Sustainable innovations in bioeconomic value chains: the case of Argentina

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BACKGROUND

Innovations play a central role in economic growth and can make a decisive contribution to the transition to a **sustainable bioeconomy**. However, different types of innovations can lead to different sustainable outcomes. Moreover, sustainable innovations take place in complex value chains and both can influence each other, so they should be analyzed together. Yet, there is so far little empirical research to examine the role that different **types of sustainable innovations** play **in different value chains.** This case study of eleven companies in Argentina aims to analyze this relationship by combining new bioeconomic innovation and value chain typologies. **Argentina** represents **an interesting case** because the bioeconomy there includes value chains based on large biomass as well as biotechnological companies and alternative local bioeconomic initiatives.

METHODS

To characterize the innovation process in these companies, we combine the **typologies** developed by Mac Clay and Sellare (2025) of bioeconomic value chain (VC) models with the typology of sustainable innovations (IT) in the bioeconomy, developed by Bröring et al. (2020), see Table 1.

- MacClay, P. & Sellare, J. (2025). The Nexus between Value Chains, Innovations and Social Sustainability in the Context of a Bioeconomy Upgrading. J. Bus. Strat. & Dev. 8:e70087.
- Bröring, S., Laibach, N. & Wustmans, M. (2020). Innovation types in the bioeconomy. J. Clean. Prod., 266, 121939.

In a **case study approach**, semi-structured interviews with eleven biomass processing and biotech companies representing different sectors and sizes were carried out in November 2022 in the provinces of Santa Fe, Chaco, and Formosa.

Value Chain Models (MacClay & Sellare 2025)	Innovation Types (IT) (Bröring et al. 2020)
1: Low-value, High-volume Biomass	IT I: substitute products
2/3: Adoption of Cascading and Circular Principles	IT II: new processes
4: Higher-Generation Feedstocks and Advanced Technologies	IT III: new products
5: Low-Volume, High-Value Biomass	IT IV: new behavior
6: Biomass-Free Biotechnologies	

Table 1: Value Chain Models and Innovation Types in the Bioeconomy

RESEARCH QUESTIONS

1. What are the drivers of sustainable innovations?
2. How are innovations linked to different features of the value chains?
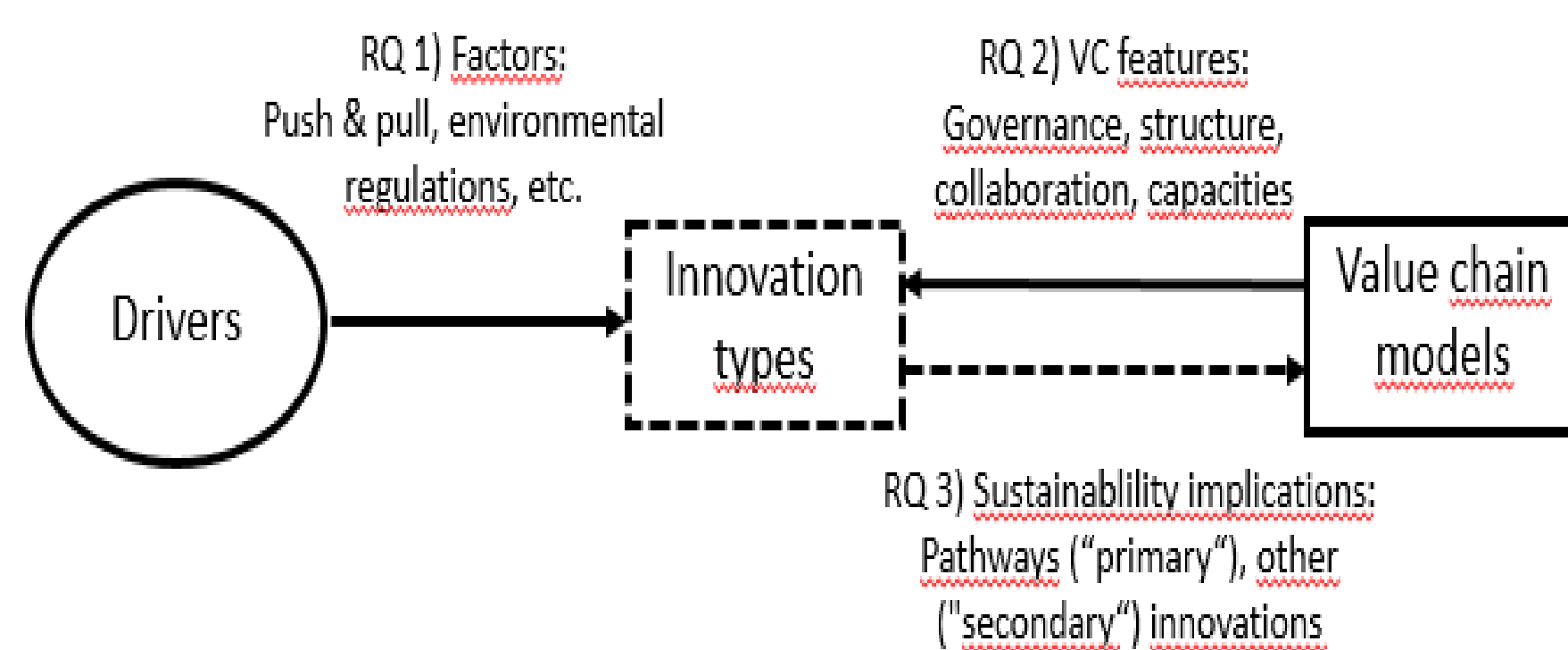3. Which types of sustainable innovations play which role in different value chains?

Figure 1: Conceptual framework

Foto: Biogas plant as an example of IT I and IV

Case 2: Soy crushing industry

Case 7: Tannin industry

Case 4: Small scale sugarcane processing

Case 8: Bio-nutrition for ruminants

Case 5: Rendering industry

Case 9: Biotech seed traits
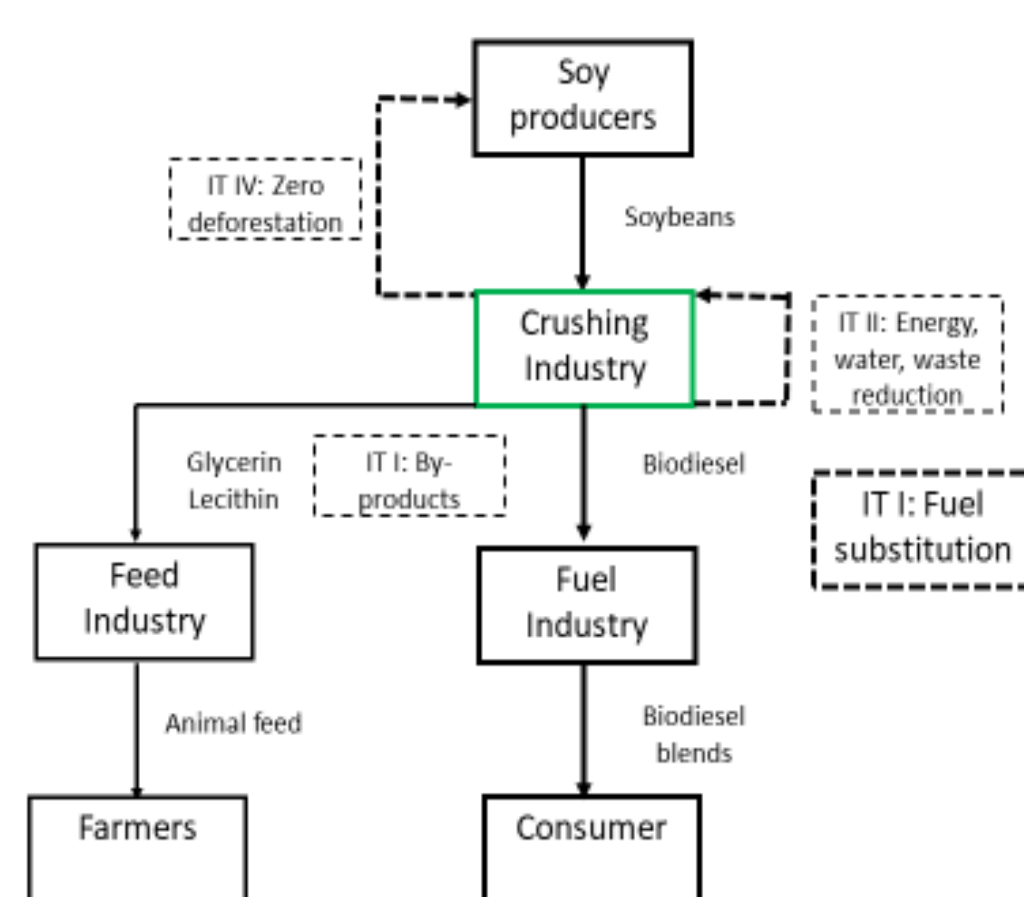
Figure 2: Different Cases of VC Models and IT

OUTCOMES

The study shows that innovations take place at different levels of value chains that complement each other. As a conceptual contribution, a distinction is made between **primary and secondary innovations**. Four primary types of innovation are at the core of bioeconomic activities and are fundamental to transformation pathways. Secondary innovations complement primary innovations and can thus make the **bioeconomy more sustainable** overall. This can also mitigate potential conflicts of interest, e.g. between food and energy use, and diminish negative environmental impacts.
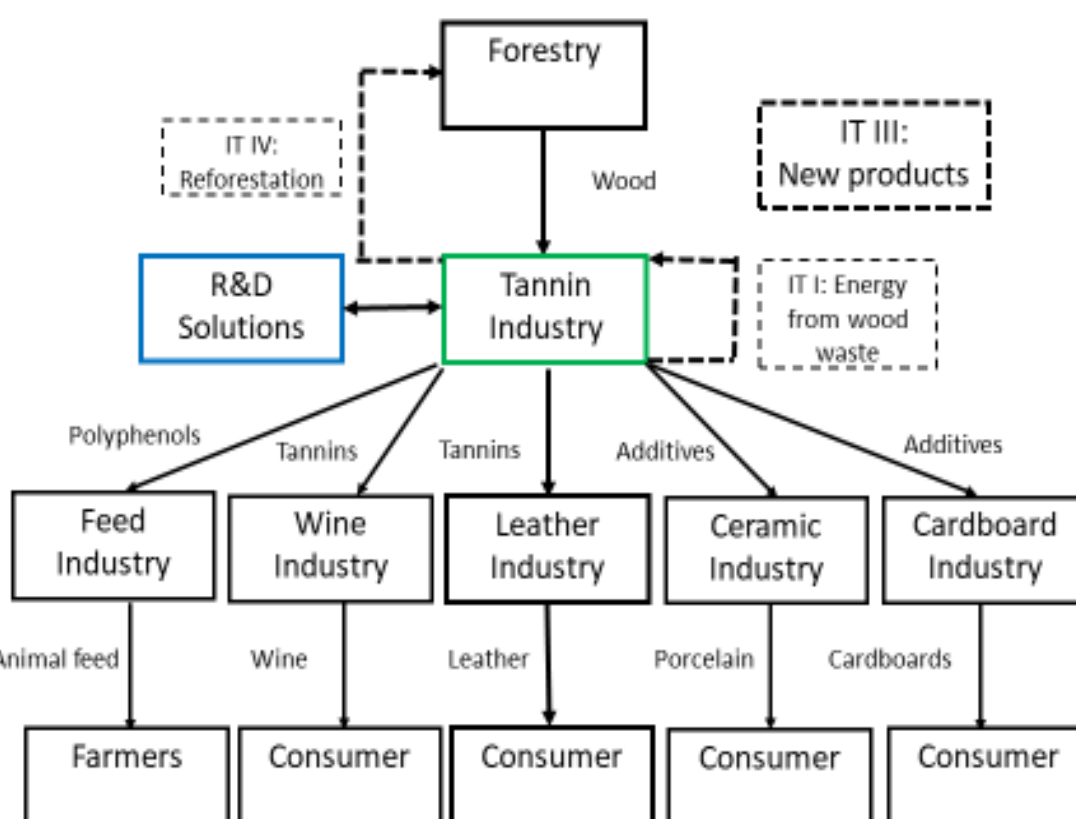
Case (Industry)	Model	Primary IT	Secondary IT
1 Dairy	1: Traditional and high-volume biomass use	– (Traditional bioeconomy)	II: New processes III: New products IV: Better quality
2 Biofuel (diesel)	1: Traditional and high-volume biomass use	I: Fuel substitution	I: By-products II: Energy reduction IV: Zero deforestation
3 Biofuel (ethanol)	1: Traditional and high-volume biomass use	I: Fuel substitution	I: By-products IV: Biogas, fertilizer from residues
4 Rum & Sugar	2: Integration of biomass production and processing and adoption of circular principles	IV: New sustainable products	I: Energy from residues III: New varieties IV: Feed, fertilizer from residues
5 Rendering	3: Transformation of biomass residues into products with value-added	IV: Use of slaughterhouse waste	II: Conversion efficiency IV: Biodigestor
6 Food (Rice flour)	3: Transformation of biomass residues into products with value-added	IV: Use of by-products (broken rice)	II: Conversion efficiency
7 Tannin	4: Feedstocks and advanced technologies for high-value products	III: New bio-products for industrial use	I: Energy from wood residues IV: Reforestation
8 Feed	5: Low-volume, high-value biomass	III: Bio-nutrition for livestock	
9 Seed traits	6: Biomass-free biotechnologies and high-tech solutions for biomass production	II: Gene editing for plant breeding	–
10 Bio-pharmaceutics	6: Biomass-free biotechnologies and high-tech solutions for biomass production	II: Biosimilars for cancer treatment	–
11 Agricultural devices	6: Biomass-free biotechnologies and high-tech solutions for biomass production	II: Precision agriculture	–

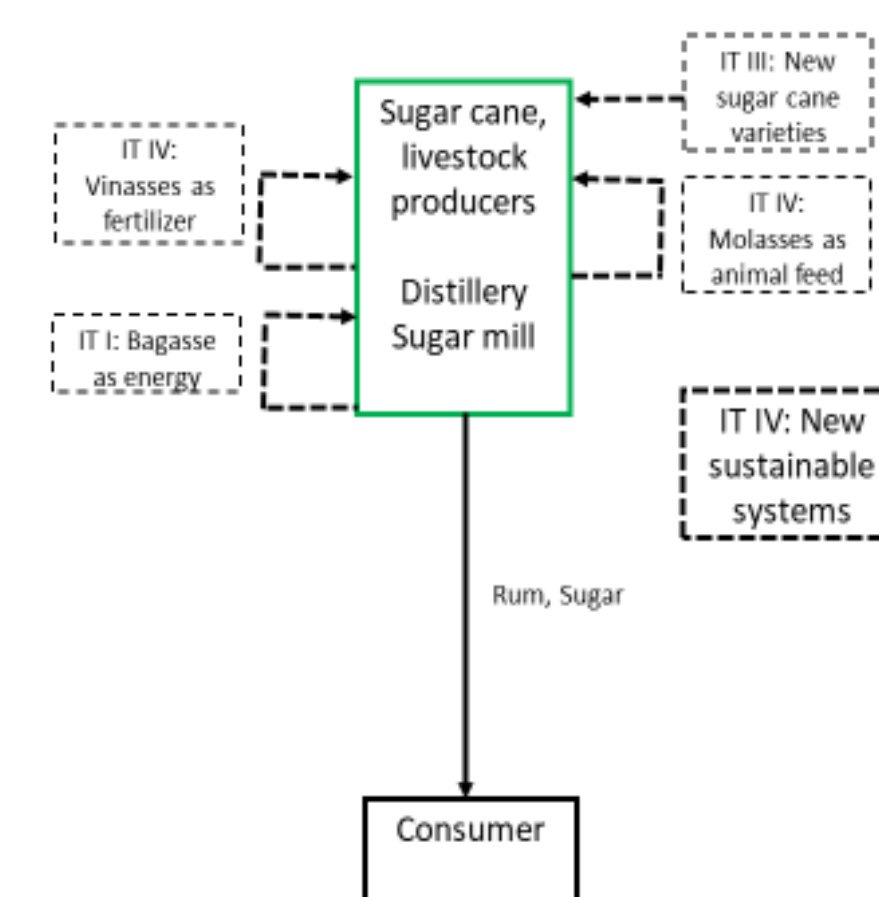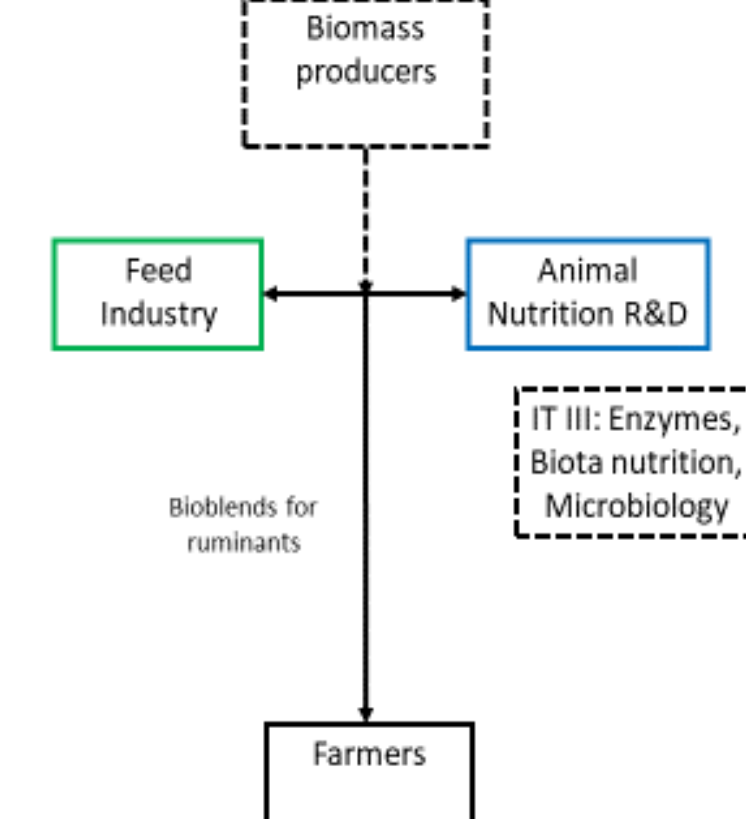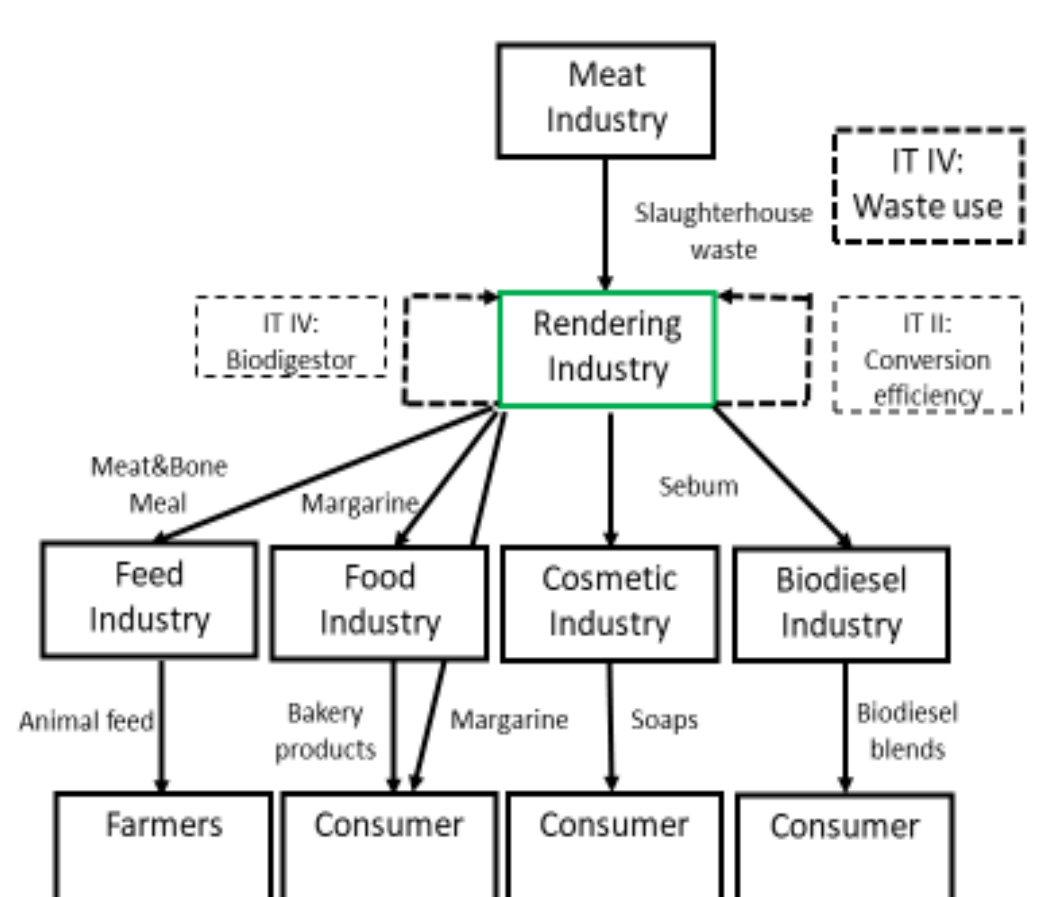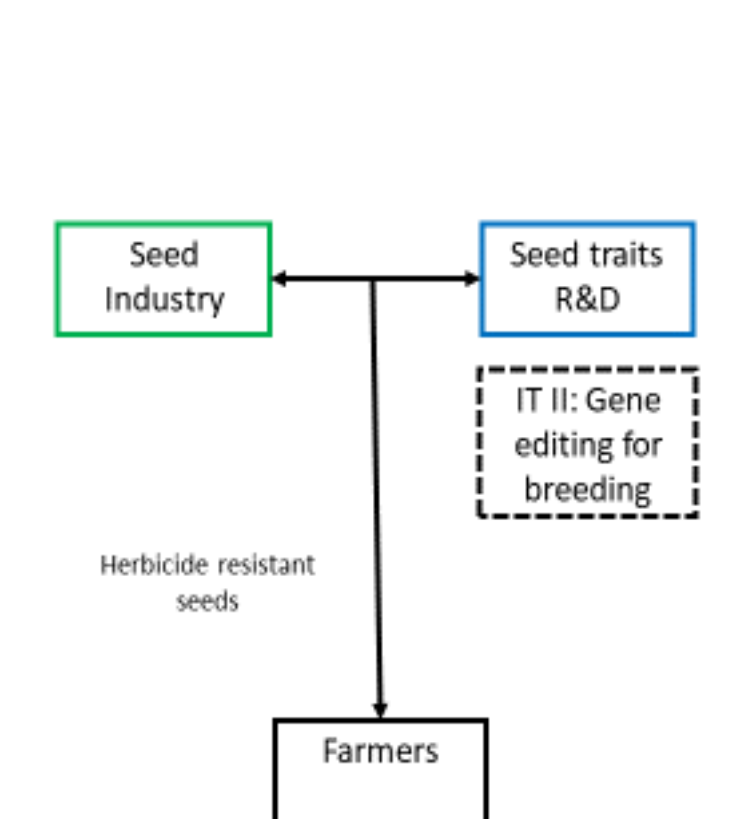Table 2: Cases, Models, Innovation Types (IT)

Dürr, J., Sili, M., Mac Clay, P., & Sellare, J. (2024). Bioeconomic innovations breeding more sustainable innovations: A value chain perspective from Argentina. Business Strategy and the Environment, 33(7), 6833-6851.