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Empirical evidence on the acceptance of CE practices and technologies by Italian farmers. A preliminary overview.

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SPOKE, WP AND TASK

Spoke 8 WP 4 Task 2

ABSTRACT

Circular Economy in agriculture

Agricultural production generates surplus food due to supply and demand variability, along with biomasses discarded during the field and post-harvest activities. The two streams may be valorized at the farm level through the adoption of CE technologies and the implementation of related practices. This study analyzes the farm- and context-level determinants (e.g. product category, farm size, post-harvest integration, organization of food waste management, soil health, incentives) of the adoption process (acceptance, adoption) undertaken by Italian farmers with 5 groups of recycling and recovery technologies for food waste and biomasses. The analysis relies on survey data collected from 1.200 Italian farmers and a discrete choice econometric model. This approach enhances the generalizability of the results on a national scale.

The objective of this analysis is to determine if and what **firms' internal characteristics**, **context features,** and **stakeholders' actions** are related to the **acceptance and adoption of recycling and recovery** technologies. The discussion of results will revolve around **two recycling technologies** developed within Agritech Spoke 8, namely technologies related to **composting** and technologies related to **biofuel production**. The **extraction of biomolecules** was analyzed but **appears to be scarcely diffused** within the agricultural sector and was adopted or accepted only in 11 over 1200 observations.

The work aims to provide a better knowledge of the conditions supporting farmers' acceptance of CE technologies, which may be useful to inform policymakers in their efforts to design evidence-based support measures and technology developers and suppliers in the identification of the most promising technologies and demand segments.

GAPS

1. Farm-level investigation of CE technologies' acceptance and adoption is based on hardly generalizable case studies
2. Incomplete investigation of antecedents of CE technologies

RESEARCH QUESTIONS

1. What are farms' internal, ecosystemic, and stakeholders-related antecedents to the firm's acceptance and adoption of recycling and recovery technologies?
2. Are the acceptance and adoption antecedents the same for different recycling and recovery technologies?

METHOD

Data collection

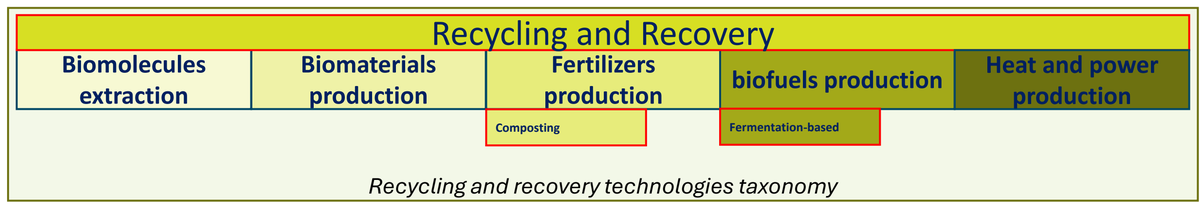
We aim to provide evidence on the adoption and acceptance of CE technologies, at the farm level, with a sample large enough to draw generalizable conclusions at the country level.

For this reason, we choose to collect our data with a large-scale survey, reaching individual farmers and collecting information on the adoption of CE practices in their farms. We also collect information about farm structure, activities, interactions with stakeholders, and other potential drivers and barriers for CE adoption.

We choose to focus on the population of **Italian farms** that legally are **joint stock companies, cooperative companies** and **other consortium forms**, we also include in the target population only farms **producing food items** (i.e. excluding wine and industrial crops).

Our **target sample** is composed of **1200 farms** (**12.6% of the populations**), stratified by type of products, farm size, and geographical area. A non-proportional stratification with sampling error lower than 15% for every dimension is adopted.

Data collection was performed with a **questionnaire** designed relying on previous empirical research with on-farm case studies to orient our questions. Then the questionnaire was **cross-validated** with experts **and tested** with 3 farmers to verify clarity and readability. The data collection is managed by a service provider in **CAWI mode** and we managed to collect **1200 observations.**



Recycling and recovery technologies taxonomy

Model variables

Farms makes adoption decisions within a Socio Ecological System, which encompasses 3 main actors, i.e. the farm, the related ecosystems and the institutional stakeholders.

Drivers (and barriers) are associated with their actions

- **Institutional drivers**: institutional stakeholders can favor or hinder CE acceptance and adoption with policies such as financial incentives, R&D funding, training programs, research and dissemination activities, enabling multi-stakeholder holistic initiatives, voluntary or mandatory targets and certifications provisioning
- **Internal drivers**: farm's features and activities like
  - Measurement and monitoring of surplus and waste production
  - Point of generation of surplus and waste (post-harvest vs in filed generation)
  - Presence of technical competences and resources (capital, labor, time)
- **Ecosystemic drivers**: the depletion of natural resources and the presence of threats from ecosystems alteration is a driver for CE adoption

Var name	*Antecedent type*	*Type*	*Description*
ecosystems	*Ecosystemic*	*Binary*	*Does the alteration of ecosystems in which the farm is embedded pose challenges to farming activities?*
fw_measure	*Internal*	*Binary*	*Does the farm measures surplus food or food waste?*
fw_resp	*Internal*	*Binary*	*Is there a responsible figure or manager for surplus or waste management?*
fw_ext	*Internal*	*Binary*	*Is the surplus and waste management performed by firms different from the farm?*
prod_type	*Internal*	*Categorical*	*Main product type from secondary data*
size_class	*Internal*	*Ordered*	*Farm's size class by land usage*
f_stage	*Internal*	*Categorical*	*Farms activities' extension along the supply chain (cultivation, post-harvest or both)*
certifications	*Instititutional*	*Binary*	*Does the farm have quality or sustainability certifications?*
incenitves	*Instititutional*	*Binary*	*Does the farm access to incentives for recycling and recovery?*

RESULTS

Data analysis

Multinomial Logit Model with standard errors robust to heteroscedasticity (n=1200) was chosen for the analysis.

In the tables are reported coefficients and p-values for the following equations:

- *Equation 1) **Acceptance** of **recycling and recovery** technologies*
- *Equation 2) **Adoption** of **recycling and recovery** technologies*
- *Equation 3) **Acceptance** of **composting** technologies*
- *Equation 4) **Adoption** of **composting** technologies*
- *Equation 5) **Acceptance** of **biofuel** technologies*
- *Equation 6) **Adoption** of **biofuel** technologies*

Biomolecule extraction is scarcely accepted and adopted in our sample, consequently, results are not reported

Variables groups	Variables	Recycling and recovery				Composting				Fermentation-based biofuel			
		E1) acceptance		E2) adoption		E3) acceptance		E4) adoption		E5) acceptance		E6) adoption	
		Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
size_class	very large	-.419	.410	1.148	.017	-.979	.463	-.488	.563	.193	.889	16.132	.000
	large	.032	.946	.499	.317	-.026	.982	-.007	.994	.903	.496	15.208	.000
	medium	.038	.937	.529	.282	-.164	.886	.284	.715	-.479	.745	14.203	.000
	small	.410	.425	.725	.158	.894	.446	.476	.559	-.367	.819	14.514	.000
prod_type	cereals	-.386	.387	-.472	.219	-15.056	.000	-15.026	.000	-14.299	.000	.405	.560
	vegetables	-.165	.633	-.244	.502	-1.027	.338	-.465	.518	.278	.750	.675	.300
	fruit	-.447	.370	-.377	.364	-.427	.614	-1.545	.116	-14.588	.000	.038	.971
	olives	-.401	.375	.011	.974	-.644	.486	.155	.745	.785	.473	.681	.511
	bovines_milk	-.299	.670	-1.087	.074	-15.695	.000	-14.72	.000	1.225	.327	-.158	.887
	bovines_meat	1.079	.086	.967	.068	-13.459	.000	-14.623	.000	2.57	.003	1.245	.114
	other_livestock	-.537	.391	.217	.576	-14.249	.000	.049	.948	.144	.907	.835	.240
f_stage	farming	-.422	.419	-.203	.667	-4.115	.000	13.78	.000	14.707	.000	-.325	.664
	post_h	.084	.897	.122	.843	.385	.776	14.819	.000	-.624	.238	-15.762	.000
	farming & post_h	-.087	.869	-.115	.809	-1.504	.082	13.675	.000	14.676	.000	-.765	.331
ecosystems	clim_pb	.837	.002	.632	.005	-.344	.649	.344	.420	-.109	.850	1.213	.044
	patho_pb	.014	.953	-.147	.486	-.153	.817	-.224	.519	.370	.450	.245	.574
	soil_pb	-.459	.139	-.645	.025	.88	.201	-.733	.199	-.479	.544	-.116	.829
certifications	cert_GI	-.099	.717	.169	.421	-	-	-	-	.332	.559	-.179	.738
	cert_bio	.076	.732	-.058	.748	.457	.431	.516	.095	-1.798	.050	-1.534	.004
	cert_sust	.480	.080	.168	.495	1.311	.115	.589	.128	.715	.246	-.168	.754
fw_measure	fw_measure	.466	.086	.321	.180	-.477	.565	.775	.017	.332	.628	-.143	.854
fw_resp	fw_resp	.636	.005	.415	.022	1.623	.022	.843	.020	.530	.300	-.845	.046
fw_ext	fw_ext	-.690	.530	.370	.547	2.636	.036	1.203	.180	-15.025	.000	2.472	.007
incentives	incentives	.891	.000	.851	.000	-.553	.365	.155	.592	1.304	.015	.866	.022
outlier	outlier	.256	.545	.412	.236	.892	.385	.518	.301	-15.247	.000	-.114	.912
constant	constant	-3.041	.000	-3.008	.000	-3.40	.003	-17.977	.000	-19.906	.000	-19.221	.000

Note. The threshold for significance has been set at 0.1 confidence level

- Antecedents correlated with the **acceptance** of technology are **not always the same** correlated with its **adoption**.
- **Firm size** does not affect the acceptance of recycling and recovery technologies, but it does **affect the adoption**.
- The production of **bovine meat** is related to both **acceptance and adoption** of recycling and recovery technologies, possibly signaling a sector sensitive to the topic and active in waste management.
- **Biofuel** technology acceptance and adoption are related to **external waste management** and the presence of **incentives**.
- The presence of **climate-related issues** is related to the **adoption** of **recycling and recovery** technologies and the adoption of **fermentation** technologies.
- The adoption of **composting** technologies adoption is **not related to farm size**. Both its **acceptance and adoption** are only related to the **internal antecedents** (such as product and type of activities) and **waste measurement and management** choices. Ecosystemic and stakeholder-related antecedents are not significantly related to this technology.

CONCLUSIONS

Preliminary results show that internal, environmental, and stakeholder-related antecedents do affect the acceptance and adoption of recycling and recovery technologies.

In the general equation for the **acceptance** (E1) **internal antecedents** are **not significant** with one exception, while they are more **significant when considering the single technologies** one by one. This suggests that their **relationship is dependent on the technology chosen.**

In the **adoption** phase **firm size** plays a relevant role, but not in acceptance. This might indicate the existence of farms that accept the use of recycling technologies as a possibility (especially smaller farms) but do not implement them for lack of the necessary resources. This is also supported by the fact that **firm size is not relevant** in determining the **adoption** of technologies requiring **fewer resources** (composting). The development of supporting policies, organizational solutions, or other tools for enabling these farmers might increase the adoption of recycling technologies in the farming sector.

Observing a single technology makes it possible to observe the relevance of **product type** in the acceptance and adoption of one technology. This might be related to technological barriers to using agricultural wastes related to such productions.

Ecosystemic antecedents are related to the acceptance and adoption of recycling and recovery practices, but their relevance changes for the different technologies. They are not relevant for composting technologies. The most relevant **stakeholder-related antecedent** is the **incentives** availability, which affects the acceptance and adoption of recycling and recovery, and of fermentation-based biofuels.

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