IMPACT ANALYSIS: RESULTS FROM TEST SITES
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Objective of FIGARO

Attain significant reduction of fresh water use at farm level by developing a cost-effective, precision irrigation management platform.

The platform support PI application through data acquisition from monitoring devices and forecasting tools, data interpretation, system control, and evaluation mechanisms.

- **irrigation strategy selection** (FI, PRD, RDI).
- **3 to 7 days plan for irrigation intervention.**
Validation of the platform

A field experiments network encompassing the full range of climate conditions and a number of water demanding crops and soil types has been designed to test the platform, using different irrigation strategies and irrigation technologies (with a strong focus on micro irrigation).
OBJECTIVE
Assess to which extent the improvement of the quality of information brought with the FIGARO DSS conditions farmer’s strategic decisions and consequently farm’s income

METHODOLOGY
COMPARATIVE ASSESSMENT - FIGARO APPROACH VS COMPARING PRACTICES
(Farm practice, Latest technologies to schedule irrigation, Direct measurement)

UNIT OF INVESTIGATION
Experimental Trial

PERIOD
INFORMATION COLLECTED IN EACH EXPERIMENTAL SITE

Conservative parameters:
- Crop characteristics, Soil Texture

Meteorological data:
- Temperature, Precipitation, Relative Humidity, Solar Radiation, Wind Speed

Water content in the soil:
- Measurement of soil water content at different depth, Water table depth

Plant growth:
- LAI and CC, Root depth, Dry and Wet Biomass, Production quality/quantity.

Irrigation:
- Flow and duration of irrigation intervention, Energy consumption (flow rate, engine power, hydraulic head).

ADDITIONAL INFORMATION TO CARRY OUT THE ECONOMIC ASSESSMENT

Output prices:
- FAOSTAT

Input prices:
- EUROSTAT

Equipment costs:
- Technical literature

Subsidies and Tariffs:
- Information from experimental sites
IMPACT ANALYSIS – Methodology

Relationship between irrigation intervention and soil water content during the growing season of a reference crop

‘Good’ Irrigation Scheduling

‘Bad’ Irrigation Scheduling

The quality of Information affect performances
Relationship between irrigation intervention and soil water content during the growing season for a reference crop.

Irrigation Scheduling

‘Good’ Irrigation Scheduling

‘Bad’ Irrigation Scheduling

The quality of Information affect performances
IMPACT ANALYSIS – Methodology

**Probability to correctly estimate irrigation requirements**

<table>
<thead>
<tr>
<th>'Good' Irrigation Scheduling</th>
<th>'Bad' Irrigation Scheduling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability to correctly predict need for irrigation</td>
<td>Probability to correctly predict no need for irrigation</td>
</tr>
</tbody>
</table>

E[c] = \( \sum_{s} q_{m,s} C_{m,s}^{*} \)  

where, 

- \( C_{m,s}^{*} \) are the consequences of farmer’s choices for state ‘s’ when receiving message ‘m’
- \( \pi_s \) is the probability of state occurrence
- \( q_{m,s} \) is the degree of accuracy of the information provided through the information systems
IMPACT ANALYSIS – Methodology

Relationship between Yield and Irrigation water uses for a reference crop

Impact on yield and irrigation water uses causes economic impacts

\[ E[c] = pE[y(E[w])] + S (t_v + c_e + C_f f)w - t_f - C \]

where:
- \( p \) = product price;
- \( w \) = amount of water applied; \( y \) = production;
- \( c_e \) = energy cost; \( c_f \) = salary;
- \( e \) = energy uses; \( f \) = labour uses;
- \( t_v \) = water tariff proportional to the amount of water applied;
- \( t_f \) = water tariff not connected to water uses;
- \( C \) = other direct costs costs;
- \( S \) = subsidies.

\( w' - w'' \) water misuse caused by wrong estimation
\( y^* - y' \) yield loss caused by wrong estimation
production fronteer
IMPACT ANALYSIS – Results

Results are shown for the experiments conducted in **Greece** and in **Denmark**

**Danish case study** – *Comparison between the FIGARO system and Direct measurement*

**Greek case study** – *Comparison between the FIGARO system and the TRADITIONAL practice*
Impact analysis – Greece

The experimental site is located in Xanthi coastal plain, at the south-east of Magiko Village, belonging administratively to Avdira Municipality. The main sources of irrigation water in the region are rivers (46%) and underground water (54%). Cotton and Tobacco are the most important irrigated crops in the area. Gun irrigation is the most common system adopted to irrigate cotton in the region.

In the experimental site, water for irrigation is pumped from underground (35 m) and the quality of water is high (no salinity). The physical soil properties of the experimental field site appear similar to those of the broader area, with high content of sand and almost equal but reduced contents in silt and clay.

The experiment conducted in Magiko compare three treatments of cotton crops for both drip and sprinkler irrigation for three growing seasons.

The treatments are:

1) irrigation scheduled with FIGARO with full irrigation
2) irrigation scheduled with FIGARO with deficit irrigation
3) irrigation scheduled according to traditional systems (farm practice)

Results are shown for treatment 1 and 3
Impact analysis – Greece (Cotton Drip Irrigated)

Relative impact of the FIGARO treatment VS the TRADITIONAL treatment (%)

<table>
<thead>
<tr>
<th></th>
<th>DRIP</th>
<th>T-TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>9%</td>
<td>t(4)=0.77</td>
</tr>
<tr>
<td>Amount of water applied</td>
<td>-14%</td>
<td>t(4)=0.28</td>
</tr>
<tr>
<td>Income</td>
<td>20%</td>
<td>t(4)=0.90</td>
</tr>
</tbody>
</table>
Impact Analysis – Greece (Cotton)

Differences in Gross Margin between FIGARO and the FARM practice during three year of investigation

FIGARO vs FARM

<table>
<thead>
<tr>
<th>Year</th>
<th>FIGARO Gross Margin (€/ha)</th>
<th>FARM Gross Margin (€/ha)</th>
<th>ΔGross Margin (€/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>100.00</td>
<td>200.00</td>
<td>-100.00</td>
</tr>
<tr>
<td>2014</td>
<td>200.00</td>
<td>300.00</td>
<td>100.00</td>
</tr>
<tr>
<td>2015</td>
<td>300.00</td>
<td>400.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>
The irrigated crops in the region are mostly winter wheat, winter and spring barley, winter rape, maize, potatoes and grass. Gun irrigation is most common system adopted in the region. Jndevad is located in the western part of Denmark (Jutland County). The field is characterized by a coarse textured soil, which is typical of the area. Water for irrigation is pumped from underground (10-100 m) and the quality of water is high (no salinity).

The experiment conducted in Jndevad compare a a series of treatment for potato crops and for both drip and sprinkler irrigation.

The treatments are:

1) irrigation scheduled with FIGARO for drip irrigation
2) irrigation scheduled for drip irrigation with direct measurement of soil moisture and for different irrigation strategies
3) irrigation scheduled with FIGARO for sprinkler irrigation

Results are shown for treatment 1 and 2 (full irrigation)
Impact Analysis – Denmark (Potato drip irrigated)

Relative impact of the FIGARO treatment VS DIRECT MEASUREMENT (%)

<table>
<thead>
<tr>
<th></th>
<th>FIGARO VS DM</th>
<th>T-TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>-10%</td>
<td>t(14)=0.67</td>
</tr>
<tr>
<td>Amount of water applied</td>
<td>2%</td>
<td>t(14)=1.56</td>
</tr>
<tr>
<td>Income</td>
<td>-28%</td>
<td>t(14)=0.5</td>
</tr>
</tbody>
</table>
Impact Analysis – Denmark (Potato Drip Irrigated)

Differences in Gross Margin between FIGARO and the FARM practice during two years of investigation
**IMPACT ANALYSIS – Results**

**Impact Analysis – Quality of information and consequences (Danish and Greek case study)**

<table>
<thead>
<tr>
<th></th>
<th>DANISH CASE STUDY</th>
<th>GREEK CASE STUDY</th>
<th>GREEK CASE STUDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIGARO VS DIRECT MEASUREMENT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability to correctly predict the event</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Need to irrigate</td>
<td>- 21%</td>
<td></td>
<td>+ 25%</td>
</tr>
<tr>
<td>No need to irrigate</td>
<td>- 48%</td>
<td></td>
<td>+ 43%</td>
</tr>
<tr>
<td>FIGARO VS FARM PRACTICE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability to correctly predict the event</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yield (t/ha)</td>
<td>- 5 t/ha</td>
<td>+ 0.5 t/ha</td>
<td></td>
</tr>
<tr>
<td>Irrigation Water uses (mm)</td>
<td>+ 44 mm</td>
<td></td>
<td>- 132 mm</td>
</tr>
<tr>
<td>Gross margin (%)</td>
<td>- 28%</td>
<td></td>
<td>+ 20%</td>
</tr>
</tbody>
</table>
IMPACT ANALYSIS – Other Results

**Italy** - The experimental field is located nearby the village of Mezzolara di Budrio (Bologna) in the plain of the Po valley. The experiment conducted in Mezzolara compare a series of treatment for Tomato and Maize crops and for both drip and sprinkler irrigation and for different irrigation strategies. Results shows that on average there is not a significant variation in the production while the amount of water applied with irrigation is reduced significantly with a consequent increases of the Gross Margin.

**Spain** – The test site is located in the municipality of Picasent in Valencia. A treatment where irrigation is scheduled with FIGARO is compared with an alternative DSS (CLM - Crop Land Model) and with the farm practice for Citrus fruit Drip irrigated. Results show that on average there is not a significant variation in the amount of water applied while the yield increases with a consequent increase of the Gross Margin.

**Portugal** – The field experiment was conducted at Herdade do Zambujeiro, Barrosa. A treatment where irrigation is scheduled with FIGARO is compared with a treatment where irrigation is scheduled with traditional systems (farm practice) for Maize crop and for Sprinkler irrigation. Results show that on average there is not a significant variation in the amount of water applied while the yield decreases with a consequent reduction of the Gross Margin.

For all the test sites, during the three year of investigation the performances obtained with FIGARO improved significantly with respect to the comparing practices.
On average, results from experimental sites reveal that the FIGARO approach compared to traditional irrigation practices has a positive impact on yield, on the use of water for irrigation and, as a consequence, on farms’ income.

For some of the comparison (not presented here), it was found that combining the FIGARO precise irrigation approach with drip irrigation ameliorate significantly the economic performances with respect to traditional sprinkler irrigation technologies (i.e. case of Maize in Italy, case of Cotton in Greece)

However, during the three years of investigation the FIGARO system was under development. That is, the implementation of the FIGARO in the first year was different from the FIGARO system implemented in the third year of investigation. This condition, together with climate variability, affect the consistency of results.

In any case, most of the field experiments show that the implementation of the FIGARO system reduces variability in yield and reveal better worst case conditions than the comparing approaches.

The comparison of the FIGARO system with direct measurement (Danish case study) reveal that there is still room of investigation to improve the accuracy in estimating and in forecast crop water requirements.
THANKS FOR YOUR ATTENTION
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