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Adoption of circular economy practices in agriculture. A case study of Italian fruit and vegetables producers

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Motivation:
Circular Economy (CE) can greatly contribute to the mitigation of environmental degradation and the economic sustainability of the agricultural activity if widely adopted in the agricultural sector. (Bartezzaghi et al. 2022, Garrone et al. 2013; Ymeri et al. 2020; Velasco et al. 2023)

Objective:
A. what is the **potential for CE adoption** in Italian fruit and vegetables sector?
B. With what **practices**?
C. What are **drivers and barriers**?

Gap:
- **CE implementation** is studied mostly **outside agricultural sector** in management and economics literature (Kirchherr et al. 2017; Velasco-Munoz et al. 2021).
- The CE implementation in agrifood imply additional issues from industrial sectors, like food safety, and to deal with perishable products and ecosystems (Pascucci, 2020; Rico Lugo et al. 2023)
- Drivers and barriers for CE implementation in agrifood are also different from industry

CE adoption in agriculture happens through the farm-level (CE) practices

What was done:
- **exploratory case studies**
- on **13 farms and 3 cooperatives**
- in 3 crops value chains
- in the Pianura Padana region

Analysis focuses on **inputs**, **practices, surplus and (organic) wastes** tied to food production, with a specific attention to surplus food and food waste

How it was done:
- 16 semi-structured interviews investigating firms' characteristics, production processes, related surplus and organic waste generation and management practices.
- Collection of additional information on CE practices and stakeholders' roles.
- Ongoing further validation in different value chains and in different geographies (different Regions).

Output:
- **framework of CE practices** adopted in the Italian fruit and vegetables supply chain
- **Drivers and barriers** for farm level adoption of CE practices

Circular agriculture

CE practices are adopted at farm level…

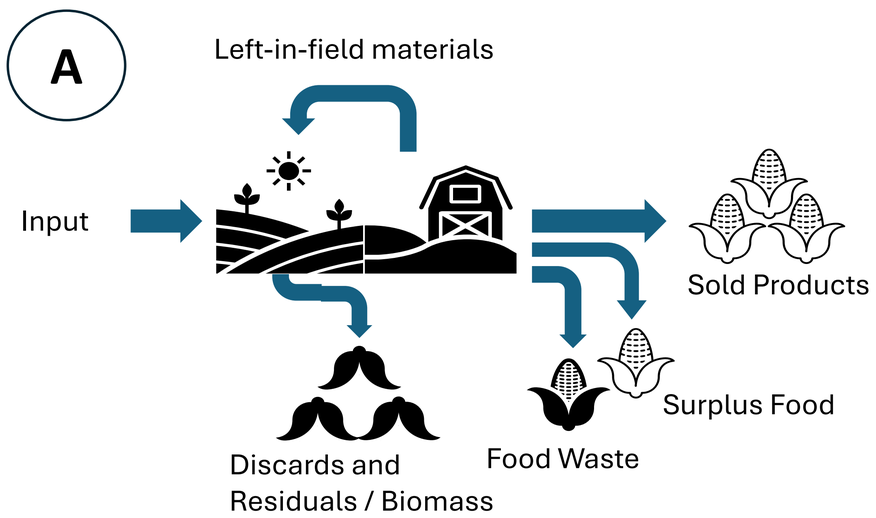
…to answer one question:

"The pears affected by alternaria fall to the ground, and those that are collected are no good for anything." *Farm 01P*

"The only by-products of radicchio, let's say, is there waste leaf waste, […] that is 8% to 10% or even less " *Farm 04R*

"…and there are periods when there is a lot of production and therefore it is not possible to sell all the product." *farm 04M*

A

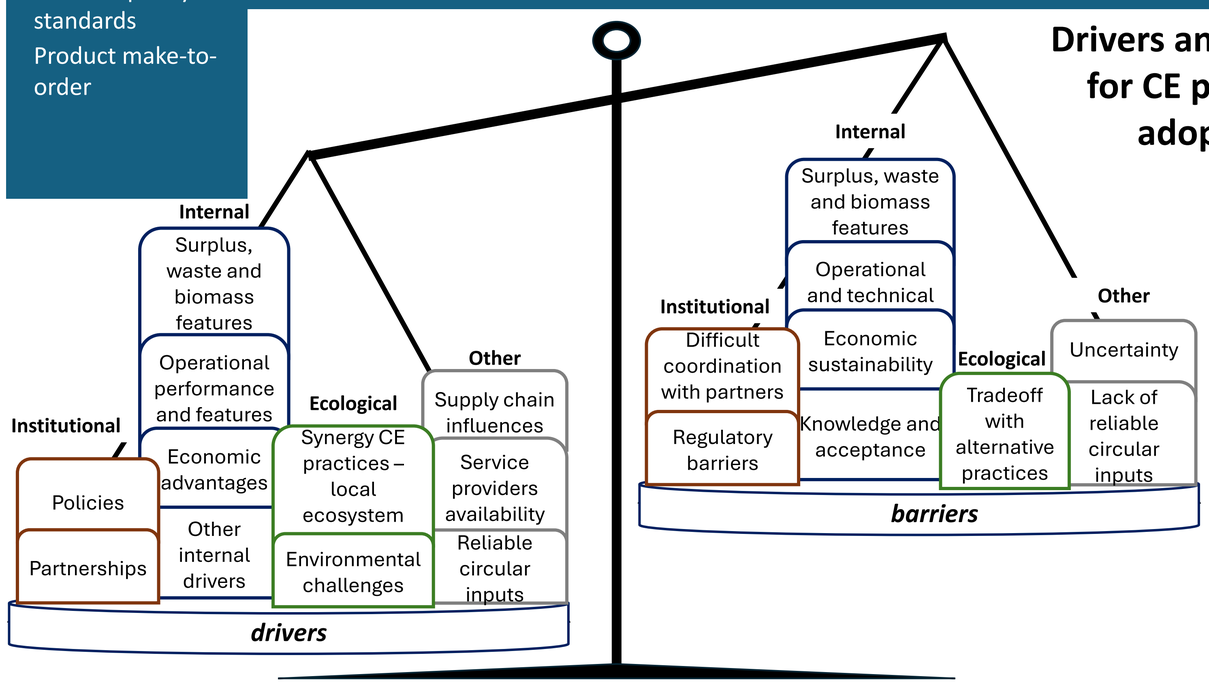


Can farmers valorize these materials?

B **CE practices**

Reduce	Reuse				Recycle	Recover	Regenerate
Prevention	**Sales on other channels**	**Food transformation**	**Donation**	**Animal feed**	**Material recovery**	**Energy recovery**	**Regenerative practices**
Products thinning Cold chain technologies Cooperation with large-scale retail Flexible quality standards Product make-to-order	Reworking or repackaging Selling in secondary markets Direct sales	Upcycling of food surplus In-house transformation	Donations to associations or privates Market withdrawals	In-farm use for animal feeding Donation or sale to others for animal feeding	Production of soil conditioners and fertilizers	Production of biofuels Heat or power generation	Use of circular organic fertilizer or soil amendment Use of energy from renewable sources produced within the company Regenerative agronomic practices (es conservative agriculture, crop rotations)

C **Drivers and Barriers for CE practices adoption**



Aggregate dimension	*Second-order category*	*First-order category*	*Interviews*
Institutional drivers	Policies	Economic incentives	"The market withdrawals are made within the scope of CMO, thus within the framework of contributions." *Cooperative PH-02P*
		Regulations	"We get the manure from the nearby farm. […] [Based on] the nitrates rule." *Farm 06P*
		Knowledge, sensibilization, know-how diffusion	"The consortium had given directives regarding an experimental program related to compost from... umm sewage wastewater." *Farm 05P*
	Partnerships		"Once [overproduction] is expected, then we try to engage in activities with the large-scale retail trade (GDO)." *Farm 02M*

Drivers' framework in detail – an **example**

Case studies sample:

ID	Crop	Province	Job profile of interviewees
01M	Melon	Mantua (MN)	Quality manager
02M	Melon	Mantua (MN)	Farm owner
03M	Melon	Mantua (MN)	Farm owner
04M	Melon	Mantua (MN)	Farm owner
05M	Melon	Ferrara (FE)	Farm owner
01R	Radicchio	Venice (VE)	Farm owner
02R	Radicchio	Venice (VE)	Agricultural manager
03R	Radicchio	Padova (PD)	Farm owner
PH-01R	Radicchio	Venice (VE)	General manager
01P	Pear	Ferrara (FE)	Agricultural manager
02P	Pear	Mantua (MN)	Farm owner
03P	Pear	Mantua (MN)	Farm owner
04P	Pear	Mantua (MN)	Farm owner
05P	Pear	Rovigo (RO)	Farm owner
PH-01P	Pear	Mantua (MN)	Plant manager
PH-02P	Pear	Mantua (MN)	Sales manager

13 **farms** & 3 **cooperatives**

Pianura Padana

3 **crops** (pear, melon, radicchio)

In progress: **validation** of frameworks **outside sample boundaries**

Conclusion

The study provides:

- detailed **classification of CE practices** adopted by farmers
- Identifies adoption antecedents for CE practices
- shows the relation between the **production of surplus, waste, and biomass** with the choice of **valorization practices**
- recognizes the crucial role of **regeneration in the CE**
- places high emphasis on the **role that ecosystems play** in the adoption of CE practices specifically

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