Collaborative Responses to Sustainability Challenges in Local Agri-Food Systems: Insights from the Dairy Cluster in Colonia, Uruguay

Encuentro internacional de la Asociación de Economistas de Lenguas Neolatinas (AENL)

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1

Contents

1. Context and research problem
2. Conceptual framework
3. Methodology and the Colonia Case
4. History and economy of the Colonia dairy LAFS
5. Sustainability challenges: economic, social and environmental
6. Innovative responses to sustainability challenges
7. Preliminary conclusion and further steps

2

Context and research problem

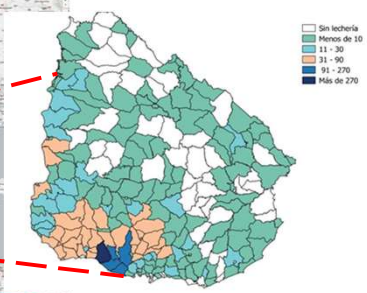
- Agri-food systems are under increasing pressure to balance competitiveness, sustainability, and territorial cohesion.
- Traditional approaches often lack the necessary territorial sensitivity.
- R&D Projects Program 2024, CSIC-UDELAR: "Local agri-food systems, collaboration networks, and environmental innovation in Uruguay", (2025–2027).
- Central Research Question:

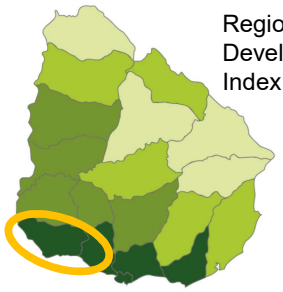
To what extent does local collaboration facilitate the emergence and implementation of innovations that address sustainability challenges?

- Two Case Studies

Case 1. Dairy LAFS in Colonia (and San José)

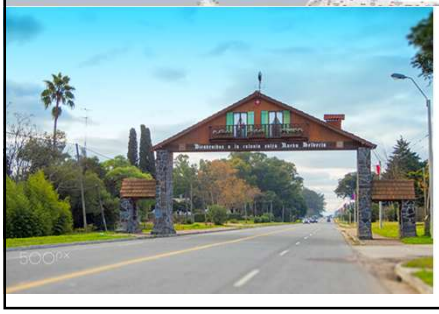






Regional Development Index

https://desarrolloterritorial.idere.ei.udelar.edu.uy/

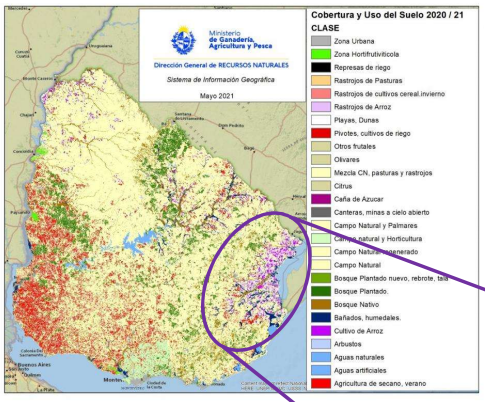


900 producers (200 hectares on average per farm): raw milk to be delivered to the industry and artisanal cheese.

20 dairy industries (small and medium size): milk, cheese, yogurt, butter, ice cream, powdered milk.

4

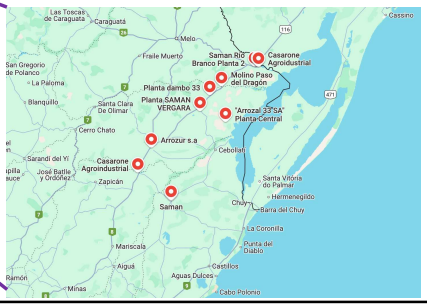
Case 2. Rice and meat in the East



Land use in Uruguay

Ministerio de Ganadería, Agricultura y Pesca (MGAP) – Dirección General de Recursos Naturales (DGRN). *Actualización de la cobertura y uso del suelo del Uruguay. Año 2020/2021.*

- Departments of Rocha, Lavalleja, Treinta y Tres, and Cerro Largo.
- Simultaneous presence of rice and extensive livestock farming, often with alternating crops and pastures on the same property.
- High technological intensity, especially in rice (irrigation, mechanization).
- Significant export potential, especially in rice (Asia, Middle East, America) and meat (EU, China, US).



Google Maps, search: "rice mill"

Conceptual framework

- This analysis uses the concept of Local Agri-Food Systems (LAFS).
- LAFS are territorially rooted production systems based on shared resources, local knowledge, and historical linkages.
- These systems function as clusters, with geographic concentration and a dense network of local actors.
- So we adopt a territorial development perspective to analyze how local collaboration fosters sustainability oriented innovations in the dairy sector.

Methodology and the Colonia (+San José) Case

- The Colonia dairy LAFS is an illustrative case due to its strong historical roots, robust artisanal cheese-making presence, and dense support network.
- The ecosystem includes family/cooperative enterprises, technical institutions (School of Dairy, UTEC), business associations and public actors.
- Methodology: qualitative fieldwork conducted in 2025.
- Data source: in-depth interviews with 17 key actors including producers, cheesemakers, industries, public officials, advisors, also researchers.

Embeddedness: history and local economy

- History: the sector is strongly linked to European immigration (Swiss, Waldensian, Italian) since the mid-19th century, introducing a strong cheese-making culture (e.g., Colonia cheese).
- Local economy: the sector generates constant employment (365 days a year) and contributes significantly to keeping the population rooted in rural communities.
- Colonia specializes in value addition (artisanal cheeses and processed dairy products), counterbalancing the commodity export model prevalent in the Uruguayan dairy sector (powered milk).
- In sum, the territory has high social capital, facilitating cooperation and organization among actors.

Economic Sustainability Challenges

1. Reduced Margins and Volatility: producers (farmers) operate with low profitability levels, are generally "price takers" (international prices are the reference, 70% of milk produced in the country is exported; and international markets are volatile).
2. Saturated Local Market and strong Competition: small industries and artisanal cheesemakers face high competition in the small Uruguayan market, particularly from larger industries (like CONAPROLE) when they redirect non-exported products domestically.
3. High Investment Requirements: profitable production models demand significant investment (a capital intensive sector); lack of financial products for small producers.
4. Commercialization and Export Difficulties: it is challenging to open new export markets for artisanal cheeses or processed dairy products (not powered milk).
5. Management Difficulties: small enterprises often struggle with administrative management; there is a lack of specialized personnel in modern business management supported by information technologies.

Social Sustainability Challenges

1. Generational Replacement: a major challenge is the lack of generational replacement, leading to an aging sector.
2. Occupational Health and Quality of Life: In many dairy farms, working conditions are hard, and there are fewer comforts than in more modern jobs or in the city.

   Producers' children often witness this conditions and lack incentive to continue the same path, hindering generational replacement.
3. Labor shortages: there is constant difficulty in finding non-technical personnel for routine and basic tasks in dairy farms, as the work is hard and constant, requiring people to live on-site.
4. Cultural Barriers: older generations often have a "traditional view" and resist breaking established customs, which can brake the innovative ideas of younger generations.

Environmental Sustainability Challenges

1. Water Contamination: this is cited as the primary environmental problem, caused by the excess of nutrients (phosphorus and nitrogen) from the poor management of effluents (dairy farms) and fertilizers.

   Effluent containment ponds ("piletas") are often poorly sized or maintained, leading to overflows, filtration, and impacts on emissions.

2. Soil Degradation and Whey Disposal: agrochemistry use is a concern. Inadequate handling of whey ("suero", a co-product) by artisanal cheesemakers, who often discard it in the field, can lead to soil contamination around industrial plants.

3. Climate Change Impacts: the sector is vulnerable to rapid transitions between droughts (causing heat stress) and floods, which affect production and infrastructure.

Innovative responses to sustainability challenges

12

Scale and innovation origin

- We find that the origin of the innovation often correlates with the scale of the environmental challenge it addresses.

  - Local root problems (effluents, soil pollution) are usually addressed through local innovations (and using local/national networks).

  - Systemic/global challenges (like climate change adaptation) rely more heavily on external expertise, funding or technologies.

- This suggests that territorial collaboration networks are better positioned to respond to territorially embedded problems.

Collaborative Innovations: Waste and Water Management

- Effluent Management (Fertigation): collaboration drives the implementation of filtration ponds and infrastructure to use dairy residues, generating natural fertilizer and water for irrigation.
- Water Purification: the Centro Emmanuel demonstrates practices using natural solvents and wetland plants to purify residual water before irrigation.
- Bioenergy (Biodigesters): some artisanal cheesemakers have implemented biodigesters, often financed by inter-institutional development projects (e.g., ANDE). Biodigesters produce biogas (used for heating) and generate biofertilizers.
- Whey utilization: initiatives range from using whey for animal feed to developing new products like a whey-based beverage (developed by UTEC and AUPYL).

Collaborative Innovations (2): Soil Health and Value Addition

- Agroecology and Soil Management: producers, sometimes form groups and (like CREA) and implement initiatives for soil care, pasture rotation, and the use of bio-inputs (like Efficient Microorganisms).
- Organizational Learning: organizations like “Grupo Los 30” and AUPYL meet for knowledge and experience exchange, allowing them to identify weaknesses and implement management improvements.
- Product Differentiation: actors seek differentiation through unique products (e.g., conservant-free cream cheese) or certification strategies (e.g., gluten-free) to enhance competitiveness.
- Energy Efficiency: implementation of solar panels and the use of biogas (with financial support from public programs).

Institutional & Digital Innovations

- Inter-institutional Cooperation: there is a Technological Network of the Dairy Chain (INALE, Conaprole, UTEC, UDELAR) that articulates research efforts to improve productive and environmental systems.
- Robotics and Automation: there is a trend toward adopting milking robots and automated cleaning systems, facilitated by institutions like the Superior Dairy School, which has a semi-robotized dairy farm (but it is still in its early stages)
- Data Management: some actors are using information management platforms (some local developed) and satellite maps to calculate indicators and analyze pasture yield.
- Traceability and Certification: some producer groups use software for sales and stock traceability, and experimental projects (with INALE/FAO) are exploring blockchain for quality certification in artisanal cheese-making.

Preliminary conclusion: The Power of Territorial Embeddedness

- Sustainability innovation in agri-food systems cannot be separated from its territorial context.
- Local **collaboration is crucial** not only for **economic coordination** but also for addressing **sustainability challenges in ways that align with local resources, knowledge, and social norms.**
- **Innovation is shaped by relational proximity and institutional embeddedness**, not just market dynamics.
- **Key Insight**: fostering green transitions requires multi-scalar coordination: empowering local networks while connecting them to national and international sources of knowledge and finance.

Where are we right now?

- Survey: semi-structured questionnaire (online/face-to-face support):
  - Census of industries and support organizations and a sample of primary producers
  - Information on: company/organization profile, collaborative links, environmental challenges, innovations, and barriers to innovation.
- Identify:
  - Firms and organizations characterisics (size, age, specialization…)
  - Collaboration links
  - Different types of sustainability innovation (e.g., energy efficiency, recycling, input efficiency, etc.), differentiating between internal developments (make innovation) and external developments (buy innovation) (Veugelers and Cassiman, 1999).
- Regression models and qualitative comparative analysis to estimate the association between the local network and environmental innovations.
- (Potential) network factors determining innovation: Centrality, intermediation between different types of actors, diversity of actors with which the company is linked (public, private, academic, productive, local, external, etc.).

18

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19