Livestock activities and ecosystem services

A tool to enhance the estimation of Agri-Environment-Climate payments in Trentino Rural Development Program 2014-2020

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Outlines

• Art.28 or Reg.1305/2013 refers to Agri-Environment-Climate payments, introducing the importance to include environmental benefits and externalities in the payment justification.

• Payments shall compensate beneficiaries for all part of the additional costs and income foregone resulting from the AEC commitments, justified by evidence of likely environmental benefits.

OBJECTIVE: TO INCLUDE THE ECOSYSTEM SERVICES IN THE ECONOMIC JUSTIFICATION OF PAYMENTS
(Trentino Rural Development Program 2014-2020, Measure 10, Operation 10.1.1 related to Meadows management)

• Environmental issues in the next Rural Programming period
• The Ecosystem service approach: the case of livestock
• The model ARIES: methodology and results
• The micro-economic results (Italian FADN/RICA)
• Conclusion
The project: build the justification for Agri-Environment- Climate payments by using an approach based on Ecosystem Services

- **Step1**: to build a model for livestock related activities
- **Step2**: scenario analysis on the management variables of the livestock related activities model
- **Step3**: linkage with the economic justification based on FADN
What is the agrosystem service for livestock related activities?

- There is no livestock ecosystem service; need to identify related provisioning services

  Need to distinguish between meadows and pasture

  - when you focus on meadows the goal becomes fodder production for feeding
  
  - when you focus on pasture the goal is grassland regeneration for grazing

- Like other provision services, the borderline between agro-system services and agronomic equations is not clearcut
Initial model

**BIOPHYSICAL ELEMENTS**

- WATER AVAILABILITY
- EVAPOTRASPIRATION
- PRECIPITATION
- SOIL CLASSES
- ORGANIC SOIL CONTENT

**SUSTAINABLE FODDER PRODUCTION**

**MANAGEMENT ELEMENTS**

- ADDED NUTRIENTS
- FERTILIZER QUANTITY
- FERTILIZER TYPOLOGY
- CUTTING REGIME
Issues related to the use of ES-based approach within a public administration

- There is the need for a simpler framework
- All the data of the model must be available
- Variables must be controllable and verifiable

Zoning substitutes the biophysical elements

LSU/ha substitutes the N input
Sustainable fodder production

Number of cuts

Effluent load

Cutting regime

Timing of cuts

Biophysical element: Zoning

Meadows of the valley floors, morenic terrace and plateau

Slope meadows

Species rich meadows

Management elements: Modelling

Current model
Zoning: outcomes

Legend
- Green: Slope Meadows
- Pink: Species Rich Meadows
- Blue: Valley Floor Meadows

Altitude (m)
- High: 3760.03
- Low: 62563
<table>
<thead>
<tr>
<th>Typologies of meadows</th>
<th>Added nutrient allowed</th>
<th>Number of cuts</th>
<th>Production</th>
<th>Fodder quality</th>
<th>Zoning class</th>
<th>proxy LSU/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromion erecti</td>
<td>&lt;25</td>
<td>1</td>
<td>4.5-5.0</td>
<td>low</td>
<td>rich of species</td>
<td>0.26</td>
</tr>
<tr>
<td>Arrhenatherion elatioris</td>
<td>25-50</td>
<td>2</td>
<td>5.8-6.2</td>
<td>low</td>
<td>rich of species</td>
<td>0.53</td>
</tr>
<tr>
<td>Festuca rubra</td>
<td>0-50</td>
<td>1 or 2</td>
<td>4.5-5.0</td>
<td>low-medium</td>
<td>rich of species</td>
<td>0.53</td>
</tr>
<tr>
<td>Centaureo transalpinae</td>
<td>0-50</td>
<td>1</td>
<td>4.4-4.8</td>
<td>low-medium</td>
<td>slope</td>
<td>0.53</td>
</tr>
<tr>
<td>Centaureo carniolicae</td>
<td>75-100</td>
<td>2</td>
<td>5.8-6.4</td>
<td>medium</td>
<td>slope</td>
<td>1.05</td>
</tr>
<tr>
<td>Anthoxantho</td>
<td>50-75</td>
<td>2</td>
<td>6.0-6.5</td>
<td>low</td>
<td>slope</td>
<td>0.79</td>
</tr>
<tr>
<td>Arrhenatheretum elatioris</td>
<td>100-150</td>
<td>2 or 3</td>
<td>7.6-8.0</td>
<td>high</td>
<td>slope</td>
<td>1.58</td>
</tr>
<tr>
<td>Arrhenatheretum el. facies</td>
<td>225-275</td>
<td>3 or 4</td>
<td>7.5-8.4</td>
<td>high</td>
<td>valley floor</td>
<td>2.89</td>
</tr>
<tr>
<td>Ranunculo repentis</td>
<td>200-225</td>
<td>2 or 3</td>
<td>7.0-7.4</td>
<td>high</td>
<td>valley floor</td>
<td>2.37</td>
</tr>
<tr>
<td>Lolietum multiflorae</td>
<td>200-250</td>
<td>3</td>
<td>9.2-9.6</td>
<td>high</td>
<td>valley floor</td>
<td>2.63</td>
</tr>
<tr>
<td>Agropyron repens</td>
<td>200-275</td>
<td>2 or 3</td>
<td>8.0-9.0</td>
<td>high</td>
<td>valley floor</td>
<td>2.89</td>
</tr>
</tbody>
</table>
Management elements of the model: the variables as set in AEC Measure

<table>
<thead>
<tr>
<th></th>
<th>LSU/ha</th>
<th>Cutting frequency</th>
<th>Cutting time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rich of species meadows</td>
<td>1,5</td>
<td>1</td>
<td>15/06-15/08</td>
</tr>
<tr>
<td>Slope meadows</td>
<td>2,0</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Valley floor meadows</td>
<td>2,5</td>
<td>3</td>
<td>-</td>
</tr>
</tbody>
</table>
Ecosystem services: outcomes for livestock_meadow

- Scenario 0: the current situation of Sustainable Fodder Production

- Scenario 1: the situation of Sustainable Fodder Production with the AEC payments
Scenario 0: current situation
Scenario 1: Situation with AEC payments eligibility conditions and commitments
Biophysical side: the work in progress

• ARIES modelling platform has been applied for the ecosystem service Sustainable Fodder Production

• Scenarios have been run on Sustainable Fodder Production

• ARIES modelling platform is being applied for the ecosystem services related to Sustainable Fodder Production

• Scenarios are being run on the ecosystem services related to Sustainable Fodder Production linked to the results of the Sustainable Fodder Production
Water purification

NITROGEN REMOVAL

SURFACE RUNOFF

DIFFUSE SOURCES

POINT SOURCES

WWTP

OTHER HUMAN ACTIVITIES

MANURE

PRECIPITATION

SLOPE

TYPE OF SOIL

FERTILIZERS
Aesthetic view (scenic beauty)
Micro-economic results (Italian FADN/RICA)

Source of data: FADN 2008-2012 + meadows zoning procedure
Software GAIA (livestock production processes)
Objective: estimation of additional costs and income foregone resulting from the sustainable management of permanent meadows in livestock farming
(Op. 10.1.1 → Meadows management: improving the biodiversity and the extensive breeding systems, Measure 10, Trentino RDP)

Farm breeding system refers to the management elements: LSU/ha is a proxy for nitrogen input.

Meadows zoning refers to the biophysical elements (biodiversity)

Farm breeding systems
Extensive vs Intensive → LSU/ha
- Extensive: < 1.5 LSU/ha
- Intermediate: 1.5 – 2.0 LSU/ha
- Intensive: 2.0 – 2.5 LSU/ha

Grass species richness (zoning)
- Species rich meadows
- Slope meadows
- Valley floor meadows
Micro-economic results (Italian FADN/RICA)

Payment scheme: the aid intensity is defined considering animal density (LSU/ha) and meadow typology.

<table>
<thead>
<tr>
<th></th>
<th>Valley floor meadows</th>
<th>Slope meadows</th>
<th>Species rich meadows</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 &lt; LSU/ha &lt; 1.5</td>
<td>180</td>
<td>180+170 = 350</td>
<td>180+170+100 = 450</td>
</tr>
<tr>
<td>1.5 &lt; LSU/ha &lt; 2.0</td>
<td>180</td>
<td>180+170 = 350</td>
<td>180+170 = 350</td>
</tr>
<tr>
<td>2.0 &lt; LSU/ha &lt; 2.5</td>
<td>180</td>
<td>180</td>
<td>180</td>
</tr>
</tbody>
</table>

Eligibility condition: minimum 0.5 LSU/ha, maximum 2.5 LSU/ha
Not beneficiaries: 2.5-4.0 LSU/ha

1. How breeding system intensity can influence farm economic results?
2. How different kind of meadows can influence farm economic results?
## Variables (Italian FADN/RICA)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSU</td>
<td>Livestock Units</td>
</tr>
<tr>
<td>UAA</td>
<td>Utilized Agricultural Area (permanent meadows and pastures)</td>
</tr>
<tr>
<td>TSP</td>
<td>Total Saleable Production (Gross Saleable Production + Variation in Livestock valuation + Farm use)</td>
</tr>
<tr>
<td>Variable Costs</td>
<td>Livestock specific inputs (feed for grazing stock, certification, veterinary fees and reproduction costs, etc.)</td>
</tr>
<tr>
<td>Transaction Cost</td>
<td>Additional cost to implement the operation (administrative cost of application for support)</td>
</tr>
<tr>
<td>Gross Margin</td>
<td>Total Saleable Production – Variable Costs</td>
</tr>
</tbody>
</table>

Only specialist dairying system have been selected (Farm type=4, Bovines)
Farm breeding system (Italian FADN/RICA)

Characteristics of breeding systems → animal density
- Gross Margin/ha increase
- LSU/UAA increase
- Extensive breeding systems seem to have a different structure in terms of UAA

The differences in gross margin per hectare justify the expected payment; the reduction depending on animal density justify the lower payments for more intensive breeding systems.

<table>
<thead>
<tr>
<th></th>
<th>TSP/UAA (€/ha)</th>
<th>Variable Costs/UAA (€/ha)</th>
<th>Transact. Costs/UAA (€/ha)</th>
<th>Gross Margin/UAA (€/ha)</th>
<th>LSU/UAA (n./ha)</th>
<th>UAA (ha)</th>
<th>Δ Gross Margin/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extensive breeding systems (0.5 - 1.5 LSU/ha)</td>
<td>2,287</td>
<td>1,492</td>
<td>13</td>
<td>782</td>
<td>1.0</td>
<td>35</td>
<td>-1,755</td>
</tr>
<tr>
<td>Intermediate breeding systems (1.5 - 2.0 LSU/ha)</td>
<td>3,573</td>
<td>2,167</td>
<td>17</td>
<td>1,389</td>
<td>1.8</td>
<td>16</td>
<td>-1,148</td>
</tr>
<tr>
<td>Intensive breeding systems (2.0 - 2.5 LSU/ha)</td>
<td>5,102</td>
<td>3,267</td>
<td>12</td>
<td>1,823</td>
<td>2.2</td>
<td>21</td>
<td>-714</td>
</tr>
<tr>
<td>Not beneficiaries (2.5 - 4.0 LSU/ha)</td>
<td>6,357</td>
<td>3,807</td>
<td>13</td>
<td>2,537</td>
<td>2.9</td>
<td>19</td>
<td></td>
</tr>
</tbody>
</table>
Grass species richness (Italian FADN/RICA)

Characteristics of meadows → biophysical elements

- Percentage on total meadows extension
- Farms with more than 60% of species rich meadows are located over 1,000 m

<table>
<thead>
<tr>
<th></th>
<th>LSU/ha</th>
<th>Altitude (m)</th>
<th>UAA (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>30%-60%</td>
<td>&gt; 60%</td>
<td>30%-60%</td>
</tr>
<tr>
<td>Species rich meadows</td>
<td>2.2</td>
<td>1.7</td>
<td>681</td>
</tr>
<tr>
<td>Slope meadows</td>
<td>2.0</td>
<td>2.0</td>
<td>837</td>
</tr>
<tr>
<td>Valley floor meadows</td>
<td>1.6</td>
<td>2.1</td>
<td>855</td>
</tr>
</tbody>
</table>

The increase of species rich meadows species (biodiversity) determines a decrease of livestock gross margin per hectare.

\[ \Delta \text{Gross Margin/ha (SRM)} = -474 \, \text{€/ha} \]
\[ \Delta \text{Gross Margin/ha (SM)} = -284 \, \text{€/ha} \]
\[ \Delta \text{Gross Margin/ha (VFM)} = +306 \, \text{€/ha} \]

\[ \Delta \text{Gross Margin/ha (SRM-VFM)} = -512 \, \text{€/ha} \]
\[ \Delta \text{Gross Margin/ha (SM-VFM)} = +30 \, \text{€/ha} \]
Conclusions: a case of applied research within a government agency

- Input from theory to practice:
  - Advantages of using BN when operating at local level
  - Advantages of using zoning instead of modelling
  - Advantages of using proxies that can be controlled and verified

- Feedback from practice to theory:
  - What is meant by ‘Livestock-Ecosystem Services’
  - Importance of understanding the ‘character’ of variables (eligibility conditions Vs. commitments)
  - Importance of distinguishing farms statistics from spatial-environmental database in order to be able to harmonize them
Conclusions from the numerical results

• The expected AEC payment scheme for operation 10.1.1 seems to be coherent with the economic results obtained analyzing FADN database: the subsample of breeding farms show lowest values of gross margin when LSU/ha decrease and species richness increase.

• The surface payment compensates the extensification efforts carried out by the Province in all the meadow typologies (Δ Gross margin/ha due to the LSU/ha variations); it compensates the totally the “species richness” element and partially the abandonment risk of slope meadows.

• The comparison between ARIES and FADN results in term of animal density shows that there is some margin to increase the sustainability in specie rich meadows (1.4 vs 1.7) and slope meadows (1.7 vs 2.0) while for valley floor meadows the index (LSU/ha) appears sustainable (2.4 vs 2.1).