Oristano, Sardinia, Italy

Winner and losers from climate change in agriculture: a case study in the Mediterranean basin

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Framing research question(s):

• How to support effective adaptive responses to CC and stimulate proactive attitudes of farmers, policymakers & researchers?
  – Which level of response are we interested to support?
    • Level 1 - No response
    • Level 2 - Compliant
    • Level 3 - Efficient management
      • Level 4 - Breakthrough projects, strategic, win-win
      • Level 5 - Strategic management at all levels to ensure resilience
      • Level 6 - Champion, visionary, influential organization

• How to co-construct the nature of the issues about CC adaptation?
  – i.e.: How to identify the right questions to engage pathways within the “adaptive space” (Wise et al GEC)?
Hybrid knowledge paradigm

- “CC adaptation” is a socially constructed concept
- Contextualized **background experience** informs...
  - ...CC understanding and response-abilities/capacities
  - ...farmers’ CC perception that drive changes in practice

Nguyen et al 2014 Int J Agric Sustain
The «Oristanese» case study

- One of the 6 Italian case studies (www.agroscenari.it)
  - Interdisciplinary team @work
  - Contextual 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

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

Rainfed area: 18,000 ha

- Barley-Oats: 27%
- Hay crops: 17%
- Other: 10%
- Pasture: 2%
- Vegetables: 5%
- Wheat: 30%
- Other: 5%
Main farming systems

Dairy Cattle
- silage maize
- Italian ryegrass
- triticale, alfalfa

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

Rice

Horticulture
## Farming system typologies

<table>
<thead>
<tr>
<th></th>
<th>% total land area</th>
<th>% total net income</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Irrigated crops</strong></td>
<td>57.7</td>
<td>82.5</td>
</tr>
<tr>
<td>Rice</td>
<td>5.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Citrus</td>
<td>1.6</td>
<td>3.9</td>
</tr>
<tr>
<td>Dairy cattle A</td>
<td>7.6</td>
<td>32.6</td>
</tr>
<tr>
<td>Dairy cattle B</td>
<td>2.4</td>
<td>5.7</td>
</tr>
<tr>
<td>Greenhouse</td>
<td>1.1</td>
<td>1.7</td>
</tr>
<tr>
<td>Vegetables - Cereals</td>
<td>23.5</td>
<td>24.2</td>
</tr>
<tr>
<td>Cereals - Forages</td>
<td>15.2</td>
<td>8.7</td>
</tr>
<tr>
<td>Tree and arable crops</td>
<td>1.1</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Rainfed crops</strong></td>
<td>42.3</td>
<td>17.5</td>
</tr>
<tr>
<td>Vegetables - Fruit</td>
<td>0.8</td>
<td>2.3</td>
</tr>
<tr>
<td>Cereals - Forages</td>
<td>4.4</td>
<td>2.0</td>
</tr>
<tr>
<td>Sheep A</td>
<td>7.4</td>
<td>2.5</td>
</tr>
<tr>
<td>Sheep B</td>
<td>14.6</td>
<td>3.8</td>
</tr>
<tr>
<td>Sheep C</td>
<td>15.2</td>
<td>6.9</td>
</tr>
</tbody>
</table>

Total: 38.3

Total: 12.2
RAMS scenarios forced by sea T coupled with atm (2000-10 vs 2020-30)  

Local weather dataset (59 yrs)  

Calibrated EPIC model for main cropping systems  

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

What-if scenario analyses Farmers’ adaptive responses under uncertainty  

Social learning

Researchers, policy makers, farmers organizations  

Emerging policy options and recommendations  

Social learning

NRD Uniss

Unitus

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

WXGEN

150 years PC vs FC

Calibrated EPIC model for main cropping systems

@RISK

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

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Local cropping system dataset

Local farming systems dataset

Researchers, policy makers, farmers organizations

Emerging policy options and recommendations

Farmers and local organizations, participatory field experiments

Social learning

Calibration
Climate change signals

Temperature:
- PC vs FC
  - Tmin: +1.5
  - Tmax: +1.7

Precipitation:
- PC vs FC
  - PC 536 mm
  - FC 505 mm (-6%)
  - Prec CP: -33%
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Silage maize

Rainfed grassland

Irrigated haycrop

Rainfed haycrop
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Cnr Ibimet

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Social learning
Cumulative ETn in April-October

<table>
<thead>
<tr>
<th></th>
<th>25,000</th>
<th>50,000</th>
<th>25,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present</td>
<td>13,000</td>
<td>37,000</td>
<td>49,000</td>
</tr>
<tr>
<td>Future</td>
<td>1,000</td>
<td>1,100</td>
<td>1,200</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>28,...</td>
<td>50,...</td>
</tr>
</tbody>
</table>
THI max in May-September
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## Net Income per farming system typology

<table>
<thead>
<tr>
<th>Farming system type</th>
<th>2000-10 (k€)</th>
<th>2020-30 (Δ%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>4,097</td>
<td>+9.9</td>
</tr>
<tr>
<td>Vegetables - Cereals</td>
<td>18,656</td>
<td>-0.8</td>
</tr>
<tr>
<td>Cereals - Forages</td>
<td>7,593</td>
<td>+1.4</td>
</tr>
<tr>
<td>Cattle A</td>
<td>26,355</td>
<td>-5.1</td>
</tr>
<tr>
<td>Cattle B</td>
<td>6,825</td>
<td>-5.9</td>
</tr>
<tr>
<td>Sheep A</td>
<td>2,461</td>
<td>-5.3</td>
</tr>
<tr>
<td>Sheep B</td>
<td>1,984</td>
<td>-11.8</td>
</tr>
<tr>
<td>Sheep C</td>
<td>3,984</td>
<td>-7.4</td>
</tr>
<tr>
<td>Other</td>
<td>3,721</td>
<td>+0.1</td>
</tr>
</tbody>
</table>
Shift of the district **economic performance** driven by CC variables considered in the assessment, by sub-zone

<table>
<thead>
<tr>
<th>Economic indicators</th>
<th>Weights</th>
<th>Δ% 2020-30 vs 2000-10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Irrigated</td>
<td>Rainfed</td>
</tr>
<tr>
<td>Total revenues</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Variable costs</td>
<td>64</td>
<td>62</td>
</tr>
<tr>
<td>Technical means</td>
<td>33</td>
<td>23</td>
</tr>
<tr>
<td>Feed</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Extra-farm labor</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Payments for irrigation</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Well water pumping</td>
<td>0.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Gross margin</td>
<td>52</td>
<td>7</td>
</tr>
<tr>
<td>Net income</td>
<td>38</td>
<td>47</td>
</tr>
</tbody>
</table>
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Farmers’ perceptions

Nguyen et al submitted

Response category (shepherds)

Response category (horticulturists)

Response category (dairy cattle farmers)

Response category (rice producers)
Annual mean temperature anomaly for Tmax and Tmin at Santa Lucia Station (Oristano) from 1959 to 2012
### Actions already taken by farmers to cope with climate variability

<table>
<thead>
<tr>
<th>Practice</th>
<th>Hort</th>
<th>Rice</th>
<th>Cattle</th>
<th>Sheep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adopt new agronomic practices</td>
<td>60%</td>
<td>25%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change/diversify crops</td>
<td></td>
<td>80%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improve irrigation systems</td>
<td>100%</td>
<td></td>
<td>55%</td>
<td></td>
</tr>
<tr>
<td>Improve animal health and welfare</td>
<td></td>
<td>88%</td>
<td>42%</td>
<td></td>
</tr>
<tr>
<td>Change/improve the diet of animals</td>
<td></td>
<td>66%</td>
<td>42%</td>
<td></td>
</tr>
<tr>
<td>Follow daily weather forecast</td>
<td>60%</td>
<td>75%</td>
<td>20%</td>
<td>57%</td>
</tr>
<tr>
<td>None</td>
<td>0%</td>
<td>25%</td>
<td>1%</td>
<td>29%</td>
</tr>
</tbody>
</table>

Nguyen et al submitted
### Actions farmers think to plan in case of climate worsening

<table>
<thead>
<tr>
<th>Practice</th>
<th>Hort</th>
<th>Rice</th>
<th>Cattle</th>
<th>Sheep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve farm infrastructures</td>
<td></td>
<td></td>
<td>89%</td>
<td>57%</td>
</tr>
<tr>
<td>Adopt new tech (i.e. air conditioning for animals, video surveillance)</td>
<td></td>
<td></td>
<td></td>
<td>89%</td>
</tr>
<tr>
<td>Improve water management</td>
<td>80%</td>
<td>100%</td>
<td>78%</td>
<td>28%</td>
</tr>
<tr>
<td>More interactions with technical advisors, colleagues, neighbors</td>
<td>50%</td>
<td></td>
<td>78%</td>
<td>50%</td>
</tr>
<tr>
<td>Participate to social networks</td>
<td>&gt;65%</td>
<td>&gt;65%</td>
<td>&gt;65%</td>
<td>14%</td>
</tr>
<tr>
<td>Consult weather forecast</td>
<td>80%</td>
<td>80%</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td>Do nothing</td>
<td></td>
<td></td>
<td>16%</td>
<td>16%</td>
</tr>
</tbody>
</table>

Nguyen et al submitted
Emerging outcomes

• The dairy cattle coop is developing a new win-win pathway linking high-input dairy cattle farming with low input beef cattle grazing systems.

• The local government is investing in the EIP for supporting the local beef production chain to reduce meat imports and enhance pasture biodiversity and ecosystem services (e.g., wildfire prevention).
Emerging challenges

Adaptive responses as co-evolution pathways

- design social learning spaces for researchers, stakeholders and policy makers
- combining integrated assessment modeling and social learning facilitation

Wise et al 2014 GEC
For further information
http://macsur.eu/index.php/regional-case-studies/