Long-term effects of conversion incentives to organic farming: A causal analysis with endogenous survival

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Motivation and research questions

Why it matters

- Organic farming is a pillar of the EU Green Deal: historical target of **25% of UAA by 2030**
- The EU *Vision for Agriculture and Food* sees organic farming as a practice that can
  - **reward farmers** for maintaining ecosystem services
  - open **new opportunities for innovation**
- Public support is meant to trigger a **durable** transition, not a temporary one

Key question: does conversion support create **lasting** organic farms?

Research questions

1. Does the conversion incentive affect **farm survival** after 9 years?
2. Among farms that would survive anyway, does it increase **long-run organic persistence**?
3. **Whom** did the policy actually reach? (targeting)
4. What **characteristics and strategies** distinguish resilient farms? (profiling)

Source: European Commission (2025), *A Vision for Agriculture and Food: Shaping together an attractive farming and agri-food sector for future generations.*

Related literature and contribution

Causal evaluations of organic and agri-environmental support

Study	Method	Main finding
Chabé-Ferret & Subervie (2013), France	DID-matching	Organic conversion scheme: high additionality, low windfall
Cisilino et al. (2019), Marche RDP	DID on matched FADN	Better environmental indicators, income unchanged
Rees et al. (2023), EU Organic Action Plans	Synthetic control	Organic area increases in half of the targeted cases
Arata & Sckokai (2016), 5 EU MS	DID-matching	AES: fewer inputs, more diversification, lower income
Raimondo et al. (2021), Italian olive farms	SFA + PSM	Organic adoption raises technical efficiency
Ait Sidhoum et al. (2022, 2023)	DEA + impact evaluation	No significant eco-efficiency gains from AES

Other contributions comparing organic and conventional agriculture confirm superior environmental outcomes per hectare but mixed evidence on profitability and income stability, reinforcing the rationale for continued public support (Tuomisto et al., 2012; Seufert et al., 2012; Gamage et al., 2023).

Our contribution

1. **Long-run evidence** (9 years) beyond adoption, with **survival as an outcome**
2. **Principal stratification** in an observational agri-policy setting: separates production effects from selection induced by exit
3. **Targeting diagnostics**: strata in the potential population vs. among beneficiaries
4. **Survey projected onto latent strata**: mechanisms behind persistence

Policy context and data

The policy

- Measure 11.1 *Introduction of organic farming*, Tuscany RDP 2014–2020, **2015 call**
- Per-hectare payments
- Follow-up until **2024** (9 years): effects are *gross* effects of the whole conversion + maintenance pathway

Data (administrative linkage)

- Ranking lists + ARTEA graphic crop plans 2016 + Business Register + ISTAT
- **28,153 farms**: 712 treated, 27,441 untreated
- Organic in 2024: at least one plot organic/in conversion (GCP 2022–2024)

	Untreated	Treated
N	27,441	712
Exited by 2024	26.4%	16.3%
Surviving & organic	11.6%	93,1%
UAA (ha, mean)	20.7	47.8
Farm age $\leq$ 10 years	29.2%	41.4%
Non-individual farm	14.4%	27.0%
Mountain area	13.6%	17.8%
Field crops	49.2%	39.9%
Permanent crops	27.8%	27.9%

Raw gaps are large, but treated farms tend to be **larger, younger, more structured**: naive comparisons mix selection, survival and production effects.

Source: ARTEA, Business Register, Tuscany RDP ranking lists.

Method (1): potential outcomes and truncation by death

For each farm i, treatment $T_i \in \{0,1\}$ and potential outcomes

$$S_i(0),\ S_i(1),\ Y_i(0),\ Y_i(1)$$

- $S_i(t)$: farm still active in 2024 under treatment t
- $Y_i(t) = I(B_i = 1 \text{ and } C_i = 1)$: organic *and* active cropping plan
- $Y_i(t)$ is defined only if $S_i(t) = 1$

Observed survival:

$$S_i = T_i S_i(1) + (1 - T_i) S_i(0)$$

Observed productive outcome:

$$Y_i = T_i Y_i(1) + (1 - T_i) Y_i(0)$$

Truncation, not missing data

When a farm exits, the productive outcome is not unobserved but **economically undefined**: there is no production to observe.

Why not condition on survivors?

Survival is a **post-treatment, endogenous** variable: active farms mix units that survive anyway and units that survive *because of* the incentive.

SUTVA: standardised payments, uniform rules; spillovers assumed second-order.

Method (2): principal stratification

Latent strata G_i defined by $(S_i(0), S_i(1))$

Stratum	$(S(0), S(1))$	Interpretation
Resilient (R)	(1,1)	Survive anyway: policy can act on *production*
Protected (P)	(0,1)	Survive only thanks to the incentive
Harmed (H)	(1,0)	Incentive leads to exit (iatrogenic effect)
Vulnerable (V)	(0,0)	Exit regardless

Observed groups are mixtures

T	S	Latent composition
0	1	R + H
1	1	R + P
0	0	V + P
1	0	V + H

No observed group isolates a single stratum
$\Rightarrow$ strata must be **modelled**, not observed.

Strata proportions are themselves a policy output: π_g in the **target population** (potential) vs. $\pi_{g,T=1}$ among **beneficiaries** (realised targeting).

Method (3): estimands, identification and Bayesian inference

Causal estimands (defined only for those who survived)

$$\text{SACE} = \mathbb{E}[Y_i(1) - Y_i(0) \mid S_i = 1]$$
$$\text{SACE}_{T=1} = \mathbb{E}[Y_i(1) - Y_i(0) \mid S_i = 1,\ T_i = 1]$$

- SACE: *potential* intensive effect; $\text{SACE}_{T=1}$: *realised* one

Identification: conditional ignorability

$$\{S_i(0), S_i(1), Y_i(0), Y_i(1)\} \perp\!\!\!\perp T_i \mid X_i$$

with X_i as covariates: UAA, farm age, legal form $\times$ gender $\times$ age, cropping system, mountain area, province FE.

Bayesian principal stratification model

Strata: multinomial logit

$$\Pr(G_i = g \mid X_i) \propto \exp(\alpha_g + X_i^\top \beta_g)$$

Outcomes: logit, only where Y is defined

$$\Pr(Y_i(t) = 1 \mid G_i = g, X_i) = \text{logit}^{-1}(\gamma_{g,t} + X_i^\top \delta_t)$$

Method (4): projecting the survey onto latent strata

Survey design

- CATI/CAWI, July–October 2025
- Target: all treated & surviving farms ($T = 1, S = 1$): **596**
- Valid responses: **187**
- Variables Z *pre* and *post* conversion: education, labour, value chain, practices, multifunctionality, economics, psycho-cognitive traits

Z is purely **descriptive**: it does not enter causal identification.

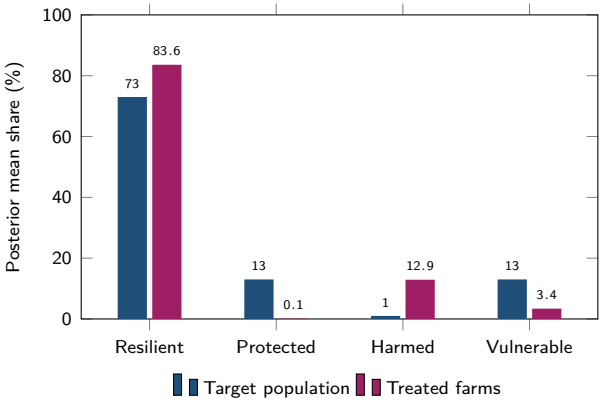
Two sources of uncertainty

1. Non-response: $\hat{p}_i = \Pr(R_i = 1 \mid X_i, T_i = 1, S_i = 1)$ (logit)
2. Stratum membership: draw $G_i^{(m)}$ at each MCMC iteration

$$W_{ig}^{(m)} = \frac{I(G_i^{(m)} = g)}{\hat{p}_i}$$

$$\bar{z}_{k,g} = \frac{1}{M} \sum_{m=1}^{M} \frac{\sum_i W_{ig}^{(m)} z_{k,i}}{\sum_i W_{ig}^{(m)}}$$

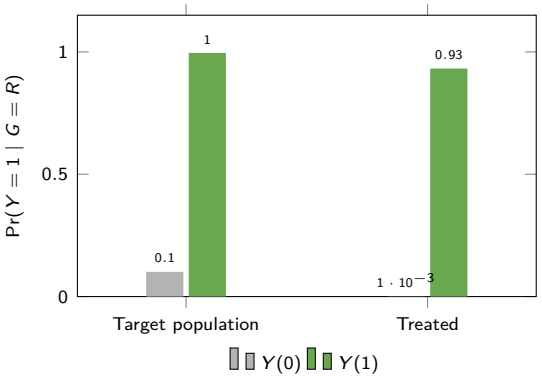
Results (1): who survives because of the policy?



- **Resilient** is over-represented among the treated (84%)
- **Protected**: 13% of the potential population, but almost absent among treated ⇒ extensive margin not activated
- **Harmed**: 1% potential, 13% among treated
- **Vulnerable** largely excluded (3%)

Limited survival effects: a strongly **selective** implementation.

Results (2): long-run organic persistence (SACE)



	Mean	95% CrI
SACE	**0.894**	[0.875; 0.927]
$\text{SACE}_{T=1}$	**0.932**	[0.926; 0.938]

- Among farms that survive anyway, the incentive raises the probability of being organic after 9 years by $\approx$ **90 p.p.**
- Larger effect on treated: selected Resilient farms had **near-zero counterfactual persistence**
- Protected (descriptive): $\mathbb{E}[Y(1) \mid P] \approx 0.76 \Rightarrow$ unexpressed potential

Results (3): structural profile of the latent strata

Target population, posterior means	R	P	H	V
UAA (ha)	24.0	14.5	34.5	13.6
Non-individual farm	0.17	0.08	0.28	0.08
Farm age $\geq$ 10 years	0.69	0.71	0.48	0.72
Grapes	0.11	0.11	0.18	0.10
Arable crops	0.49	0.48	0.35	0.47
Siena + Grosseto	0.41	0.36	0.60	0.36
Male 40+, individual	0.47	0.52	0.32	0.52

Treated Resilient: UAA = **50.8 ha**

- **R and H**: larger, more often companies $\Rightarrow$ survival rooted in land endowment and organisation
- **P and V**: small, individual, mature farms
- **Harmed**: younger, complex systems (viticulture, mixed), concentrated in Siena/Grosseto
- Program selected the **largest** Resilient farms (51 vs 24 ha)

Survey results (1): who are the treated Resilient farms?

Structure and human capital

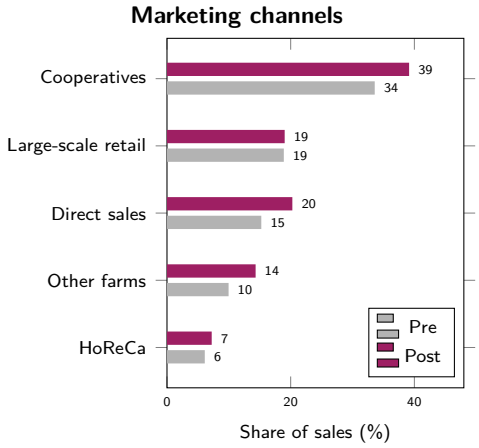
- 64% upper secondary or tertiary education (14% agricultural)
- Market-oriented: only 18% self-consume >50% of output; 34% use hired labour
- 38% in consortia, 18% in Producer Organisations

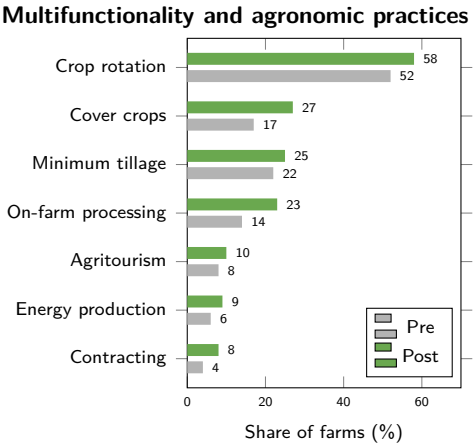
Trajectory after conversion

- Higher revenues, but profitability pressure persists
- Labour (60%) and UAA (62%) mostly **stable**

Source: IRPET survey on Measure 11.1 beneficiaries (n=187), weighted for non-response and stratum membership.

Survey results (2): value chain, diversification and practices





Source: IRPET survey on Measure 11.1 beneficiaries (n=187), weighted for non-response and stratum membership.

Policy implications

Stratum	Ex-ante signals	Relevant margin	Policy direction
Resilient	Medium–large, companies, organisational capacity	**Intensive**: large, stable effect on organic persistence	From area-based maintenance to **valorisation**: aggregation, commercial capacity, on-farm processing
Protected	Small, individual, mature farms	**Extensive**: continuity as precondition	**Enabling** tools before conversion: training, advisory, demonstration
Harmed	Larger, younger, complex systems (viticulture)	Negative effect on continuity	**Ex-ante screening** and orientation; avoid automatic conversion
Vulnerable	Very small, late life cycle	None identifiable	Other policy areas: generational renewal, territorial measures

Effectiveness depends less on *strengthening* the instrument than on **matching instruments to heterogeneous farm margins**.

Take-home messages

1. **Large intensive effect**: among Resilient farms (the only stratum where the effect on organic production is defined), the incentive raises the probability of being organic after 9 years by about 90%
2. **Extensive margin not activated**: Protected farms, whose survival depends on support, are almost absent among beneficiaries
3. **Selection amplifies iatrogenic risk**: Harmed farms are 1% of the potential population but 13% of the treated
4. **Persistence rests on organisation**: aggregation, cooperative and direct channels, on-farm processing, despite persistent margin pressure
5. **From "one-size-fits-all" to tailored strategies**: not more incentives, but better-targeted ones (valorisation for Resilient, enabling tools for Protected, ex-ante screening for Harmed)

Thank you!

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Backup: posterior potential outcomes by stratum

	$\mathrm{E}[Y(0) \mid H]$	$\mathrm{E}[Y(1) \mid P]$	$\mathrm{E}[Y(0) \mid R]$	$\mathrm{E}[Y(1) \mid R]$	SACE
Target population					
Mean	0.593	0.760	0.101	0.996	0.894
95% CrI	[0.035; 0.984]	[0.235; 1.000]	[0.072; 0.113]	[0.990; 0.998]	[0.875; 0.927]
Treated farms					
Mean	0.199	0.030	0.001	0.932	0.932
95% CrI	[0.000; 0.654]	[0.000; 0.000]	[0.000; 0.003]	[0.931; 0.938]	[0.926; 0.938]

Only Resilient columns are causal; H and P columns are descriptive (one potential outcome undefined).

Backup: posterior stratum counts

	Resilient	Protected	Harmed	Vulnerable
Target population (N = 28,153)				
Mean	20,536 (0.73)	3,583 (0.13)	345 (0.01)	3,689 (0.13)
95% CrI	[19,880; 20,790]	[376; 6,866]	[25; 1,014]	[403; 6,938]
Treated farms (N = 712)				
Mean	595.2 (0.836)	0.8 (0.001)	91.7 (0.129)	24.3 (0.034)
95% CrI	[592; 596]	[0; 4]	[51; 116]	[0; 65]