



Food and Agriculture  
Organization of the  
United Nations

GLOBAL  
SYMPOSIUM on  
**SOILS** and **WATER**

02-05 October, 2023

Soil and water:  
a source of life



Integrated management of soil and  
water resources to support economic  
and environmental policies

Domenico Ventrella,  
Council for Agricultural Research (CREA)  
Research Centre Agriculture and Environment



## Definition of Agricultural Policies:

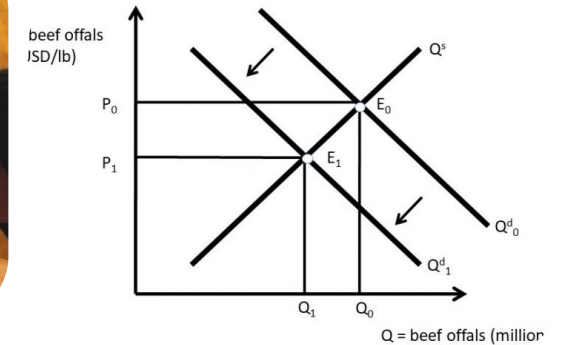
The Agricultural Policy is a **partnership between society and agriculture** with 4 goals:

- To ensure a stable supply of **food**
- To safeguard farmer **income**
- To protect the **environment**
- To keep **rural areas** vibrant

## A good agricultural policy safeguards:



Food Security



Farmer Income



Environment



Rural Area

## General context of Agricultural Policies today: Climate Change for Water-Agriculture system



IPCC, TAR, WG1

- Increased evapotranspiration demand for the atmosphere
- Reduced availability of water resources
- Increased water or irrigation requirements
- Geographically uneven impacts (especially for rainfall) and accentuated in hotspot areas



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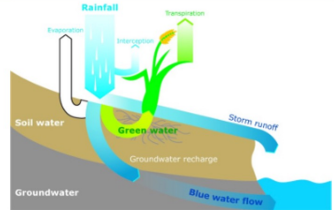
Soil and water:  
a source of life

**Goal:** to identify the most efficient agronomic practices for an integrated management of **soil** and **water** resources that agricultural **policies** will have to support in context of **adaptation** and **mitigation** of cropping systems



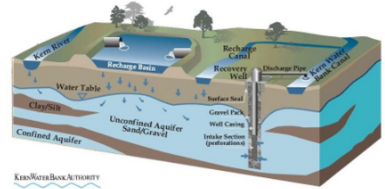
### Green Water

Water from rain that infiltrates into the soil



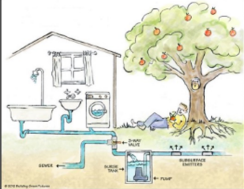
### Blue Water

Water in groundwater and surface bodies







### Grey Water

Wastewater available and good for agriculture



Water available to meet the demand of evapotranspiration of the atmosphere

## WATER 4 AGRI FOOD

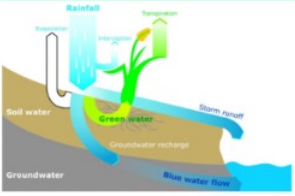
**Improvement of Mediterranean Agri-Food production in conditions of water scarcity**

Domenico Ventrella  
CREA Agricoltura e Ambiente

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### Green Water

Water from rain that infiltrates into the soil



Modern dry farming is based on effective agronomic techniques that retain water in the soil, reduce losses due to runoff, deep percolation and evaporation.

The water used is mainly Green Water but also Blue Water through irrigation deficit.

## Soil Amendment

to increase  
soil water retention

## Deficit irrigation

Preserving Yield,  
Increasing WUE

## Conservative agriculture

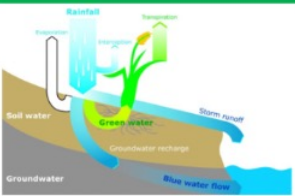
No-tillage,  
mulching crop residues,  
crop rotation

## 1. Soil amendment

- Improvement of soil physical and hydraulic proprieties for bulk density or porosity, water retention, and hydraulic conductivity
- Improvement of soil retention and infiltration capacity.
- Reducing water losses by deep percolation and runoff
- The effects are typically medium or long-term depending mainly on the type of material (compost, manure, biochar, etc.) and annual rates, etc.

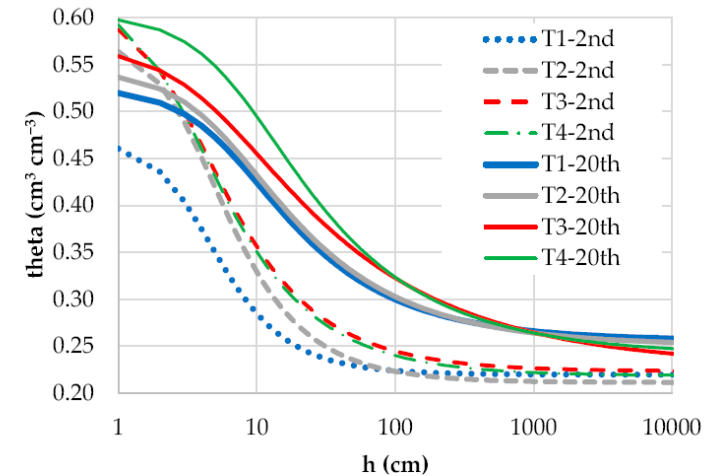
### Green Water

Water from rain that infiltrates into the soil



Castellini M., Diacono M., Preite A., Montemurro F. 2022. Short- and Medium-Term Effects of On-Farm Compost Addition on the Physical and Hydraulic Properties of a Clay Soil. *Agronomy*, 12, 1446.

Effects on soil water retention curves of compost addition by crop residues of 3 doses (1.5, 15 and 75 kg m<sup>-2</sup>) compared with unamended treatment (T1) in a clay soil of Southern Italy



Large increase of Soil Water Retention curve as a function of compost annual rate after 20 months after application

Dry Farming

Water4Agrifood. New dry farming techniques to increase water use efficiency, Pasquale Campi (CREA).  
Rutigliano (Bari) – Southern Italy

1. Soil amendment

Effects of three doses of mixed composted amendament on drip-irrigated Peach orchard (0, 5 and 10 t ha<sup>-1</sup>) on:

- ✓ soil water balance,
- ✓ yield,
- ✓ soil cover,
- ✓ ecophysiology,
- ✓ CO<sub>2</sub> emission.

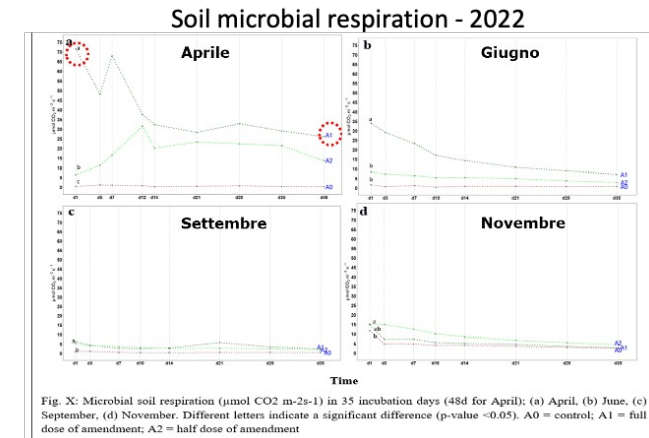
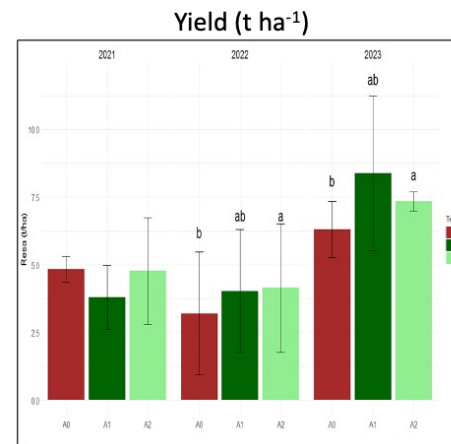
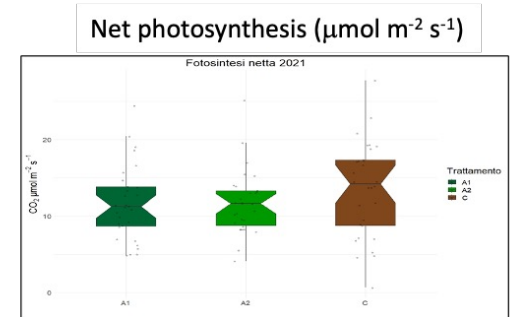
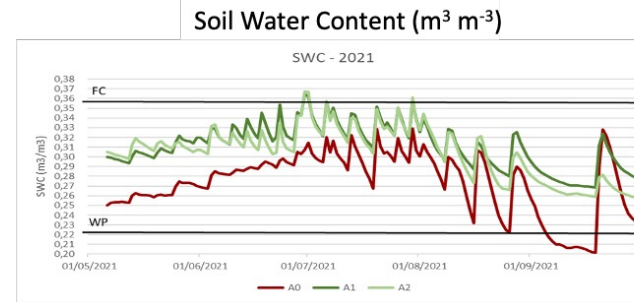


Fig. X: Microbial soil respiration ( $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$ ) in 35 incubation days (48d for April); (a) April, (b) June, (c) September, (d) November. Different letters indicate a significant difference ( $p$ -value  $< 0.05$ ). A0 = control; A1 = full dose of amendment; A2 = half dose of amendment

Green Water

Water from rain that infiltrates into the soil



Dry Farming



Water4Agrifood. New dry farming techniques to increase water use efficiency, Pasquale Campi (CREA).  
Rutigliano (Bari) – Southern Italy

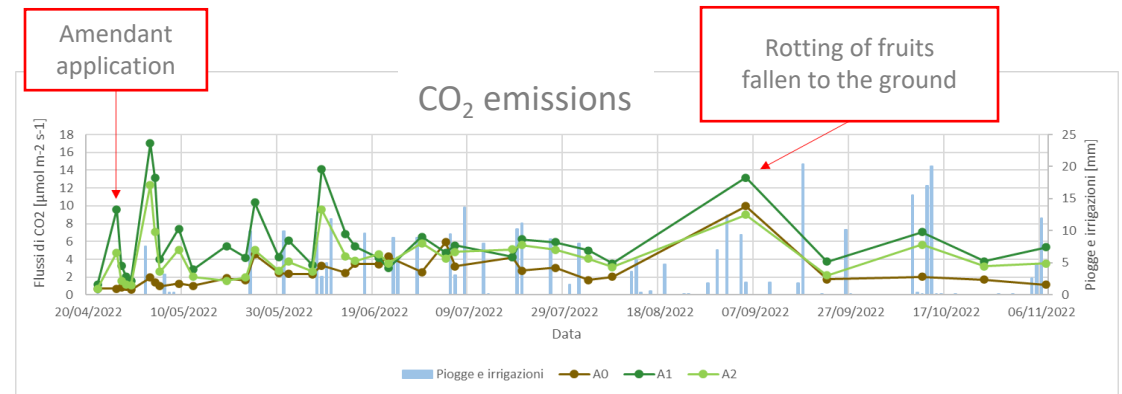
1. Soil amendment

Emissions of Greenhouse Gases

Significant differences between treatments with peaks of CO<sub>2</sub> emission after irrigation or rain.

The use of compost can lead to emissions of greenhouse gases

Need to estimate the Global Warming Potential of the cropping system

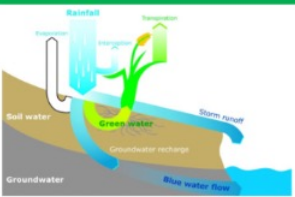


$$SOCsequestrationRate = \frac{SOCstock_{t_f} - SOCstock_{t_i}}{t_f - t_i}$$

$$NGWP = 34CH_4 + 298N_2O - \frac{44}{12} SOCsequestrationRate$$

$$GHGI = \frac{NGWP}{yield}$$

Green Water  
Water from rain that infiltrates into the soil



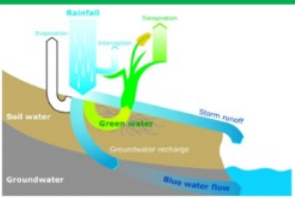
Dry Farming

## 2. Deficit Irrigation

Deficit irrigation = less water irrigation, preserving yield, higher Water Use Efficiency

### Green Water

Water from rain that infiltrates into the soil



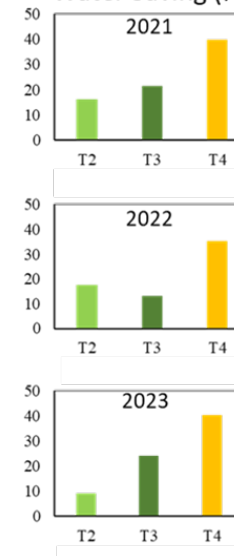
Comparison of 4 different strategies of Irrigation Deficit on Citrus orchard:

- T1 = 100% of Etc
- T2 = 75% of ETC with sub-surface drip irrigation
- T3 = from 100% to 50% of ETC depending on crop cycle
- T4 = 50% dell'ETc, alternately on the 2 sides of tree rows (Partial Root-Zone Drying)

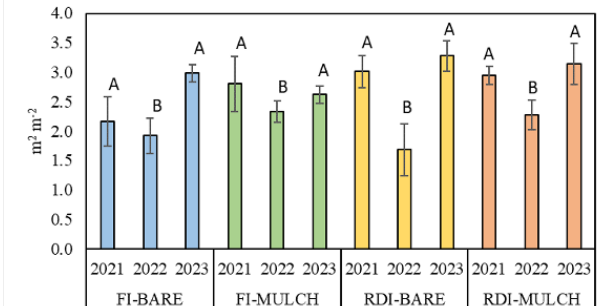
Dry Farming

Water4Agrifood. Adaptation of farm irrigation management methods.  
Simona Consoli. University of Studies of Catania, Southern Italy

Water Saving (%)



LAI



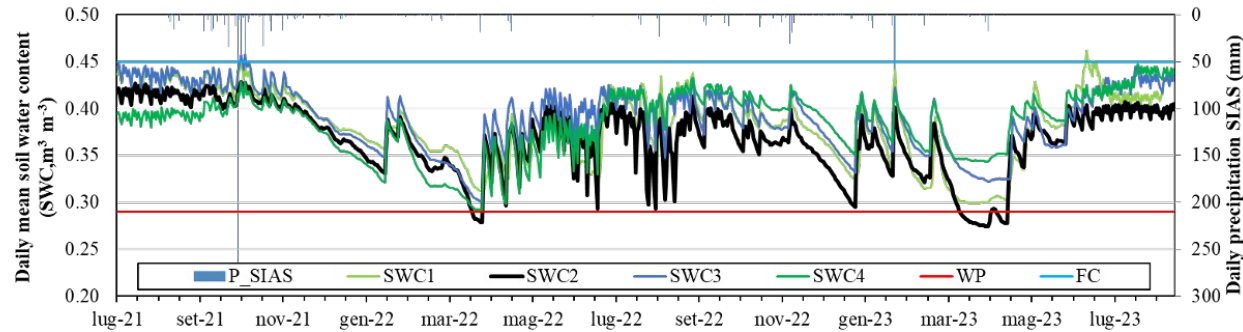
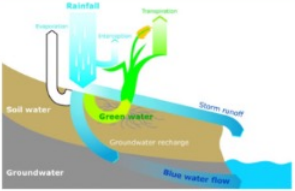
No significant differences of treatments

## 2. Deficit Irrigation

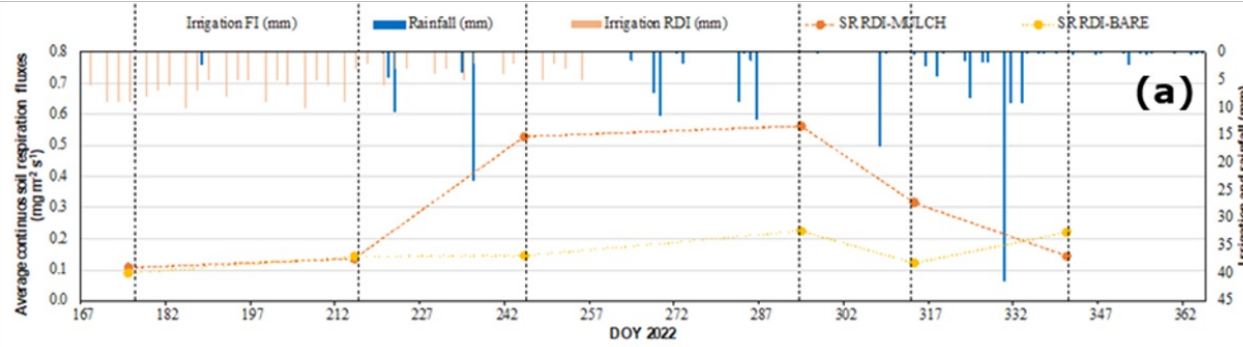
Water4Agrifood. Adaptation of farm irrigation management methods.  
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### Green Water

Water from rain that infiltrates into the soil



Evolution of Soil Water Content



The application of organic mulching resulted in an increase in soil respiration due to greater microbial activity

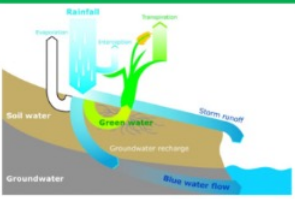
Dry Farming



### 3. Conservation Agriculture

#### Green Water

Water from rain that infiltrates into the soil




Dry Farming

**Conservation Agriculture** is a farming system that promotes maintenance of a permanent soil cover, minimum soil disturbance (i.e. no tillage), and diversification of plant species. It enhances biodiversity and natural biological processes above and below the ground surface, which contribute to increased water and nutrient use efficiency and to improved and sustained crop production.

### Three principles of Conservation Agriculture:



#### 1. Minimum mechanical soil disturbance

(i.e. no tillage) through direct seed and/or fertilizer placement.



#### 2. Permanent soil organic cover

(at least 30 percent) with crop residues and/or cover crops.



#### 3. Species diversification

through varied crop sequences and associations involving at least three different crops.

from: [www.fao.org/conservation-agriculture/](http://www.fao.org/conservation-agriculture/)

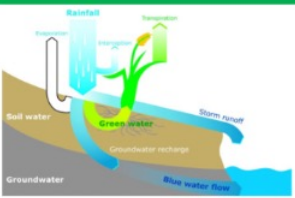
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### 3. Conservation Agriculture

## Stability analysis of winter wheat productivity in conservation agriculture compared to other management systems in Southern Italy. Domenico Ventrella CREA

#### Green Water

Water from rain that infiltrates into the soil



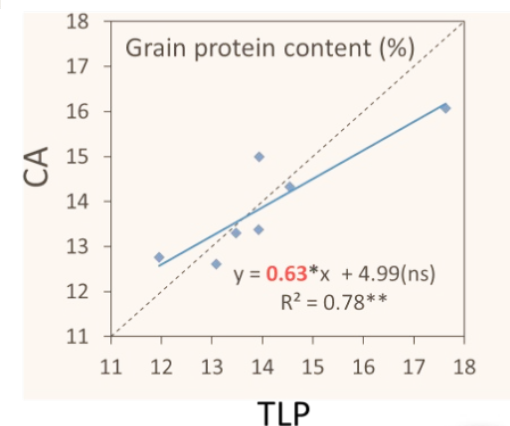
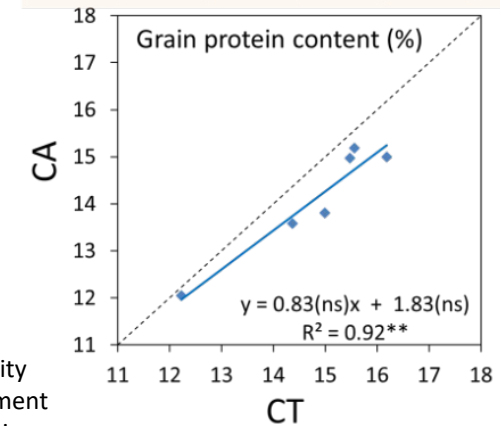
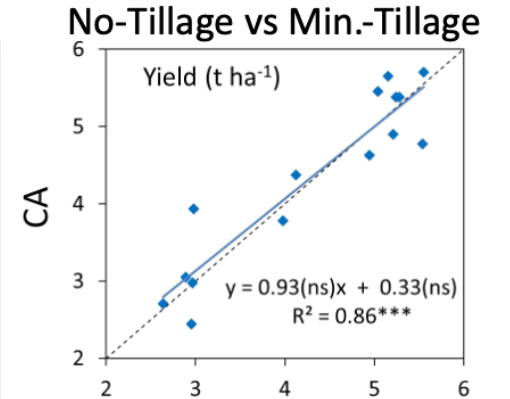
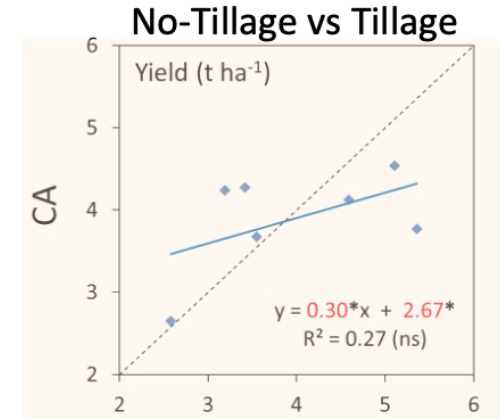
**Objective:** to investigate the long-term effects (15 years) on yield and soil in a one-year of cultivation of winter durum wheat submitted to:

- conservative tillage (CA),
- minimum tillage (TLP, two-layer ploughing),
- conventional tillage (CT).

#### Dry Farming



Ventrella D., Vonella A.V., Castellini M., Garofalo P., Rinaldi M., Fornaro F., Giglio. 2018. Stability analysis of winter wheat productivity in conservation agriculture compared to other management systems in Southern Italy. Atti del XLVII Convegno Nazionale della Società Italiana di Agronomia, "L'Agronomia nelle nuove Agricolturae (Biologica, Conservativa, Digitale, di Precisione)", Marsala (TP), 12-14 settembre, 51-52.

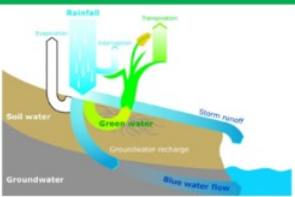


### 3. Conservation Agriculture

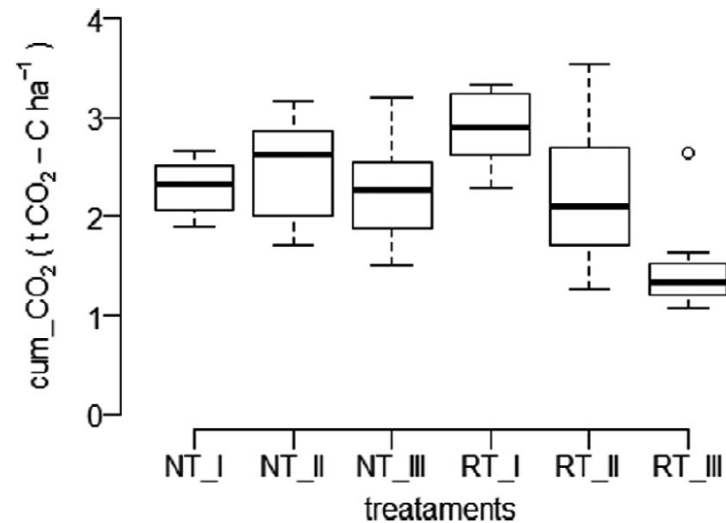
Ferrara, R.M., Campi P., Muschitiello C., Leogrande R., Vonella A.V., Ventrella D., Rana G. 2021. Soil respiration during three cropping cycles of durum wheat under different tillage conditions in a Mediterranean Environment. *Soil Use and Management*, 38, 4. 1547-1563.

#### Green Water

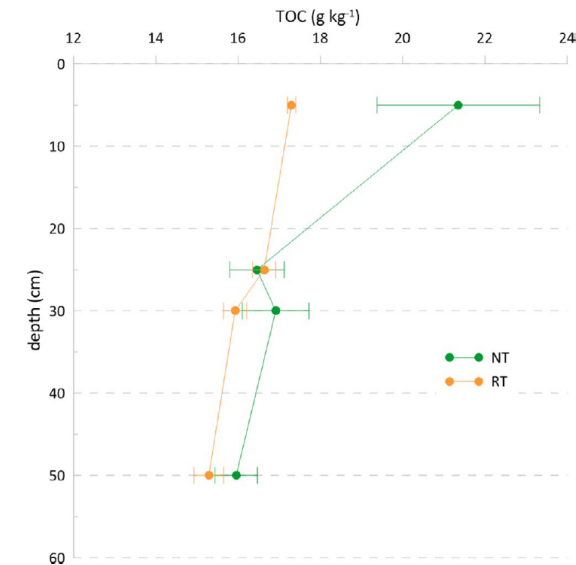
Water from rain that infiltrates into the soil



Cumulative CO<sub>2</sub> fluxes in 3 years for no-tillage (NT) and minimum tillage (RT) treatments



TOC profiles in NT and RT treatments



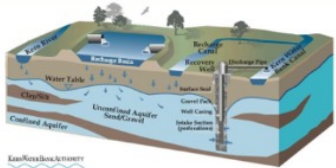
#### Dry Farming



**Blue water  
tools**

**Blue Water**

Water in groundwater  
and surface bodies



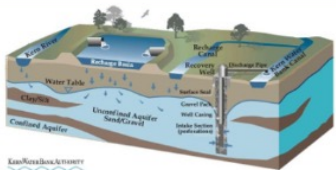
*What are the tools of precision irrigation for an efficient and effective use of Blue Water and which agricultural policies should support?*

## 1. Technical Innovations

Water4Agrifood. New precision irrigation techniques and innovative cultivation practices.  
Stefano Anconelli, Canale Emiliano Romagnolo, Bologna, Italy.

### Blue Water

Water in groundwater  
and surface bodies



Development and use of superficial and sub-surface micro-flow systems (Ultra Low Drip Irrigation) suitable for water deficit conditions.

Field researches in citrus, apple, tomato and potato in Sicily and Emilia Romagna.



30% reduction in irrigation volumes without significant effects on tomato and potato yields



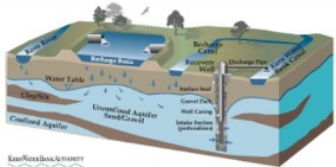


## 2. Covering soil and plant

Water4AgriFood. Increased water use efficiency by reducing water consumption through innovative cultivation practices. Rossana Monica Ferrara (CREA)

### Blue Water

Water in groundwater and surface bodies



Field research in Rutigliano on Peach orchard based on use of shade nets and mulching.

Positive effects of shade nets on fruit growth, weight and size.

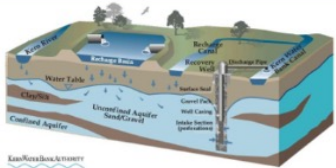


### 3. Decision Support System

Water4Agrifood. Development and use of web applications for the sustainable management of irrigation and water saving in agriculture. Francesco Cavazza (Canale Emiliano Romagnolo, Bologna, Italy)

#### Blue Water

Water in groundwater and surface bodies



#### IRRIFRAME.

Decision Support System for irrigation management with reduced water availability

At basin and farm scale.

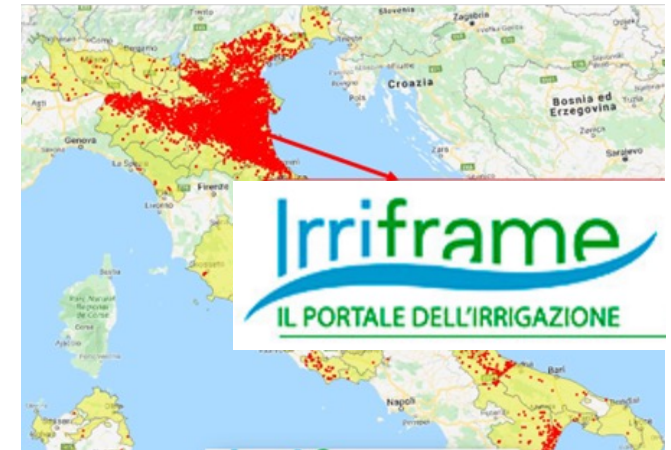
Utilized in 7 million hectares of 16 of 23 Italian regions

*Development prospects:*

Fertigation

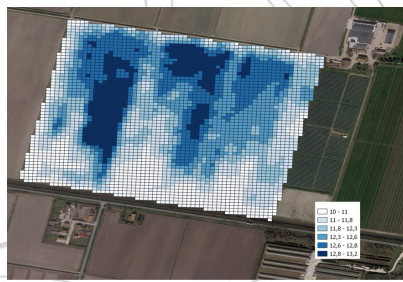
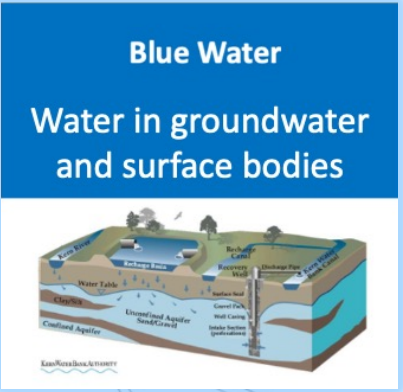
Proximal sensing sensors

Prescription maps

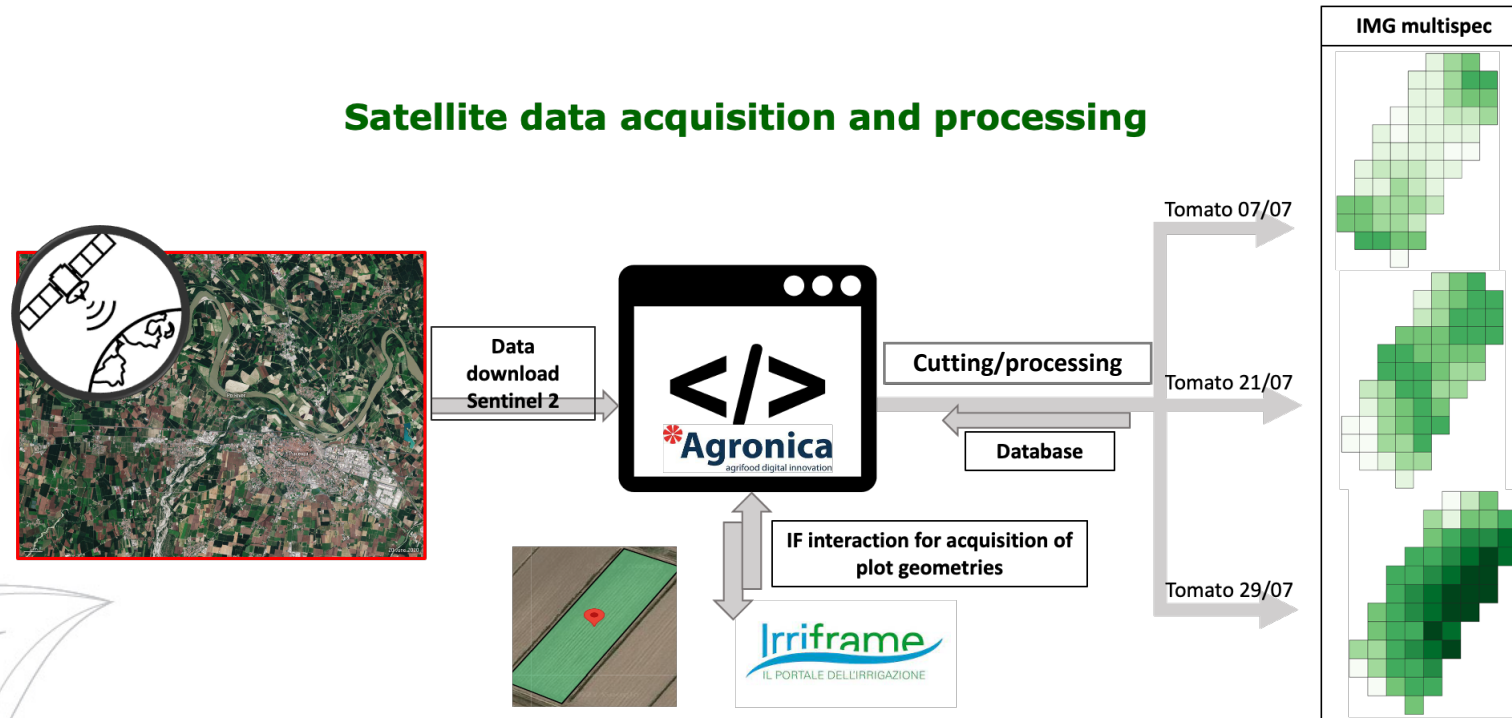


### 3. Decision Support System

Variable rate irrigation by processing vegetation indices from satellite images.  
Salvatore Gentile (Canale Emiliano Romagnolo, Bologna, Italy)



### Satellite data acquisition and processing



# Conclusions

Integrated management of soil and water resources to support economic and environmental policies



## Soil Amendment

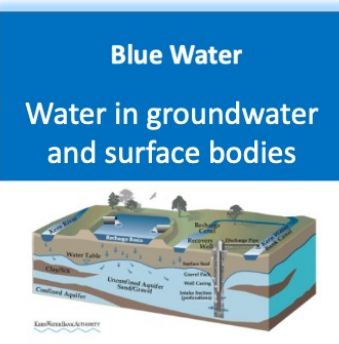
to increase soil water retention

## Deficit irrigation

including all strategies for - water, = Yield, + WUE

## Conservative agriculture

no-tillage, mulching of crop residues, crop rotation



## Innovation

of hardware of irrigation systems

## Covering soil and plant

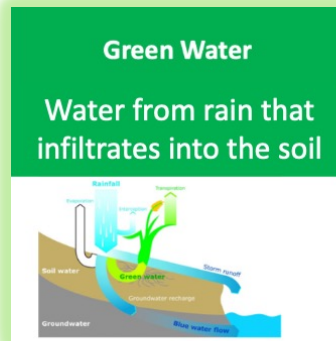
for reducing water consumption

## Decision Support Systems

for irrigation and ferti-irrigation

# Thanks for your attention

Integrated management of soil and water resources to support economic and environmental policies



## Soil Amendment

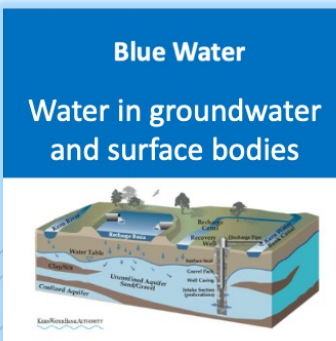
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for irrigation and ferti-irrigation