FIGARO

FLEXIBLE AND PRECISE IRRIGATION PLATFORM TO IMPROVE FARM-SCALE WATER PRODUCTIVITY

GWRI, TECHNION
7 September, 2016
Cotton cultivation spatial distribution for year 2007 (after Karamanos and Vodoulakis 2011)

- The cotton crops occupy approximately 13% of the total cultivated area in Greece.
- In the cultivating procedure engaged 80,000 - 100,000 families.
- In the various stages of production and processing employed more than 150,000 people.
Current Situation in Xanthi, Greece

- Cotton cultivation data during 2012 – 2015 in Regional District of Xanthi, northern Greece

- In average, **76.7%** of the cultivated cotton is irrigated

- Mean seed cotton yield (2.9 tn/ha) is **substantially low**
Current Situation in Xanthi, Greece

• How are the Farmers obtain the necessary quantities of water?

➤ By pumping underground water via DRILLINGS

➤ Utilizing an existing irrigation network
Current Situation in Xanthi, Greece

- FARMERS in Greece are not paying any direct tariffs for water consumption.

- The majority of them are ignorant and uninterested to quantify water used for farming, as they do not use water-meters.
Current Situation Greece

Cotton Irrigation Methods in Greece

- Sprinkler: 67%
- Drip: 22%
- Furrow: 8%
- Rainfed: 3%
FIGARO experiment in Xanthi, north Greece
4 Steps for Precision Irrigation

Step 1:
- Textural soil analysis up to 1 m depth
- Chemical soil analysis for the determination of the needed fertigation
Step 2: Numerical simulation for local weather prediction within the next 48 hours, to locally forecast the precipitation height.
Step 3:
Based on the meteorological prediction we calculate the ET₀.

In parallel, via a soil moisture sensors network we were measuring the soil moisture in real time at different points and depths.
4 Steps for Precision Irrigation
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Step 3: Canopy Cover determination
4 Steps for Precision Irrigation

**Step 4**: Crop Growth Simulation – Irrigation Recommendation

<table>
<thead>
<tr>
<th>Day</th>
<th>Recommended Irrigation events</th>
<th>Farmer forecast</th>
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</thead>
<tbody>
<tr>
<td>Δευ Σεπ05</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>Τρι Σεπ06</td>
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<td>0</td>
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<tr>
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Programme funded by the EUROPEAN UNION
# Results - 2013

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Irrigation Method</th>
<th>Irrigation (m³/ha)</th>
<th>Real Seed Cotton Yield (tn/ha)</th>
<th>Estimated Seed Cotton Yield (tn/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1⁰ pick</td>
<td>2⁰ pick</td>
<td>Sum</td>
</tr>
<tr>
<td>Deficit</td>
<td>Drip</td>
<td>2,270</td>
<td>3.03</td>
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<tr>
<td>FIGARO</td>
<td>Drip</td>
<td>2,710</td>
<td>3.64</td>
<td>0.667</td>
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<tr>
<td>Farmer</td>
<td>Drip</td>
<td>3,680</td>
<td>3.94</td>
<td>0.545</td>
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<tr>
<td>Deficit</td>
<td>Canon</td>
<td>3,410</td>
<td>3.21</td>
<td>0.73</td>
</tr>
<tr>
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<td>3,510</td>
<td>2.85</td>
<td>0.61</td>
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<tr>
<td>Farmer</td>
<td>Canon</td>
<td>4,000</td>
<td>3.21</td>
<td>0.73</td>
</tr>
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</table>
Results - 2013
Results - 2013

- Farmer - Canon
- FIGARO - Canon
- Deficit - Canon
- Farmer - Drip
- FIGARO - Drip
- Deficit - Drip

Water Productivity (Kg/m³)
Results - 2013

- Farmer - Canon
- FIGARO - Canon
- Deficit - Canon
- Farmer - Drip
- FIGARO - Drip
- Deficit - Drip

Water Savings (%)
Results - 2013

• Converting Water savings to Energy savings

➢ The exact number of KWhs in the electric consumption meter was checked before and after the end of 4 irrigation events (both canon and drip). It was found that, in average, 1.6 KWh were required to pump 1 m³ of water.
Results - 2013

![Bar chart showing energy savings percentages for different farming methods and irrigation systems.](chart.png)
## Results - 2015

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Irrigation Method</th>
<th>Irrigation (m³/ha)</th>
<th>Real Seed Cotton Yield (tn/ha)</th>
<th>Estimated Seed Cotton Yield (tn/ha)</th>
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</thead>
<tbody>
<tr>
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<td>pick</td>
<td>SD</td>
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<tr>
<td>Deficit</td>
<td>Drip</td>
<td>3,020</td>
<td>3.97</td>
<td>1.1</td>
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<tr>
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<td>Drip</td>
<td>3,100</td>
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<td>Farmer</td>
<td>Drip</td>
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<td>Deficit</td>
<td>Canon</td>
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<td>FIGARO</td>
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<td>Farmer</td>
<td>Canon</td>
<td>4,383</td>
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Results - 2016

**soil water content (SWC)** for soil depth: 1.00 meter

**Statistical indicators**

- $r$: Pearson Correlation Coefficient = 0.96
- RMSE: root mean square error (mm water) = 24.8
- CV(RMSE): normalized root mean square error (%) = 8.1
- EF: Nash-Sutcliffe model efficiency coefficient = 0.86
- $d$: Willmott's index of agreement = 0.96

Observed/simulated pairs (n): 24
Average of observed Soil water content: 306.5 mm
Average of simulated Soil water content: 292.8 mm

0 mm 360 mm

Scale

Programme funded by the European Union

FIGARO Irrigation Platform
### Results

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2015</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Yield (tn/ha)</td>
<td>Potential yield increase (%)</td>
</tr>
<tr>
<td>Regional Average Production</td>
<td>2.8</td>
<td></td>
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<tr>
<td>FIGARO DRIP</td>
<td>4.3</td>
<td>53.6</td>
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<td>FIGARO CANON</td>
<td>3.8</td>
<td>35.7</td>
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<tr>
<td></td>
<td>2.7</td>
<td>4.04</td>
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<td></td>
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<td>49.6</td>
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<tr>
<td></td>
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<td>55.5</td>
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</table>

A potential average increase roughly 48.6% ± 9 over the mean regional seed cotton yield
Regional – Local Databases

Through the FIGARO platform consultants, authorities or interested farmers will be able to create local and regional databases for

- Weather data
- Agricultural practices
Weather Databases

Sum of monthly GDD for the cotton cultivation period during FIGARO project

- 2013
- 2014
- 2015
- 2016
Monthly precipitation sum for the cotton cultivation period during FIGARO project.
Agricultural Practices

Air and soil (10 cm) temperature fluctuation between 17 and 24 April 2016
Cotton sowing 2016! Approximately 30kg of Pioneer’s ST 405 seeds were applied in 1 ha. The distance between the plant rows was 96 cm, while the distance between the seeds within a row was roughly 5 cm (equal to 20 plants/m). In parallel, the field was fertilized with 150 kg/ha 30/10/5 N/P/K and 150 kg/ha 32/11/0 N/P/K mineral fertilizers. An irrigation event, equal to 30 mm, followed the sowing to grant the required for germination moisture.
Conclusions

FIGARO platform could stimulate transition from empirical to Precision Irrigation and ultimately to Precision Agriculture as a common practice in Greece by:

- Providing short term irrigation recommendations, improving the efficiency of farmer’s irrigation scheduling
- **Reducing** cultivation costs by **reducing the energy** consumption required for the pumping of irrigation water
- **Increasing** substantially the regional **mean cotton seed production**, contributing to the local and regional growth of agricultural sector
- Helping Farmers, Agronomists and irrigation consultants to **create** local weather, soil and agricultural databases, to further understand and improve their practices
Thank you for your attention!