Toward the adaptation to new regulation on water pricing in the agricultural sector: a case study from northern Italy

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Outline

1. INTRODUCTION
   • the question
   • theoretical background

2. STUDY AREA

3. METHODOLOGY
   • water-crop production function
   • economic analysis

4. RESULTS

5. SUMMARY AND CONCLUSION

6. FURTHER CONSIDERATIONS
1. INTRODUCTION

• THE QUESTION:

How should local reclamation and irrigation boards (R.I.B) allocate their water supply costs amongst users to meet Emilia-Romagna regional guidelines?

• Do volumetric tariffs affect irrigation water consumption?
1. INTRODUCTION

• THEORETICAL BACKGROUND


60/200/EC – Water Framework Directive

- Polluter pays
- Full-cost recovery (flat rate + variable charge)
- Incentive pricing
2. STUDY AREA

• THE BURANA RIB BASIN: 17,000 km²

OBJECTIVE:

✓ THE STUDY ASSESSES THE ECONOMIC IMPACTS OF TWO PRICING CRITERIA (NEW AND CURRENT), IN RELATION TO:

(A) APPLIED WATER VOLUMES,
(B) LAND ALLOCATION,
(C) IRRIGATION TECHNOLOGY ADOPTION.
## 2. STUDY AREA

<table>
<thead>
<tr>
<th>MEAN CHARACTERISTICS OF INTERVIEWED FARMS</th>
<th>DISTRICTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(June 2014)</strong></td>
<td>BASSA PIANURA</td>
</tr>
<tr>
<td>N. FARMS</td>
<td>12</td>
</tr>
<tr>
<td>AGE OF THE OWNER</td>
<td>46</td>
</tr>
<tr>
<td>EDUCATION (2 - DEGREE; 1 - DIPLOMA; 0 - NO DIPLOMA)</td>
<td>1,3</td>
</tr>
<tr>
<td>WATER RESERVOIR (FARM WITH N. / TOTAL FARM N.)</td>
<td>-</td>
</tr>
<tr>
<td>SINK (FARM WITH N. / TOTAL FARM N.)</td>
<td>0,3</td>
</tr>
<tr>
<td>MEAN UAA (ha)</td>
<td>115</td>
</tr>
<tr>
<td>UAA IRRIGATED (%)</td>
<td>56</td>
</tr>
<tr>
<td>ORCHARD (%)</td>
<td>6</td>
</tr>
<tr>
<td>FIELD CROPS (%)</td>
<td>78</td>
</tr>
<tr>
<td>HORTICULTURAL (%)</td>
<td>16</td>
</tr>
<tr>
<td>VINEYARD (%)</td>
<td>0</td>
</tr>
<tr>
<td>DRIP IRRIGATION</td>
<td>42</td>
</tr>
<tr>
<td>FURROW IRRIGATION</td>
<td>0</td>
</tr>
<tr>
<td>SPRINKLER IRRIGATION</td>
<td>25</td>
</tr>
<tr>
<td>T - WATER CHARGE LEVEL (€/ha)</td>
<td>17</td>
</tr>
<tr>
<td>ML - GROSS INCOME (€/ha)</td>
<td>599</td>
</tr>
<tr>
<td>CURRENT TYPE OF TARIFF(1)</td>
<td>D</td>
</tr>
</tbody>
</table>

(1) D – BASED ON THE DISTANCE FROM THE MAIN ABDUCTION SOURCE; W – TWO PART TARIFF: FLAT AND BASED ON WATER CONSUMPTION; WL – TWO PART TARIFF: PER IRRIGATED SURFACE AND BASED ON WATER CONSUMPTION; C – TWO PART TARIFF: FLAT AND BASED ON CROP TYPE; F – FLAT TARIFF
NEW TARIFF SCENARIOS:

(A) ONE TARIFF FOR SECTORS SERVED BY OPEN CANALS;
(B) ONE FOR SECTORS SERVED BY PRESSURE PIPES.
3. METHODOLOGY

• Water-crop production function

CROP-YIELDS ESTIMATION AS A FUNCTION OF THE IRRIGATION WATER VOLUMES, THROUGH MATHEMATICAL MODELS, SIMULATING:

A - LOCAL CROP EVAPOTRANSPIRATION, ASSUMING WELL-WATERED CONDITIONS (GUERRA ET AL, 2014).

B - WATER REDUCTION EFFECT ON CROP YIELDS (STEDUTO ET AL, 2012) FOR DIFFERENT WATER DISTRIBUTION SYSTEMS.
3. METHODOLOGY

• Economic analysis

\[
\begin{align*}
\text{max} & \quad \prod_a = \sum_{z,i,t} \left[ p_i y_{i,t}(w_{i,t}) - c_{z,i,t}(x_{a,z,i,t}, w_{i,t}) - \left( t_{d,i,t} + tw_{i,t} \right) \right] x_{a,z,i,t} \quad \forall a \\
\text{s.t.} & \quad \sum_i x_{a,z,i,t} \leq \text{land}_{a,z} \quad \forall a \in Z \quad \text{EQ. 2} \\
& \quad \sum_i x_{a,z,i,t} w_{i,t} \leq \text{Wat}_a \quad \forall a \quad \text{EQ. 3} \\
& \quad \sum_i x_{a,z,i,t} l_{i,t} \leq \text{lab}_a \quad \forall a \quad \text{EQ. 4} \\
& \quad \sum_{z,i,t} [(t_{a,z,i,t} + t_a w_{i,t})] x_{a,z,i,t} \geq F^{sc}_a + \sum_{z,i,t} [V^{sc}_a(w_{i,t}) x_{a,z,i,t}] \quad \text{EQ. 5} \\
& \quad x_{a,z,i,t} \geq 0, w_{i,t} \geq 0, (tf, tv^a_{d,i,t}, tv^b_{d,i,t}) \geq 0 \quad \text{EQ. 6}
\end{align*}
\]

PMP APPROACH (HOWITT, 1995; QUIRINO, 2015)

- ASSUMPTION: FARMER = PROFIT MAXIMIZER;
- THE OBSERVED CROP DESIGN AND WATER USES ARE OPTIMAL;
- THE REGULATOR ACTS ON BEHALF OF USERS.
3. METHODOLOGY

• Scenario analysis
WATER CHARGE CRITERIA VARY FROM FLAT TO DIFFERENCIATED BY CONSIDERING DIFFERENT LAND USES, WATER DELIVERY SYSTEMS, AND IRRIGATION TECHNOLOGIES.

• Sensitivity analysis
BASED ON NEW WATER CHARGE CRITERIA, THE RATIO BETWEEN FLAT AND VARIABLE PART OF TARIFF IS DIFFERENCIATED ACCORDING TO DIFFERENT WATER DELIVERY SYSTEMS.
4. RESULTS

- Water-crop production function

\[ y_{drip} = -3 \times 10^{-6} x^2 + 0.0266x + 12.079 \]
\[ R^2 = 0.992 \]

\[ y_{fur} = -2 \times 10^{-6} x^2 + 0.0192x + 11.767 \]
\[ R^2 = 0.992 \]

Source: own elaboration
4. RESULTS OF ECONOMIC ANALYSIS

- Crop-Water demand function

![Diagram showing the relationship between irrigation water volume and tariff. The gross margin equals the marginal cost, which is the water charge. Source: own elaboration.]
4. RESULTS OF SCENARIO ANALYSIS

TABLE 1 - IMPACT OF DIFFERENT WATER CHARGE SCENARIOS ON LAND AND WATER USE FOR DIFFERENT GROWING CATEGORIES, FOR BOTH WATER DELIVERY SYSTEMS (UNIT: DIFFERENCES IN PERCENTAGE, COMPARED TO THE CURRENT SCENARIO, %).

<table>
<thead>
<tr>
<th>GROWING CATEGORIES</th>
<th>LAND USE</th>
<th>WATER USE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OPEN CANALS</td>
<td>PRESSURE PIPES</td>
</tr>
<tr>
<td>NON IRRIGATED CROPS</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>VINEYARDS</td>
<td>0%</td>
<td>-2%</td>
</tr>
<tr>
<td>ORCHARDS</td>
<td>0%</td>
<td>-1%</td>
</tr>
<tr>
<td>ARABLE CROPS</td>
<td>0%</td>
<td>-2%</td>
</tr>
<tr>
<td>HORTICULTURAL CROPS</td>
<td>0%</td>
<td>-5%</td>
</tr>
</tbody>
</table>

Source: own elaboration
4. RESULTS OF SCENARIO ANALYSIS

<table>
<thead>
<tr>
<th>GROWING CATEGORIES</th>
<th>SCENARIO 1</th>
<th>SCENARIO 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OPEN CANALS</td>
<td>PRESSURE PIPES</td>
</tr>
<tr>
<td>NON IRRIGATED CROPS</td>
<td>5%</td>
<td>59%</td>
</tr>
<tr>
<td>VINEYARDS</td>
<td>1%</td>
<td>8%</td>
</tr>
<tr>
<td>ORCHARDS</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>ARABLE CROPS</td>
<td>4%</td>
<td>24%</td>
</tr>
<tr>
<td>HORTICULTURAL CROPS</td>
<td>1%</td>
<td>6%</td>
</tr>
</tbody>
</table>

Source: own elaboration
4. RESULTS OF SENSITIVITY ANALYSIS

FIGURE 3 – RELATIVE VARIATION OF IRRIGATED FARMLAND (A), OF WATER APPLIED (B) AND OF FARM PROFITS (C) IN RELATION TO THE VARIATION IN THE ‘FIXED AND VARIABLE’ RATIO, OF THE TWO-PART TARIFF IN THE ALTERNATIVE SCENARIO
4. RESULTS OF SENSITIVITY ANALYSIS

ABSOLUTE VARIATION IN THE ALTERNATIVE SCENARIO FOR:
Furrow (dark), Sprinkler (medium), Drip (light).

TOP - IRRIGATED FARMLAND

ACCORDING TO THE RATIO BETWEEN ‘FIXED/VARIABLE’ COMPONENTS OF TARIFFS, THE EFFECT IS MORE EVIDENT FOR PRESSURE PIPES, THAN OPEN CANALS-CROSSED SECTORS, ESPECIALLY FOR IRRIGATED LAND.

BOTTOM - APPLIED WATER
5. SUMMARY AND CONCLUSION

- HYPOTHETICAL AND ACTUAL PRICING POLICIES SCENARIOS WERE ANALYSED, BASING ON CURRENT ORGANIZATIONAL RULES OF THE BURANA IRRIGATION NETWORK, IN NORTHERN ITALY.

- THE IMPLEMENTATION OF WATER TARIFFS WAS FOUND NOT TO SIGNIFICANTLY AFFECT IRRIGATION WATER USES, IN MOST OF THE DISTRICTS, MAINLY BECAUSE OF:

  1. STRUCTURAL CONSTRAINTS, LIMITING THE NUMBER OF AVAILABLE PRICING OPTIONS.
  2. THE VARIABLE COMPONENT AMOUNT IS TOO LOW.
  3. WATER-DEMAND FUNCTION FOR MAIN IRRIGATED CROPS IS STRONGLY INELASTIC.
6. FURTHER CONSIDERATIONS

- FIRST RESULTS CONFIRMED THAT THERE IS NO MUCH EVIDENCE THAT WATER PRICING HAS A SIGNIFICANT IMPACT ON CONDITIONING IRRIGATION WATER USES (MOLLE, 2008).

- WATER PRICING, COULD DESERVE TO CO-FINANCE SUBSIDIES ON INVESTMENTS, FURTHER PROMOTING THE ADOPTION OF PRECISE IRRIGATION TECHNOLOGIES (LOPEZ-MORALES, 2011).


- THE NEW CAP-REFORM IS ADDRESSING THIS ISSUE, EITHER BY FINANCING ADVISORY WEATHER SERVICES, AND BY TRAINING FOR SUPPORTING INVESTMENTS (EC, 2013).
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