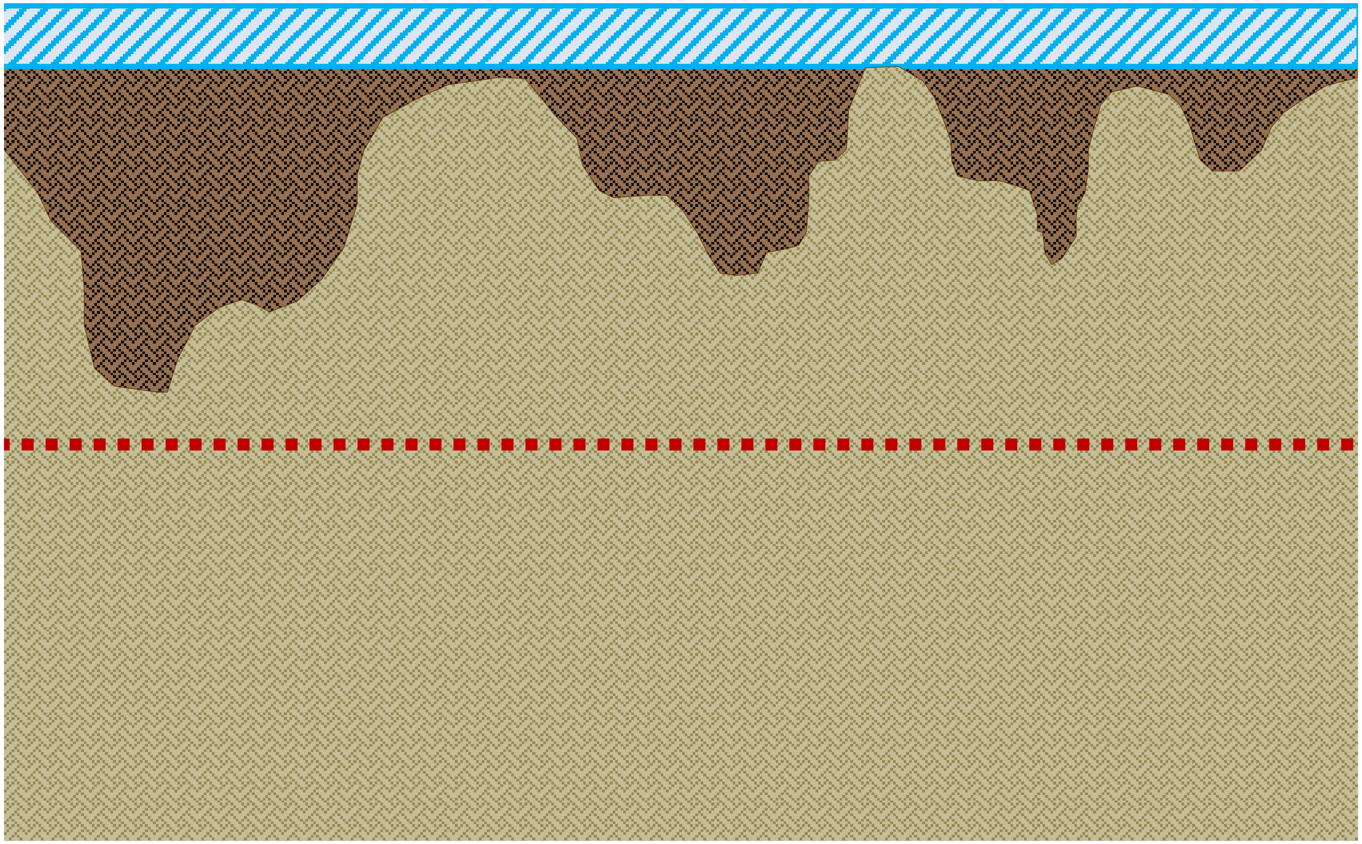
Evolution of irrigated area in Andalusia, Spain

Fereres et al., 2011, J. Ex. Bot. 62,

FLOOD IRRIGATION HAS BEEN PRACTICED FOR THOUSANDS OF YEARS

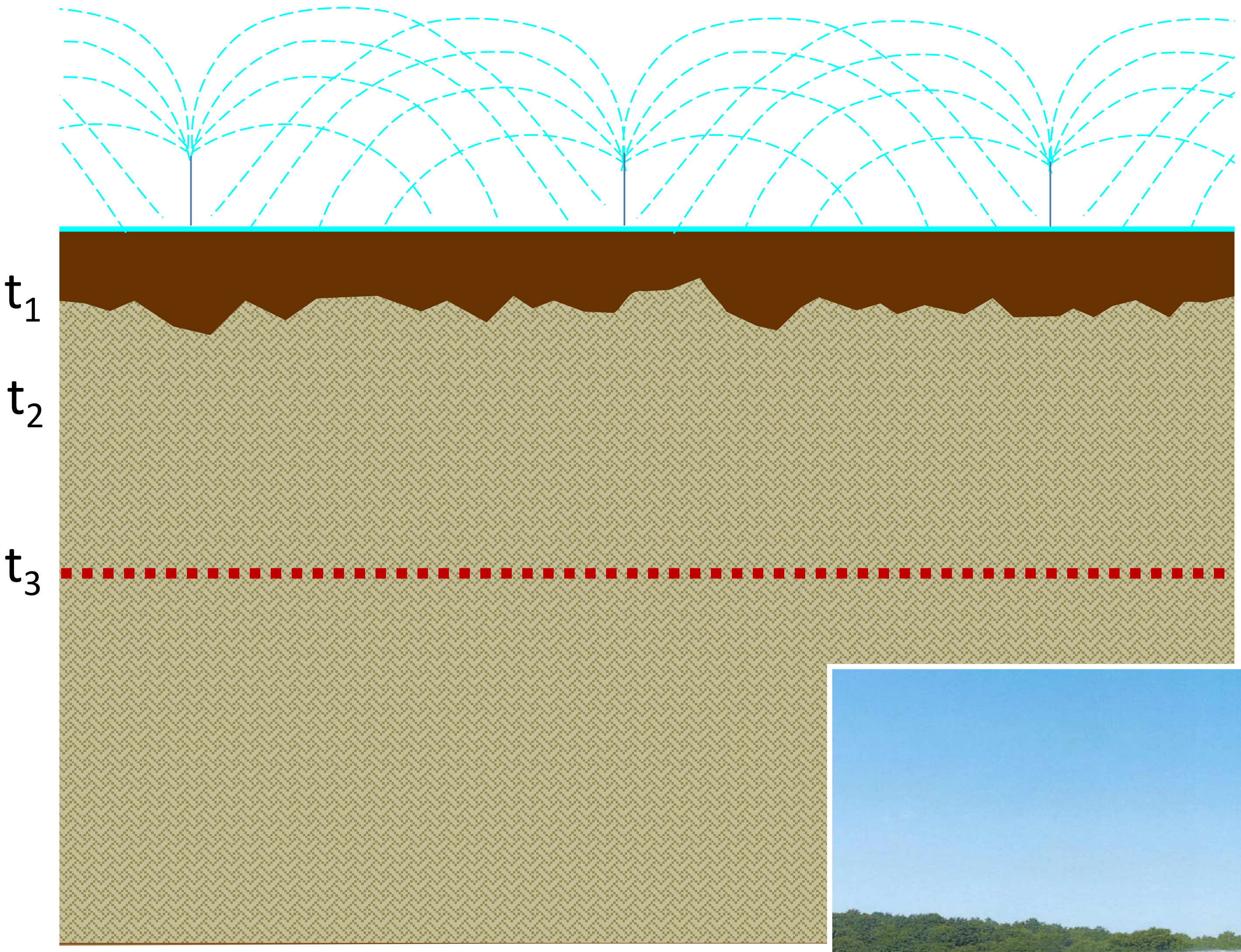


IN FLOOD IRRIGATION: THE SOIL CONTROLS THE INFILTRATION OF WATER

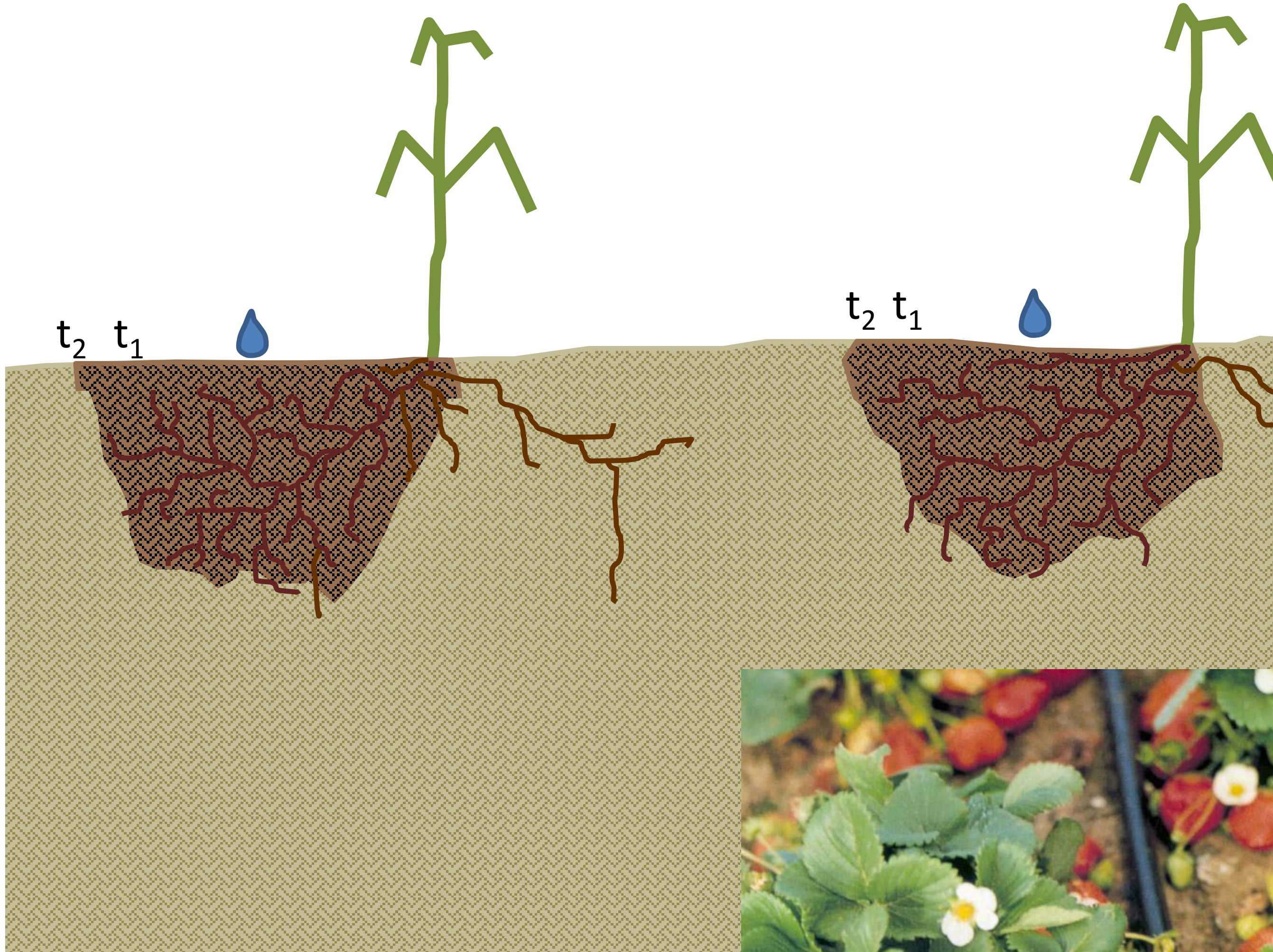


SOILS ARE INHERENTLY VARIABLE

PRESSURIZED SYSTEMS: THE SYSTEM CONTROLS THE INFILTRATION

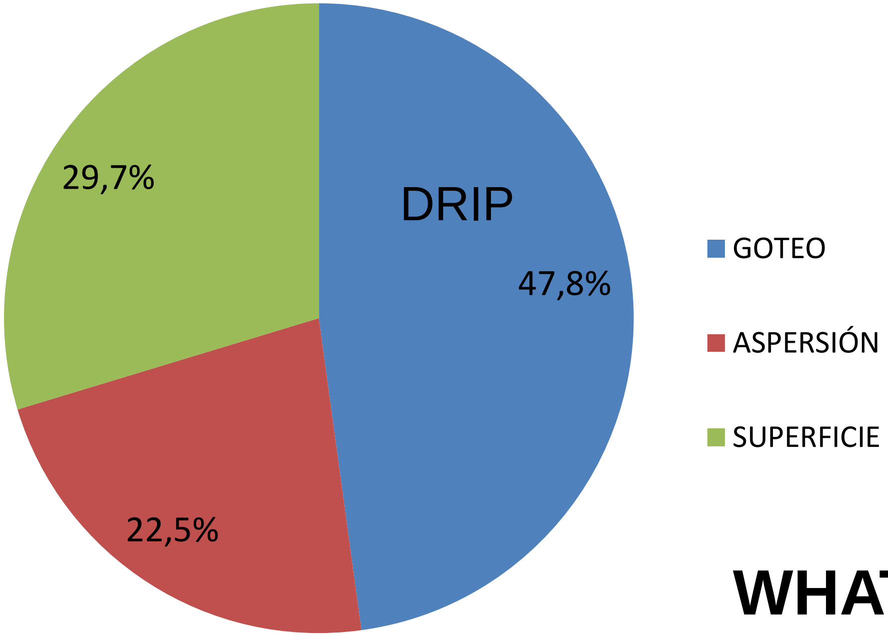


IN DRIP IRRIGATION, CONTROL OF TIME AND SPACE



SURFACE IRRIGATION WENT FROM 90% TO 30% IN THIRTY YEARS

IN ANDALUSIA, DRIP IRRIGATION IS NEAR 70 %



WHAT ABOUT ENERGY?

IRRIGATION METHODS IN SPAIN (2011)

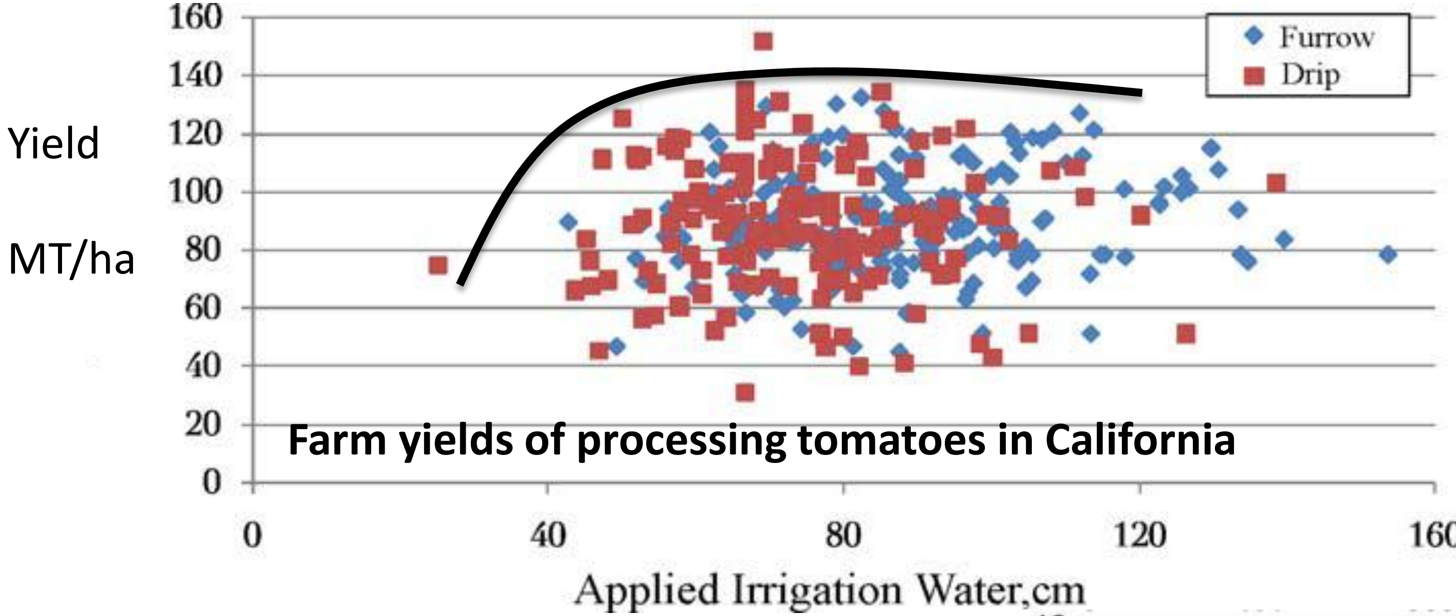
Control, high uniformity, and ease of water application have been the key factors until now

Photo Courtesy Dr. D. Goldhamer,

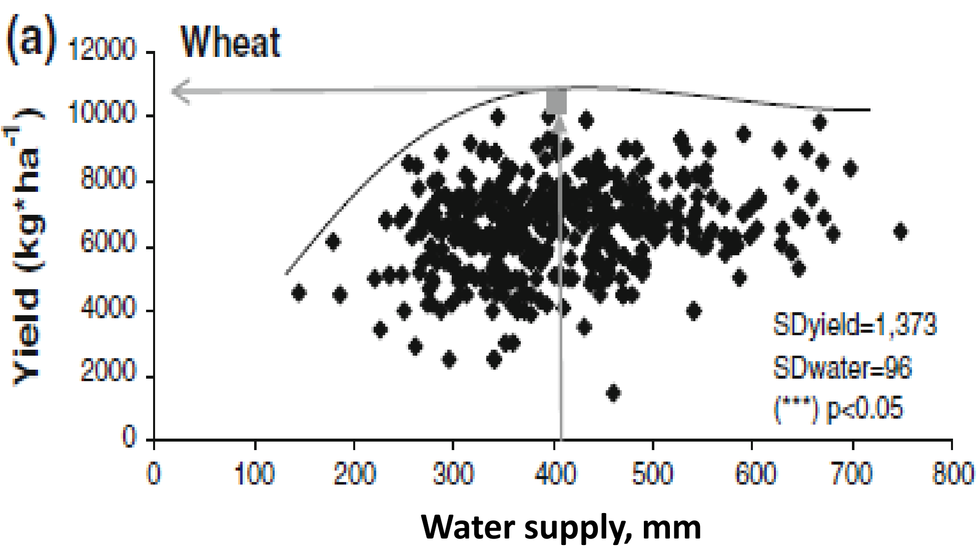
Irrigation faces three challenges:

- <u>Engineering</u>
- Management
- Biological

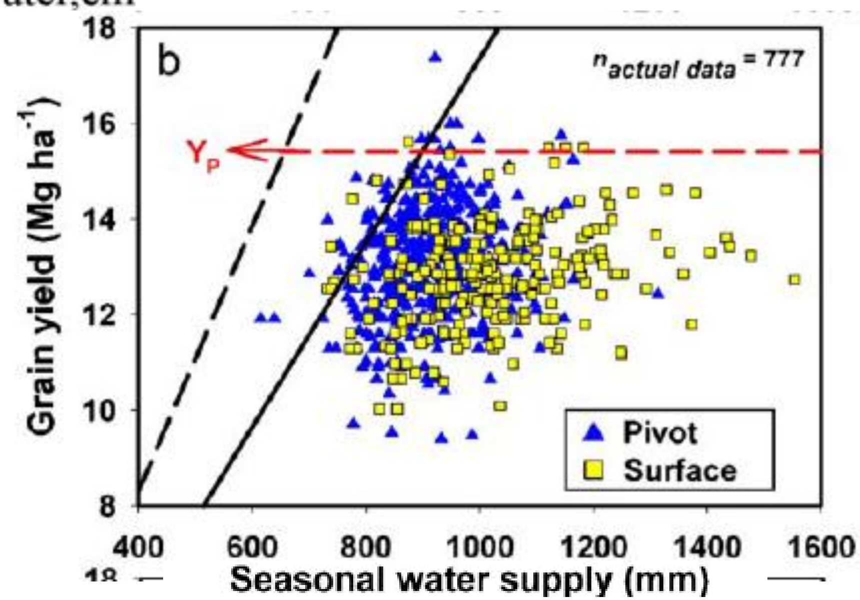
THE YIELD GAP and HOW TO BRIDGE IT



Burt & O'Neill, (2007)

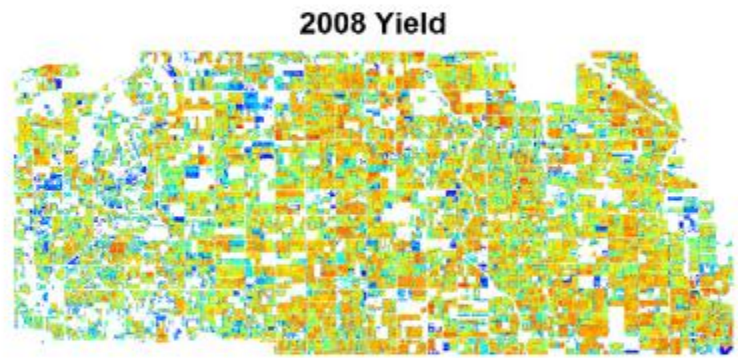


La Mancha, Spain, *Montoro et al., (2011)*



Maize, Nebraska, USA, *Grassini et al.,(2011)*

Focus on measuring the magnitude and causes of yield gaps



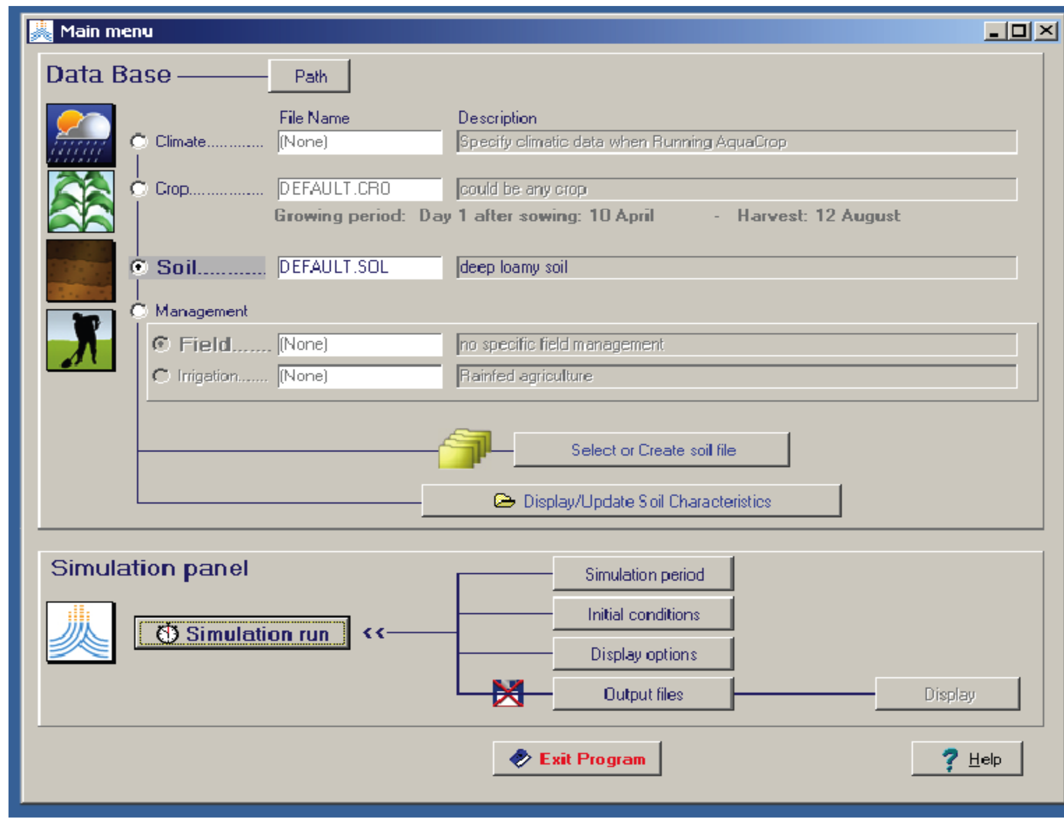
(Lobell, 2012)

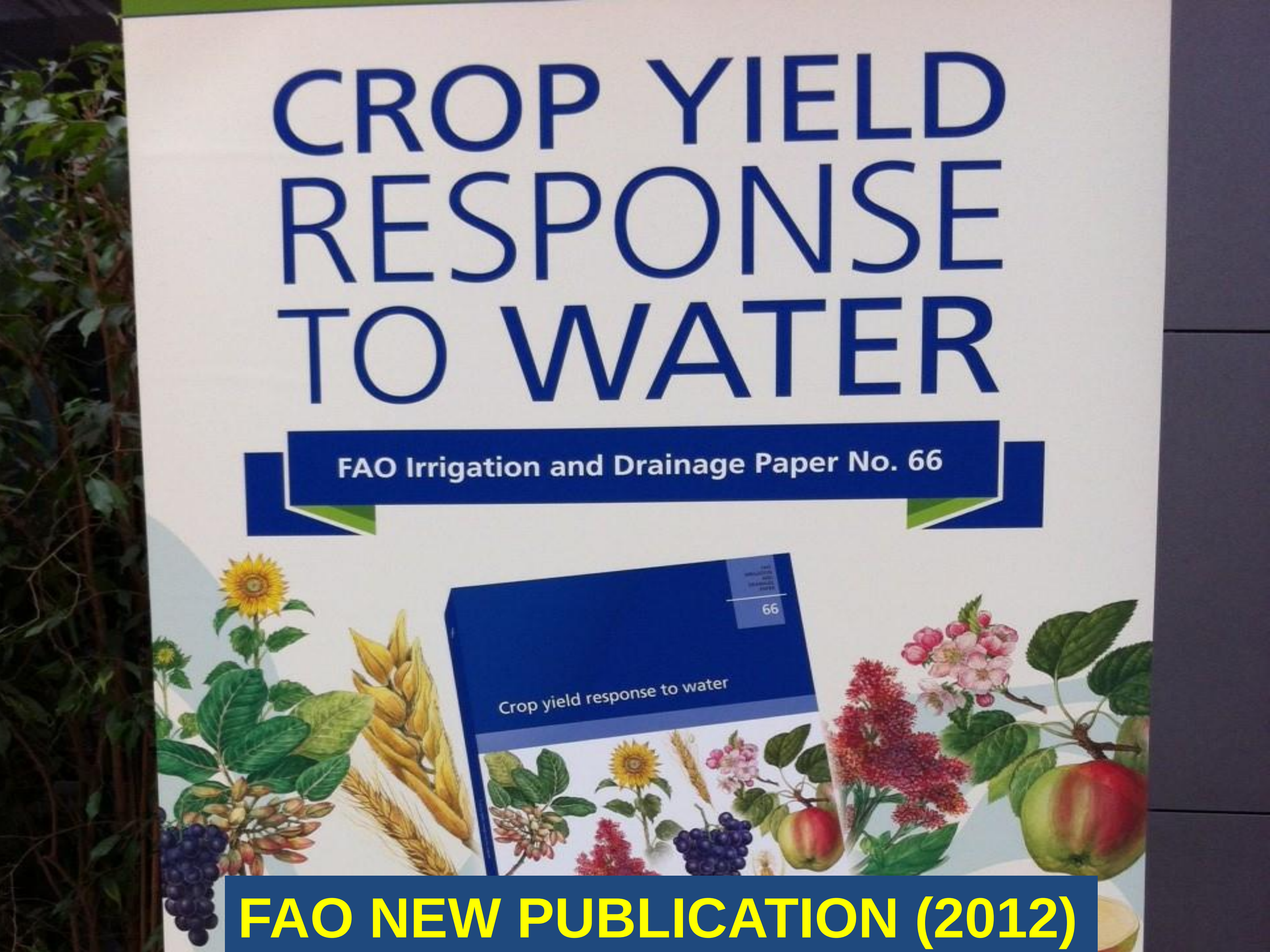
REMOTE SENSING

SIMULATION MODELS

AquaCrop:

FAO simulation model of water-limited crop production





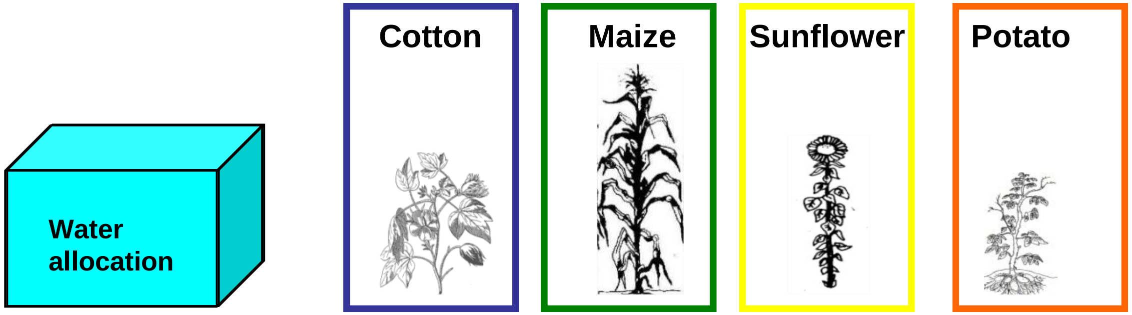
FAO NEW PUBLICATION (2012)

Optimizing water use at the farm level

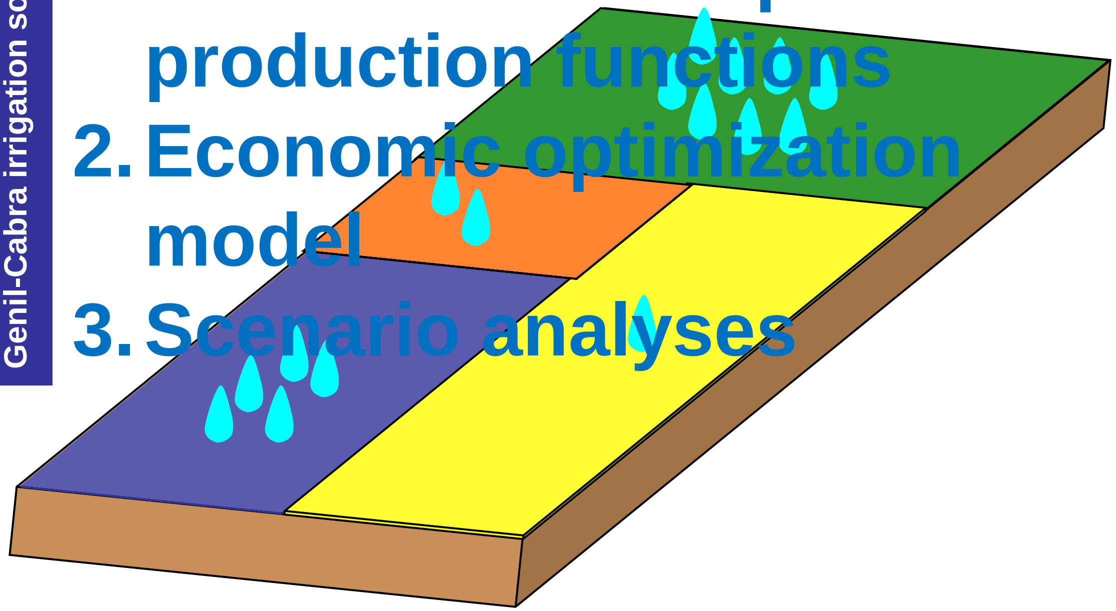
TARGET

Develop a pre-season economic optimization model designed to optimize irrigation water management and cropping patterns at farm level

Genil-Cabra irrigation scheme



1. Simulation of crop-water production functions
2. Economic optimization model
3. Scenario analyses

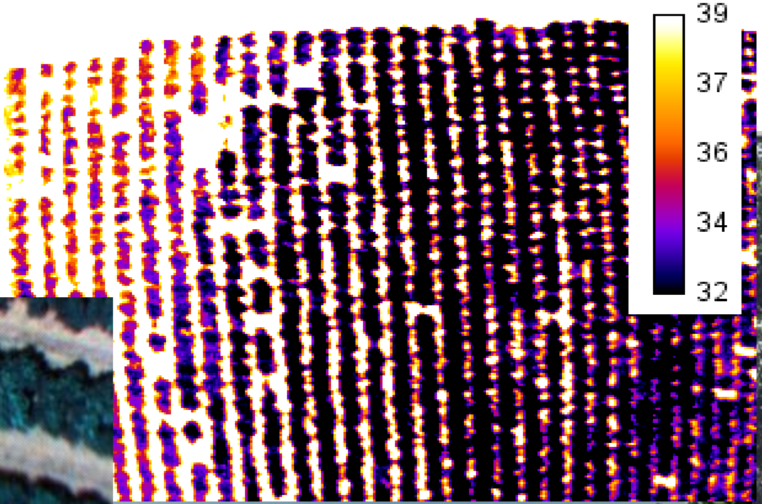


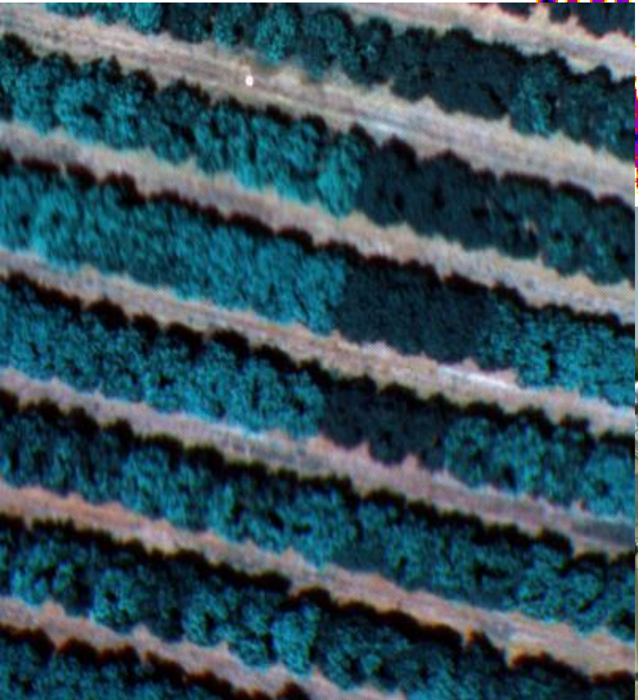
UPSCALING MODELS TO IRRIGATION DISTRICTS AND REGIONS

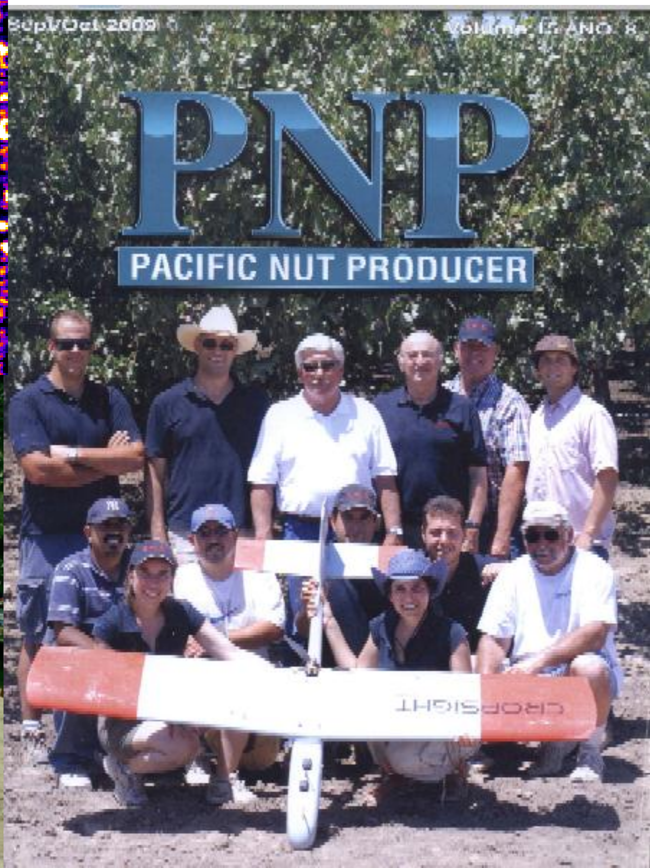
(Garcia-Vila & Fereres, 2012)

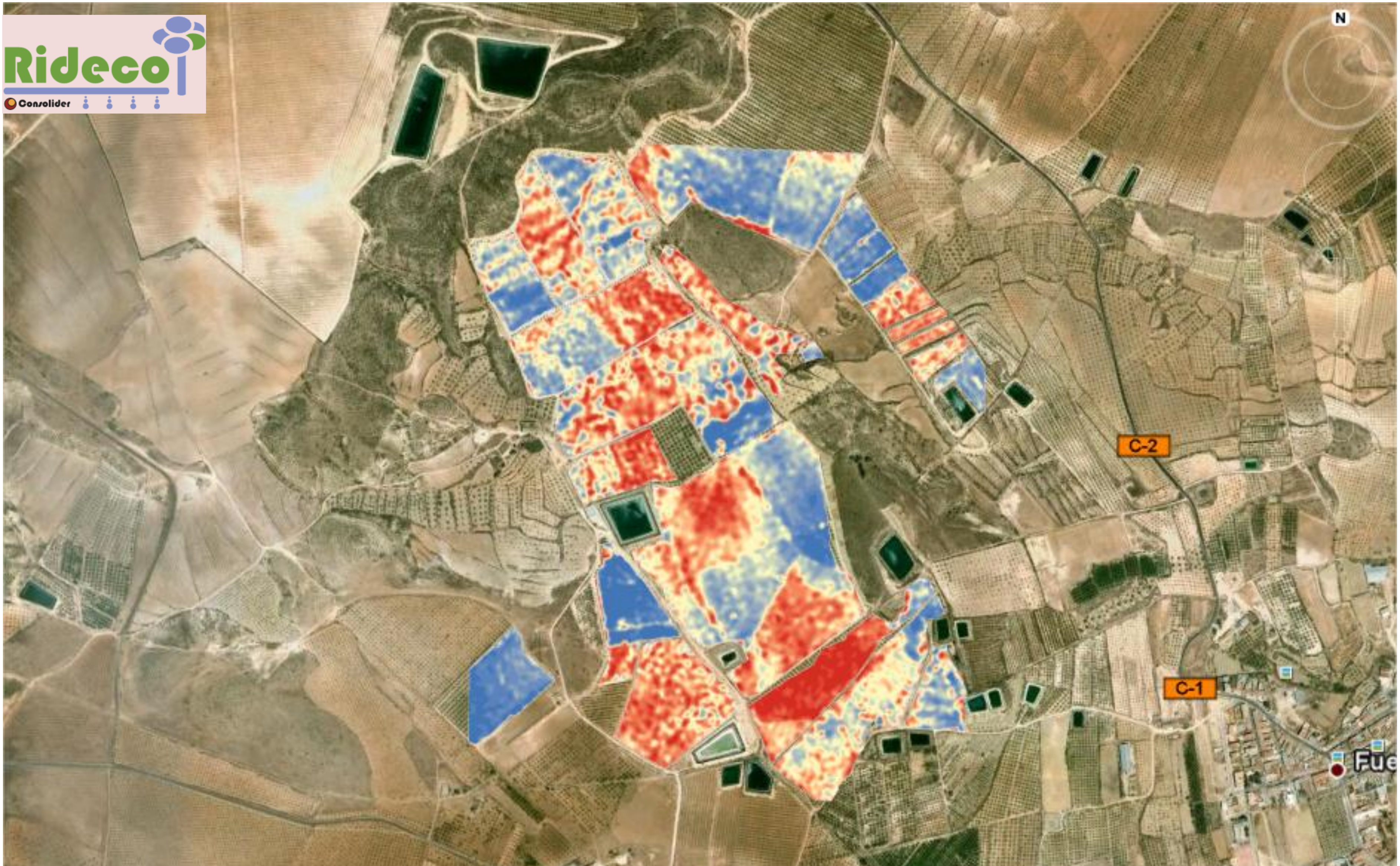
IMPROVING MANAGEMENT: POINT & AREA SENSORS

DEVELOPMENT OF A REMOTE SENSING PLATFORM FOR IRRIGATION SCHEDULING







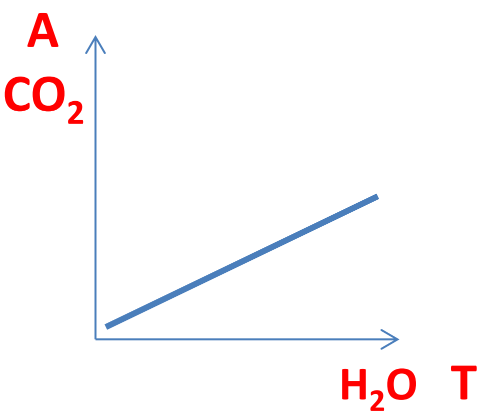


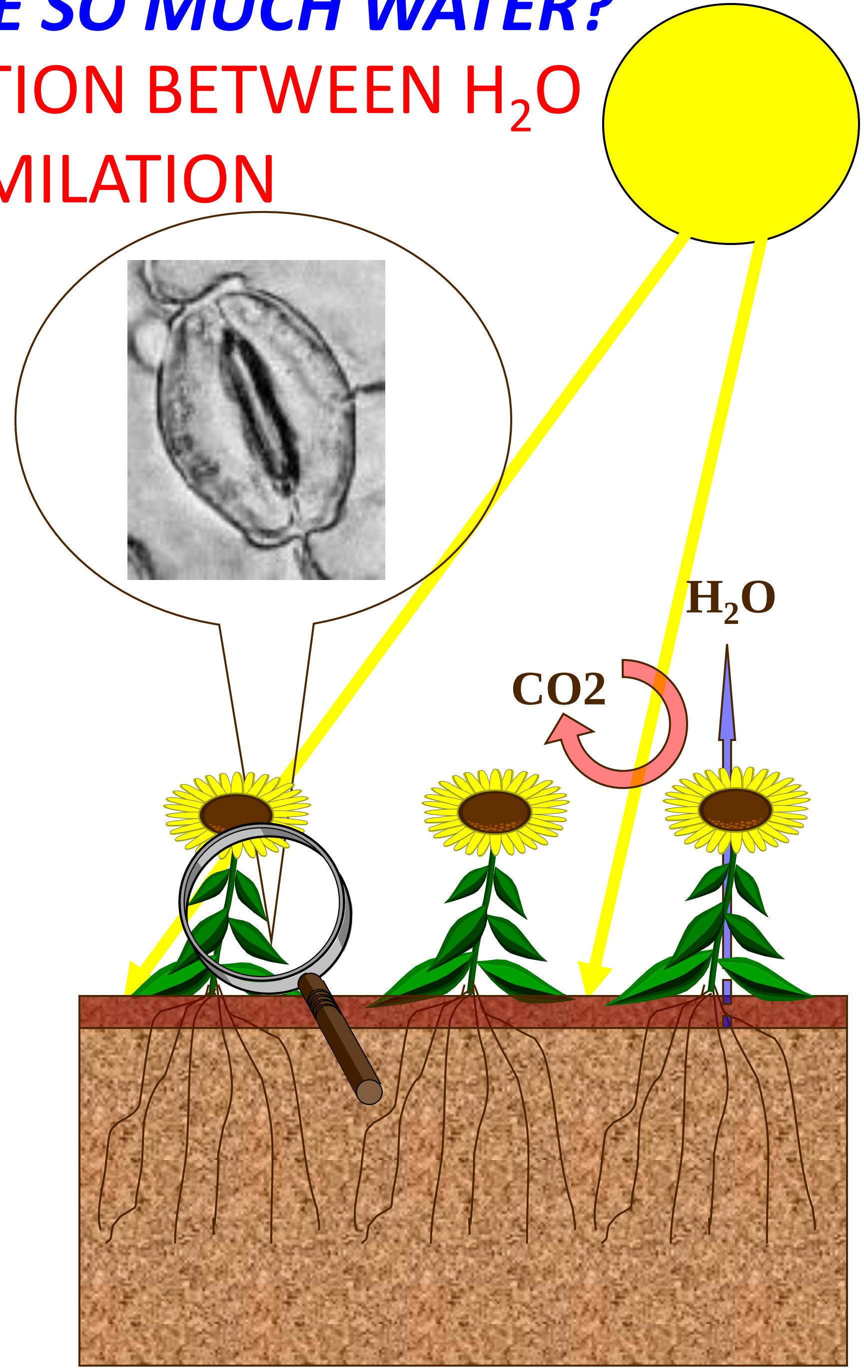
Reduce risks by monitoring stress accurately and using precision irrigation where it is economically viable

WHAT ABOUT THE BIOLOGICAL CHALLENGE (THE GENETIC OPTION) ?

WHY CROPS CONSUME SO MUCH WATER?

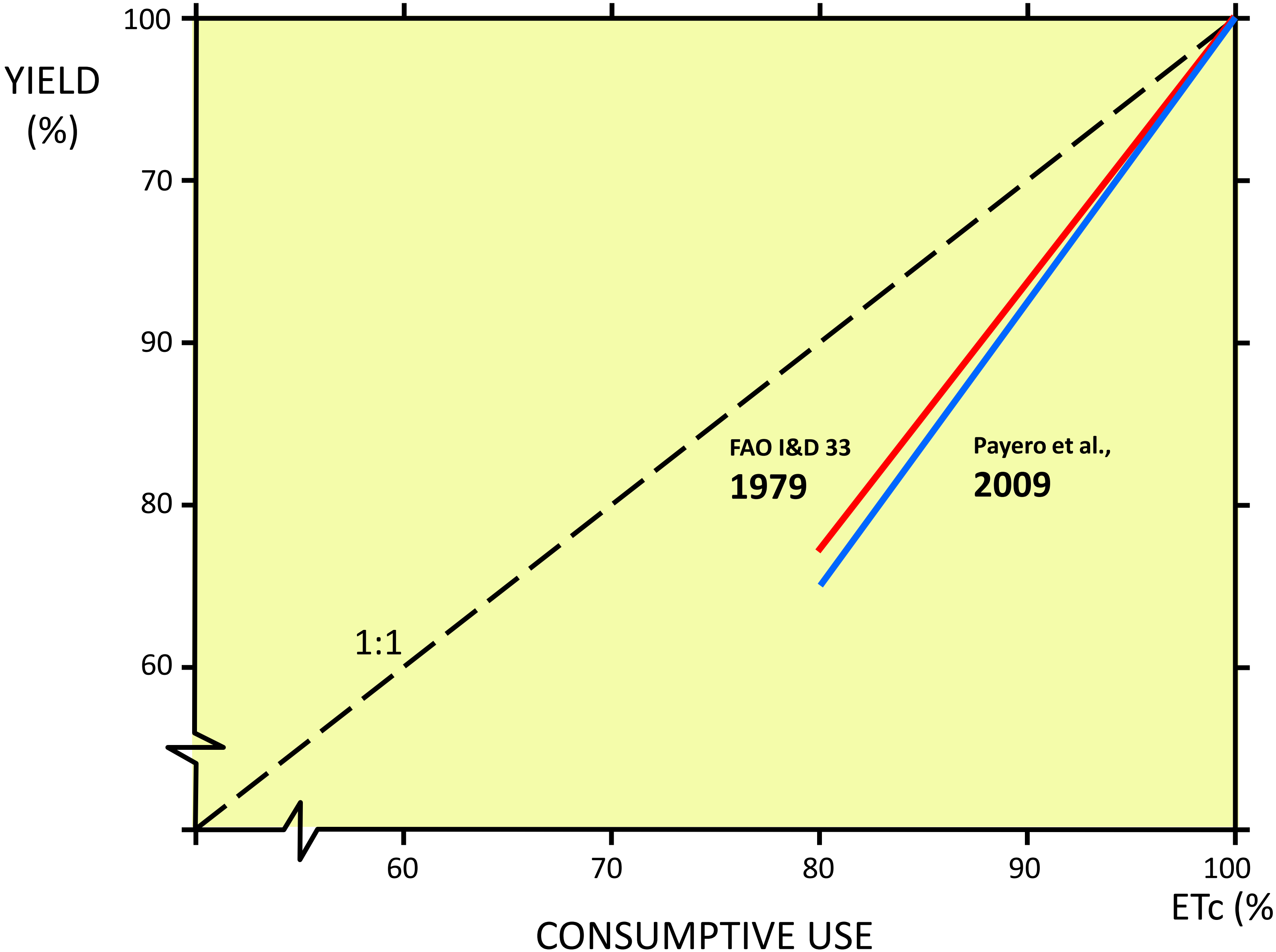
THE FUNDAMENTAL CONNECTION BETWEEN H_2O LOSS AND CO_2 ASSIMILATION

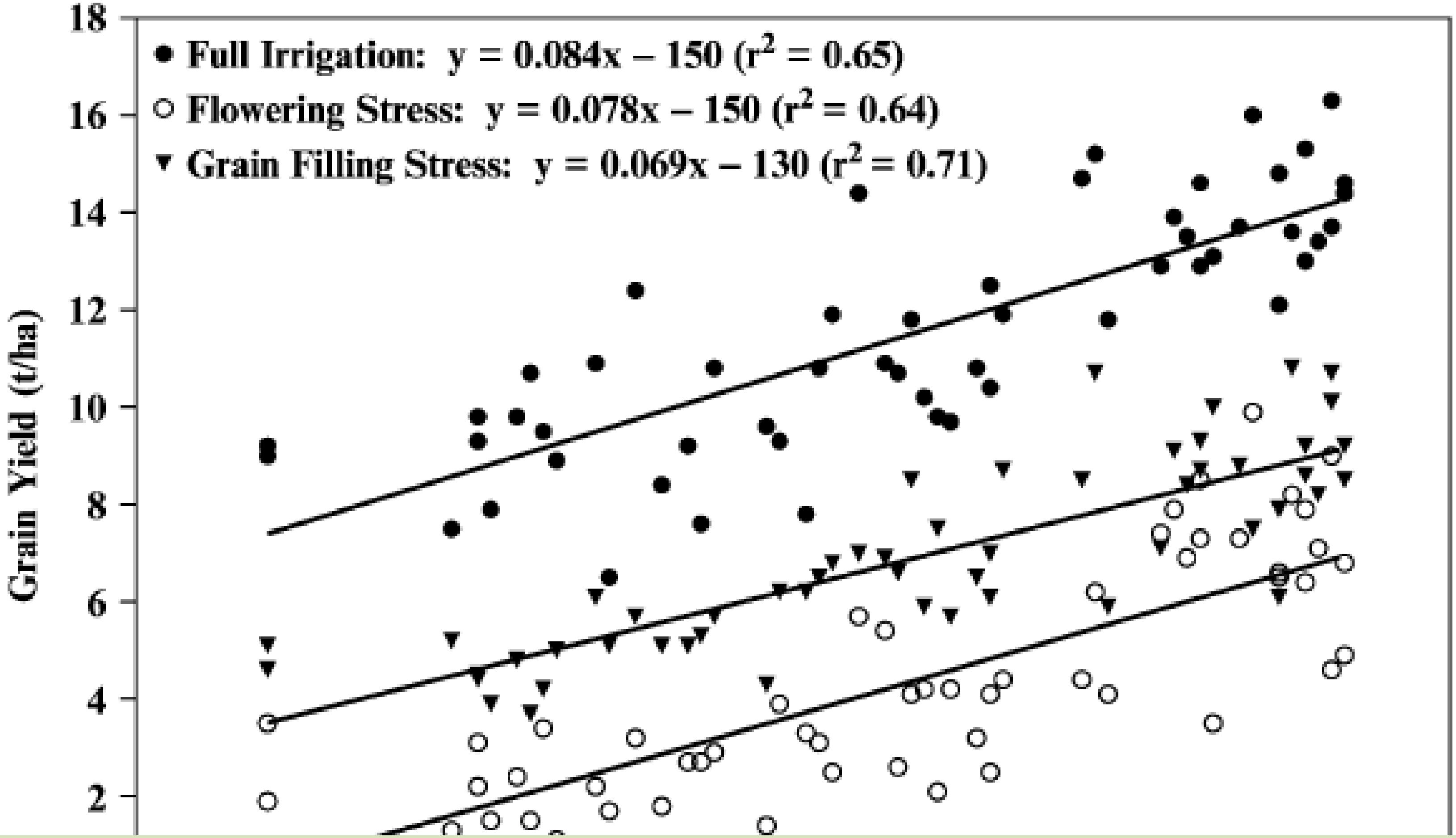




$WP = CO_2 / H_2O$

MAIZE WATER PRODUCTION FUNCTION





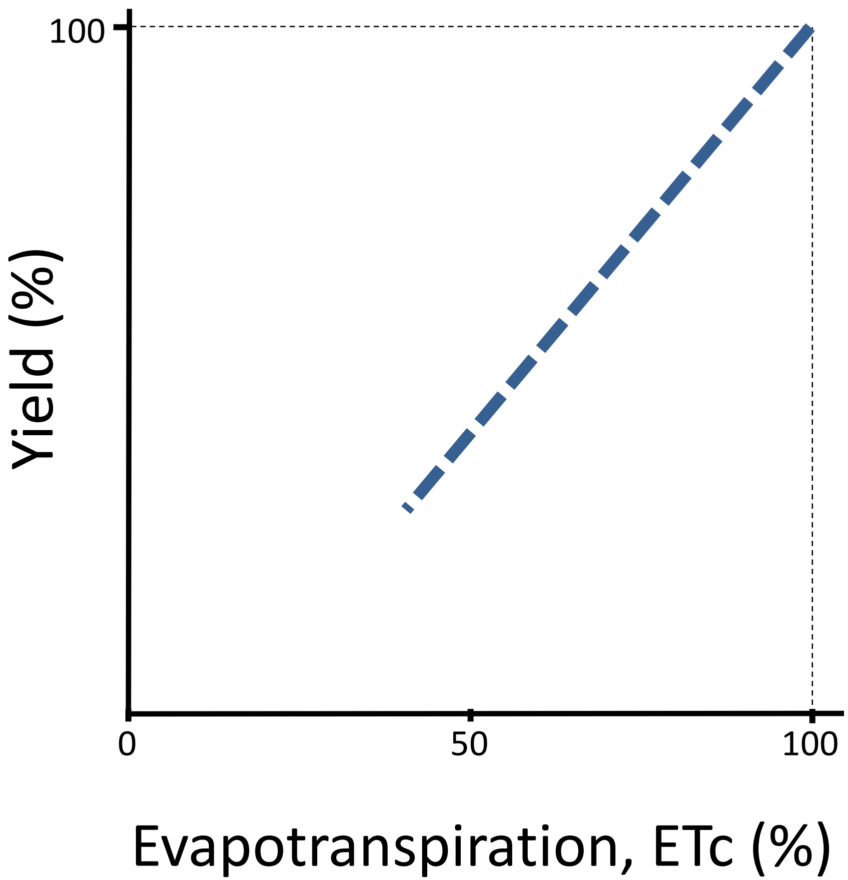
Monsanto to Introduce Genuity Droughtgard Hybrids in the Western Great Plains In 2013 (one year too late)

up to 6 bushel advantage over competitor hybrids

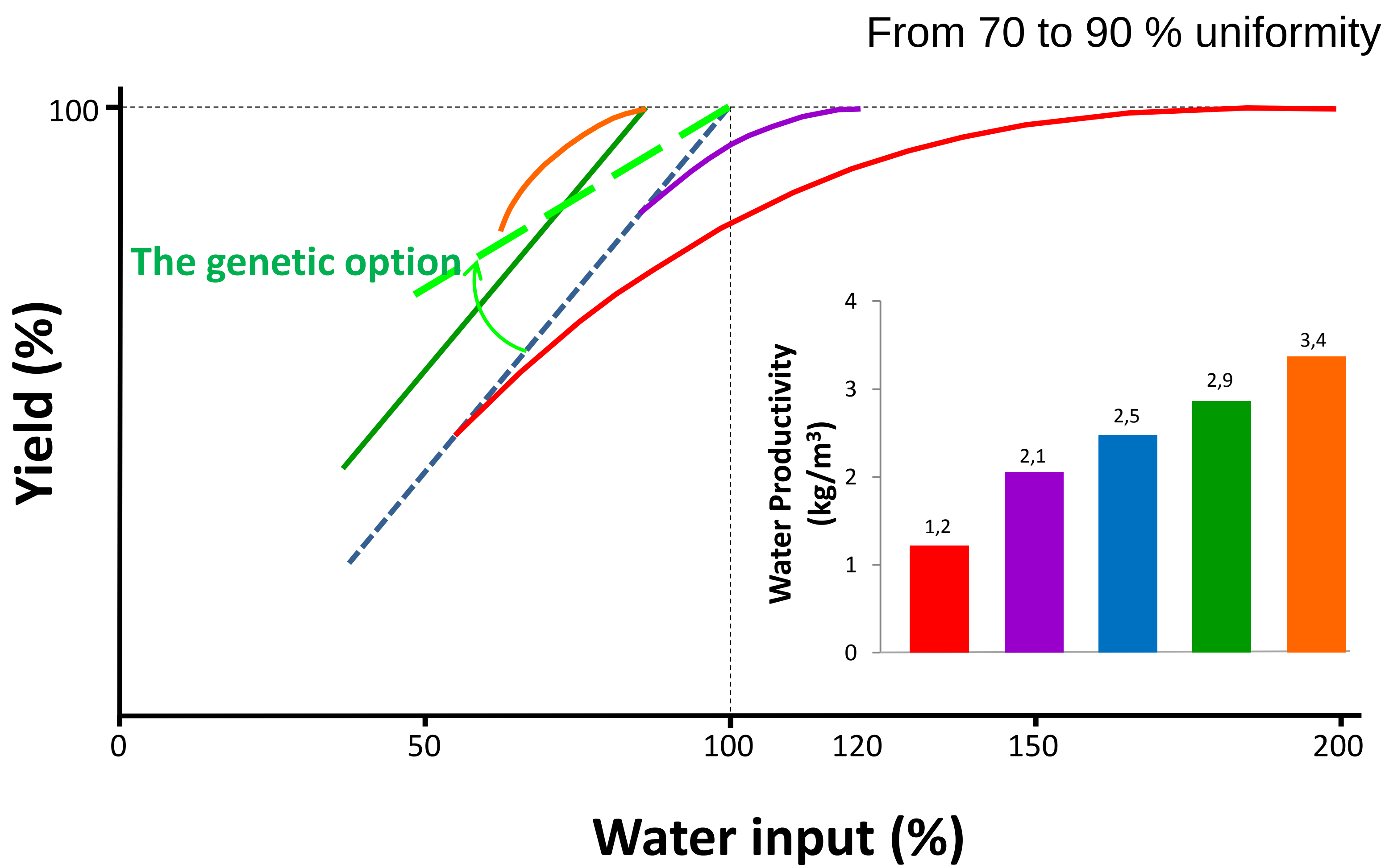
were grown in Woodland, California … in three managed stress environments: full irrigation, flowering drou… ng drought stress. Adapted from Barker *et al.* (2005).

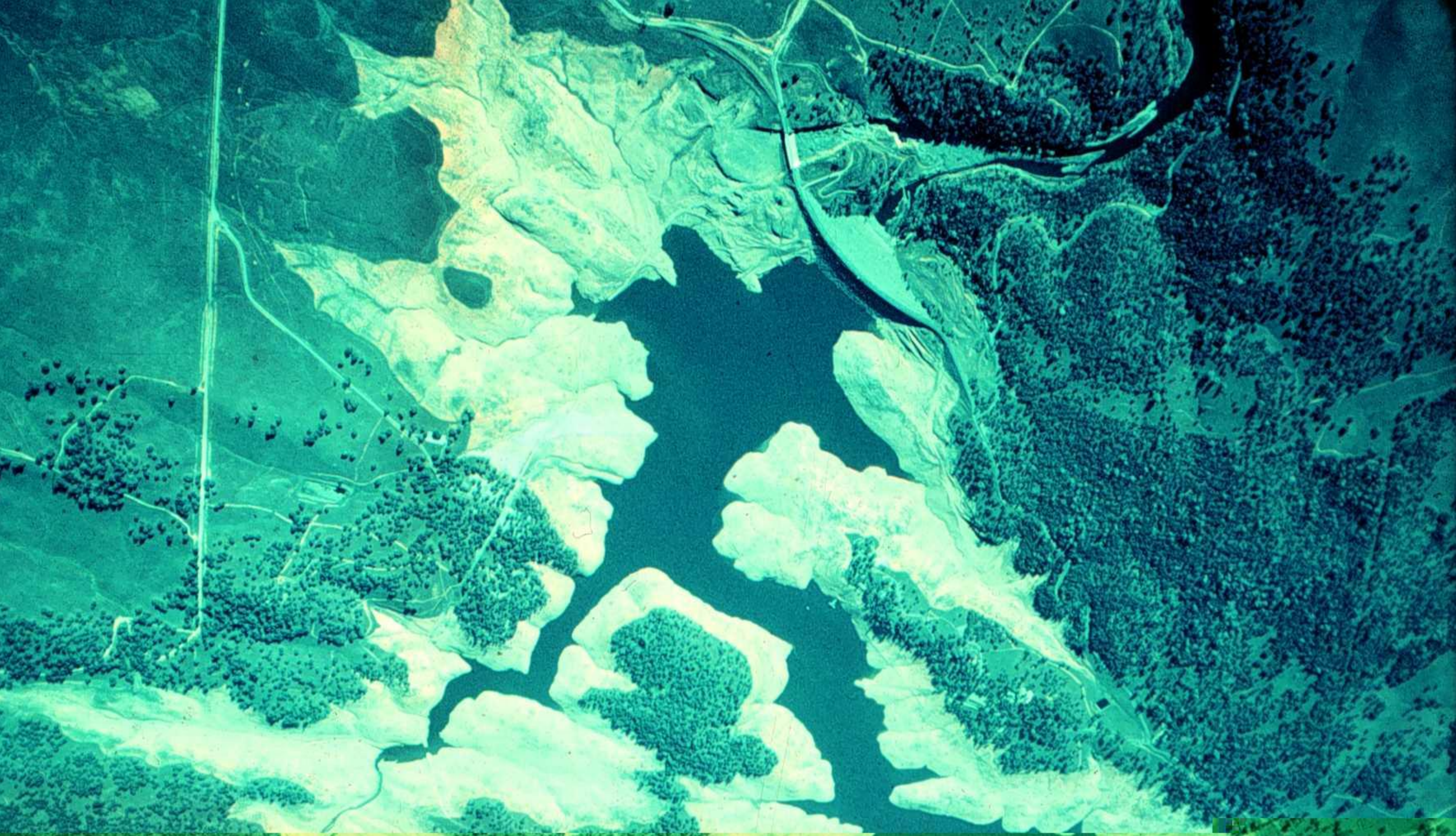
(or 360 kg/ha)

THE BASIC RELATION BETWEEN YIELD AND CONSUMPTIVE USE, ETc, IS LINEAR FOR THE MAJOR CEREALS; i.e., WP IS CONSTANT



EVOLUTION OF WATER PRODUCTIVITY IMPROVEMENTS

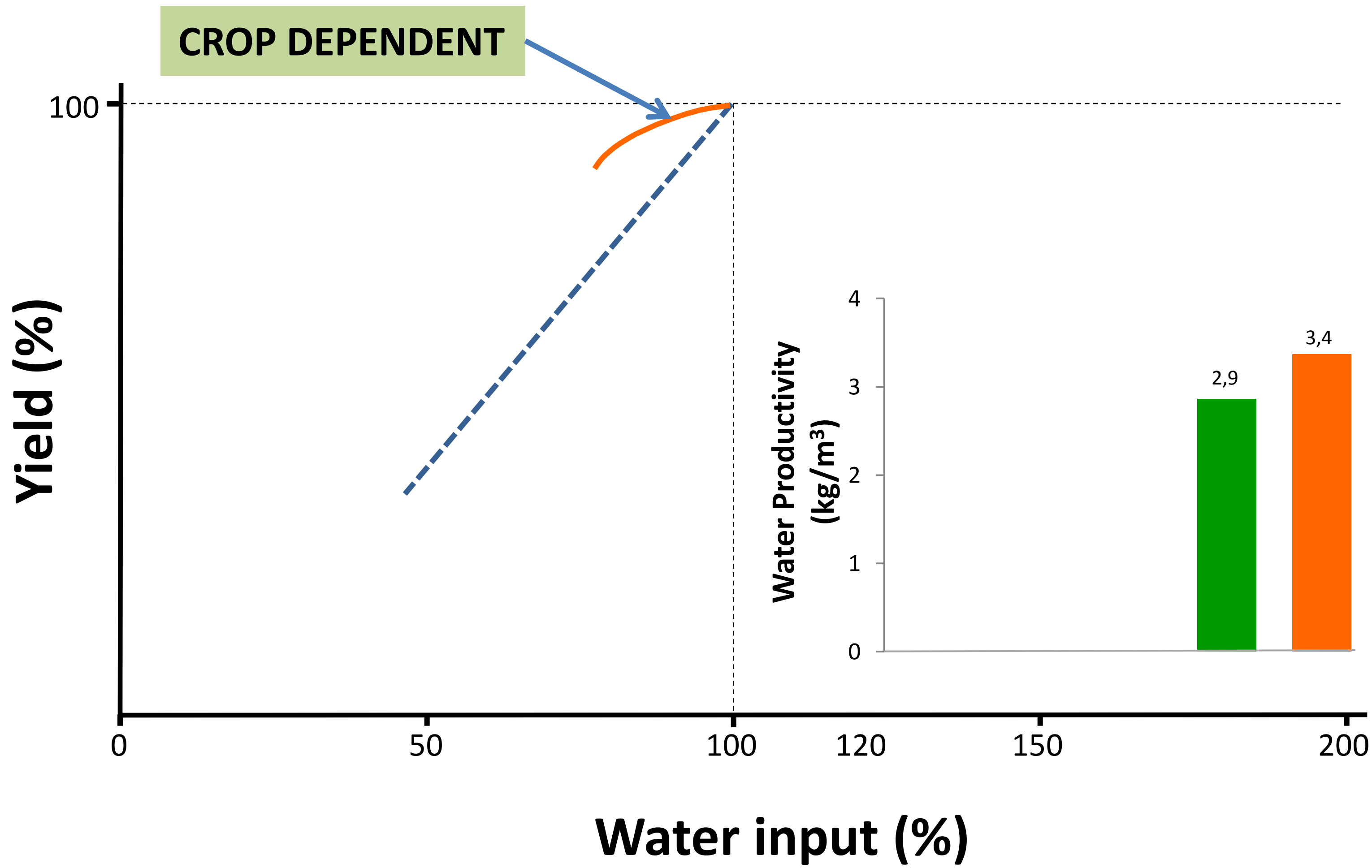




Optimizing the use of a limited water supply

BECAUSE OF NECESSITY

STRESS MANAGEMENT VIA DEFICIT IRRIGATION



In conclusion,

- ***Engineering advances were largely responsible for past increases in WP***

- ***WP limits have largely been reached, but big gaps remain in most farming systems.. Focus on measuring WP gaps and determining their causes***

- ***Water supply limitations will force adoption of deficit irrigation. Opportunities for the optimization of limited supplies at scales from field to regions***