Oristano, Italy

Combining modeling and stakeholder involvement to build community adaptive responses to climate change in a Mediterranean agricultural district

Pier Paolo Roggero, Giovanna Seddaiu, Luigi Ledda, Luca Doro, Paolo Deligios, Thi Phuoc Lai Nguyen, Massimiliano Pasqui, Sara Quaresima, Nicola Lacetera, Raffaele Cortignani, Gabriele Dono
Regional Pilots’ meta-question:

What would be the different contributions of different European adaptation strategies to ensure global food security until 2050 at different scales [farm to EU] while keeping the GHG targets?
Why the Oristanese case study?

• One of the six case studies in Italy within the Agroscenari project (www.agroscenari.it)
  – Interdisciplinary team @work
  – Context data available from other projects

• Very diversified agricultural district in a Mediterranean context
  – Irrigated and rainfed farming systems
  – Variety of cropping systems, intensity levels, farm size

• Multiple stakeholders
  – Cooperative agro-food system
  – Producers’ organizations (rice, horticulture)
  – Variety of extensive pastoral systems
Infrastructured area for irrigation: 36,000 ha

Rainfed area: 18,000 ha

- Silage maize: 18%
- Forage crops: 14%
- Other: 11%
- Pasture: 5%
- Rice: 8%
- Vegetables: 17%
- Wheat: 18%

- Barley-Oats: 30%
- Hay crops: 5%
- Other: 10%
- Pasture: 2%
- Vegetables: 3%
- Wheat: 50%
## Farming system typologies

<table>
<thead>
<tr>
<th>Typology</th>
<th>Represented farms (n)</th>
<th>Farm land size (ha)</th>
<th>Typology % total land area</th>
<th>Family Labour Units</th>
<th>Gross sales (€ 000)</th>
<th>Net Income per farm (NI - € 000)</th>
<th>Typology % total NI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigated crops (WUA)</td>
<td></td>
<td></td>
<td>57.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rice</td>
<td>24</td>
<td>115</td>
<td>5.2</td>
<td>2.0</td>
<td>303</td>
<td>139.5</td>
<td>4.2</td>
</tr>
<tr>
<td>Citrus</td>
<td>68</td>
<td>13</td>
<td>1.6</td>
<td>1.7</td>
<td>74</td>
<td>45.7</td>
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<tr>
<td>Dairy cattle A</td>
<td>130</td>
<td>31</td>
<td>7.6</td>
<td>4.4</td>
<td>507</td>
<td>199.2</td>
<td>32.6</td>
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<td>Dairy cattle B</td>
<td>40</td>
<td>32</td>
<td>2.4</td>
<td>6.3</td>
<td>453</td>
<td>112.7</td>
<td>5.7</td>
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<tr>
<td>Greenhouse</td>
<td>46</td>
<td>13</td>
<td>1.1</td>
<td>3.5</td>
<td>147</td>
<td>29.7</td>
<td>1.7</td>
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<tr>
<td>Vegetables - Cereals</td>
<td>562</td>
<td>22</td>
<td>23.5</td>
<td>1.7</td>
<td>98</td>
<td>34.2</td>
<td>24.2</td>
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<td>Cereals - Forages</td>
<td>55</td>
<td>146</td>
<td>15.2</td>
<td>1.2</td>
<td>236</td>
<td>126.3</td>
<td>8.7</td>
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<tr>
<td>Tree and arable crops</td>
<td>100</td>
<td>6</td>
<td>1.1</td>
<td>2.0</td>
<td>44</td>
<td>11.8</td>
<td>1.5</td>
</tr>
<tr>
<td>Rainfed crops</td>
<td></td>
<td></td>
<td>42.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetables - Fruit</td>
<td>100</td>
<td>4</td>
<td>0.8</td>
<td>1.7</td>
<td>65</td>
<td>18.2</td>
<td>2.3</td>
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<tr>
<td>Cereals - Forages</td>
<td>94</td>
<td>25</td>
<td>4.4</td>
<td>1.2</td>
<td>41</td>
<td>16.9</td>
<td>2.0</td>
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<tr>
<td>Sheep A</td>
<td>45</td>
<td>87</td>
<td>7.4</td>
<td>2.1</td>
<td>111</td>
<td>43.6</td>
<td>2.5</td>
</tr>
<tr>
<td>Sheep B</td>
<td>188</td>
<td>41</td>
<td>14.6</td>
<td>1.5</td>
<td>35</td>
<td>16.1</td>
<td>3.8</td>
</tr>
<tr>
<td>Sheep C</td>
<td>129</td>
<td>62</td>
<td>15.2</td>
<td>1.6</td>
<td>82</td>
<td>42.5</td>
<td>6.9</td>
</tr>
</tbody>
</table>
Major farm types
(seamless categories)

- **Irrigated area**
  - Farm size
    - Small: 0.0%
    - Medium: 9.8%
    - Large: 90.2%
  - Farm intensity
    - Low: 0.0%
    - Medium: 62.5%
    - High: 37.5%
  - Specialization
    - Dairy cattle (temp. grass)
    - Arable: cereals incl rice, forage crops
    - horticulture

- **Rainfed area**
  - Farm size
    - Small: 0.0%
    - Medium: 74.5%
    - Large: 25.5%
  - Farm intensity
    - Low: 0.0%
    - Medium: 82.0%
    - High: 18.0%
  - Specialization
    - Dairy sheep (permanent grasslands, temporary grasslands)
    - Arable: cereals, forage crops
Main farming systems

Dairy Cattle

- silage maize
- Italian ryegrass
- triticale, alfalfa

Rice

Dairy sheep

- Permanent or temporary pastures, autumn-winter hay-crops (winter grazing + hay or grain)

Horticulture
RAMS scenarios forced by sea T coupled with atm (2000-10 vs 2020-30)

Local weather dataset (59 yrs)

Local cropping system dataset

150 years PC vs FC

Calibrated EPIC model for main cropping systems

Calibration

P distributions of performance of main crops and net ET under CP vs FC

Calibration

Calibrated 3-stages DSP model for main rainfed and irrigated farm typologies and @district scale

Calibration

What-if scenario analyses Farmers’ adaptive responses under uncertainty

Social learning

Farmers and local organizations, participatory field experiments

Researchers, policy makers, farmers organizations
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Temperature:

- PC vs FC

Precipitation:

- PC vs FC

Climate change signals

ETn = ET - prec

PC irrigated
FC irrigated
PC rainfed
FC rainfed

PC 536 mm
FC 505 mm (-6%)

Temperature: PC vs FC

Precipitation: PC vs FC
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@RISK

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Cumulative ETn in April-October

<table>
<thead>
<tr>
<th></th>
<th>Present</th>
<th>Future</th>
</tr>
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<tbody>
<tr>
<td>25,...</td>
<td></td>
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<tr>
<td>13,...</td>
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<tr>
<td>1,0...</td>
<td>50,...</td>
<td>49,...</td>
</tr>
<tr>
<td>1,1...</td>
<td>37,...</td>
<td>25,...</td>
</tr>
</tbody>
</table>

mm of wa...

- **Present**
- **Future**
Spring Hay yield from rain-fed crops

<table>
<thead>
<tr>
<th>Present</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>25,...</td>
<td>25,...</td>
</tr>
<tr>
<td>58,...</td>
<td>12,...</td>
</tr>
<tr>
<td>50,...</td>
<td>29,...</td>
</tr>
</tbody>
</table>

Kg of...
THI max in May-September

Present

Future

<table>
<thead>
<tr>
<th>THI</th>
<th>Present</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>54,..</td>
<td>20,..</td>
<td>76,..</td>
</tr>
<tr>
<td>44,..</td>
<td>73,..</td>
<td>80,..</td>
</tr>
</tbody>
</table>
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### Gross Margin (GM) per typology and farm

<table>
<thead>
<tr>
<th></th>
<th>Hectares per farm</th>
<th>Present (000 €)</th>
<th>Near Future (% changes over baseline)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Typology</td>
<td>Farm</td>
</tr>
<tr>
<td>Rice</td>
<td>115.3</td>
<td>3,876</td>
<td>161.5</td>
</tr>
<tr>
<td>Citrus</td>
<td>12.6</td>
<td>2,768</td>
<td>40.7</td>
</tr>
<tr>
<td>Cattle A</td>
<td>30.9</td>
<td>35,546</td>
<td>273.4</td>
</tr>
<tr>
<td>Cattle B</td>
<td>31.9</td>
<td>10,100</td>
<td>252.5</td>
</tr>
<tr>
<td>Greenhouse</td>
<td>12.9</td>
<td>1,865</td>
<td>40.5</td>
</tr>
<tr>
<td>Vegetables</td>
<td>22.2</td>
<td>26,041</td>
<td>46.3</td>
</tr>
<tr>
<td>Cereals</td>
<td>146.4</td>
<td>4,940</td>
<td>89.8</td>
</tr>
<tr>
<td>Vegetables</td>
<td>5.8</td>
<td>2,766</td>
<td>27.7</td>
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<tr>
<td>Vegetables - Fruit</td>
<td>4.1</td>
<td>1,381</td>
<td>13.8</td>
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<tr>
<td>Cereals - Forages</td>
<td>24.5</td>
<td>3,672</td>
<td>39.0</td>
</tr>
<tr>
<td>Sheep A</td>
<td>86.9</td>
<td>2,748</td>
<td>61.1</td>
</tr>
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<td>Sheep B</td>
<td>41.2</td>
<td>4,579</td>
<td>24.3</td>
</tr>
<tr>
<td>Sheep C</td>
<td>62.4</td>
<td>7,060</td>
<td>54.8</td>
</tr>
</tbody>
</table>
## Impacts on net income

<table>
<thead>
<tr>
<th></th>
<th>Present (000 €)</th>
<th>Near Future (% changes over baseline)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total area</td>
<td>WUA facilities</td>
</tr>
<tr>
<td>Total revenue</td>
<td>203,564</td>
<td>177,876</td>
</tr>
<tr>
<td>Variables costs</td>
<td>125,867</td>
<td>112,460</td>
</tr>
<tr>
<td>Feeds</td>
<td>18,731</td>
<td>16,639</td>
</tr>
<tr>
<td>Gross margin</td>
<td>107,343</td>
<td>87,903</td>
</tr>
<tr>
<td>Net income</td>
<td>67,471</td>
<td>56,031</td>
</tr>
</tbody>
</table>
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@risk

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### Levels of responses for adapting to CC

<table>
<thead>
<tr>
<th>Response level</th>
<th>Attitude</th>
<th>Investments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No response</td>
<td>Reluctant</td>
<td>None</td>
</tr>
<tr>
<td>2. Compliant</td>
<td>Tick-box</td>
<td>Minimum as prescribed by norms</td>
</tr>
<tr>
<td>3. Efficient</td>
<td>Low-level, active</td>
<td>To achieve a target state (eg. ISO 14001)</td>
</tr>
<tr>
<td>management</td>
<td></td>
<td>(eg. ISO 14001)</td>
</tr>
<tr>
<td>4. Breakthrough</td>
<td>High level, strategic</td>
<td>Explore issues and options in depth seeking “win-win” opportunities</td>
</tr>
<tr>
<td>projects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Strategic</td>
<td>Strategic, all levels</td>
<td>CC adaptation key for strategic management to ensure resilience</td>
</tr>
<tr>
<td>resilience</td>
<td>of management</td>
<td></td>
</tr>
<tr>
<td>6. Champion</td>
<td>Visionary, influential</td>
<td>Focus on influencing the political, social, legal and tech level towards</td>
</tr>
<tr>
<td>organization</td>
<td></td>
<td>sustainability</td>
</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>
Level 2 - Compliant

- Listen to farmers, **involve** actors
- Increase access to **credit** for youngs
- Invest on risk **insurances**
- Extend **access to land and farming independently of age**
Level 3 - Efficient management

- Invest on agrometeo, weather forecast and extension services
- Adapt cropping & livestock systems
- Invest on monitoring and open access data
- Increase farm size (eg dairy cattle)
- Integrate income with renewable energy
- Invest in marketing strategies
- .....
Level 4 - Breakthrough projects

- Finalize stakeholder involvement beyond formal requirements
- Design new learning spaces around monitoring and data
- Involve payment officers in the design of PSR calls
- Invest on catchment scale actions
- ...
Level 5 - Strategic resilience

- Link complementary districts to increase resilience...
Emerging issues

• What kind of changes...?
  – E.g. what praxes to change for designing effective research processes? (Colvin et al 2014, Research Policy)

• At what scale/level...?
• What kind of knowledge...?
• Who to involve...? And how...?
http://macsur.eu/index.php/regional-case-studies/