Ecological transformation of Spanish crop farms

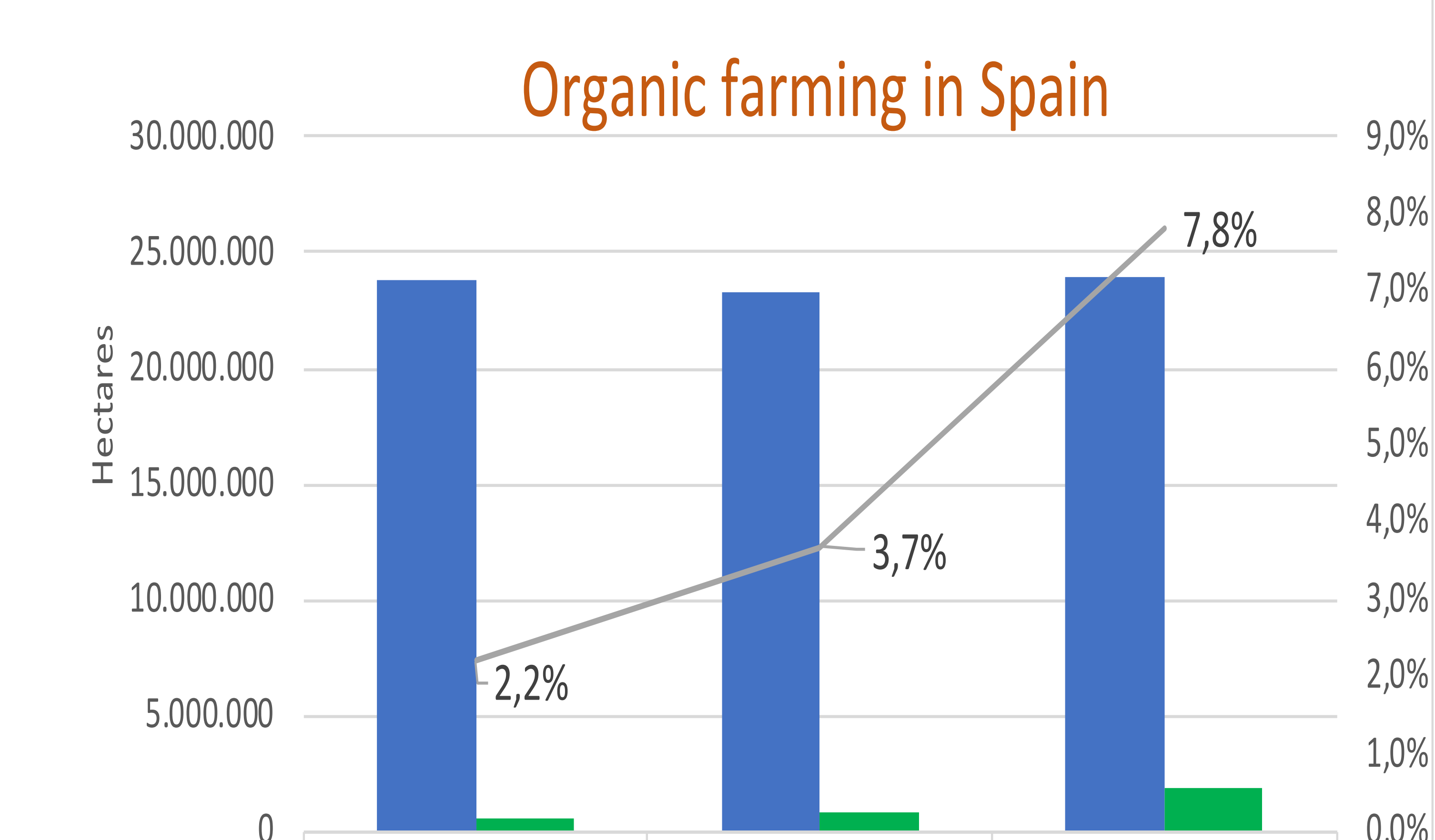
Jesús Barreiro-Hurlé [1]
Ángel Perni [2]
Laura Riesgo [2]

[1] European Commission - Joint Research Center (Jesus.BARREIRO-HURLE@ec.europa.eu)
[2] Universidad Pablo de Olavide, Facultad de Ciencias Empresariales (aperllo@upo.es, lriealv@upo.es)

Outline

1. Introduction and objectives
2. Literature review
3. Performance changes in organic farms
4. Potential ecological transformation

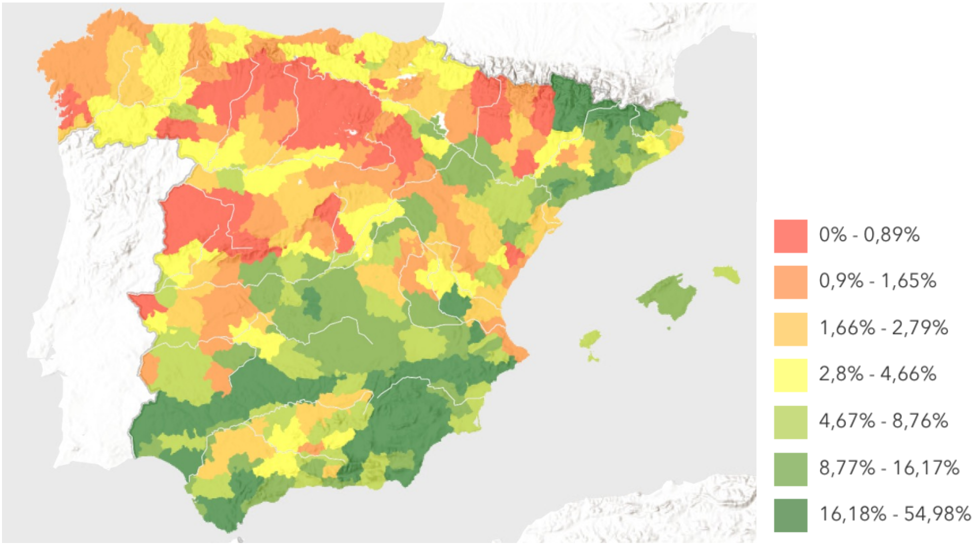
1. Introduction and objectives



	2009 Census	2016 EEA	2020 Census
UAA (Ha)	23.752.688	23.229.753	23.913.682
Organic UAA (Ha)	525.914	857.981	1.871.529
% Organic UAA	2,2%	3,7%	7,8%

- **Crop activities distribution** (2020)
  - Pastures (41.69%)
  - Arable crops (28.09%)
  - Permanent crops (29.94%)
  - Crops under shelter (0.29%)

- **Geographical distribution** (2020)



1. Introduction and objectives

- **FARMPERFORM** project aims to assess the trade-offs between economic and environmental performance of farms driven by agricultural policies that are more and more focused on protecting agri-ecosystem services.

- **Our objectives**:

  Objective 1: Performance changes in organic farms.

  Objective 2: Potential ecological transformation.

2. Literature review

- Ecological transformation of farms: A triangular problem
- Determinants of organic transformation of farms:
  - Farmers’ behaviour and skills
  - Agronomic and climatic conditions
  - Externalities and Policy support
- Debate:
  - Productivity and performance changes
  - Income distribution in rural area.

2. Literature review

Scope: Literature using FADN / RECAN data

- Mary, S. (2013). Assessing the impacts of pillar 1 and 2 subsidies on TFP in French crop farms. Journal of Agricultural Economics, 64(1), 133-144.
- Rizov, M., Pokrivcak, J. & Ciaian, P. (2013). CAP subsidies and productivity of the EU farms. Journal of Agricultural Economics, 64(3), 537-557
- Koiry, S., & Huang, W. (2023). Do ecological protection approaches affect total factor productivity change of cropland production in Sweden? Ecological Economics, 209, 107829.
- Baráth, L. & Fertö, I. (2024). The relationship between the ecologisation of farms and total factor productivity: A continuous treatment analysis. Journal of Agricultural Economics, 75(1), 404-424.

2. Literature review

Scope: Literature using FADN / RECAN data

Components of total factor productivity change 2010–2016.

Year	Technical efficiency change	Technical change	Scale change	Total factor productivity change
2010	–	–	–	–
2011	0.005	−0.018	0.265	0.251
2012	0.027	−0.034	0.039	0.032
2013	−0.012	−0.026	0.0003	−0.038
2014	−0.074	−0.029	−0.045	−0.148
2015	0.006	−0.028	0.010	−0.011
2016	0.023	−0.026	−0.039	−0.042
Mean	−0.004	−0.026	0.038	0.007

Koiry, S., & Huang, W. (2023). Do ecological protection approaches affect total factor productivity change of cropland production in Sweden? Ecological Economics, 209, 107829.

Factors affecting total factor productivity change.

	Coefficient
Specialisation	−0.077***
	(0.035)
Organic farming	−0.032
	(0.032)
Ln Payment of agricultural insurance	−0.007
	(0.006)
Location in less favoured area	
(1) Constraints area	−0.074
	(0.054)
(2) Less favoured but not mountain	−0.144***
	(0.063)
(3) Mountain area	0.009
	(0.079)
(4) Phasing-out area	0.053
	(0.109)
Constant	0.048
	(0.042)

2. Literature review

Scope: Literature using FADN / RECAN data

Martín-García, J., Gómez-Limón, J. A., & Arriaza, M. (2024). Conversion to organic farming: Does it change the economic and environmental performance of fruit farms?. *Ecological Economics*, *220*, 108178.

Composition of the RECAN subsamples by TF and main crops and average yields for conventional and organic farming (year 2020).

Farm/crop (observations)	Average yields		Observed difference Org.-Conv. (%)
	Organic farms (kg/ha)	Conventional farms (kg/ha)	
TF 361 Fruits (organic = 32, conventional = 213)	17,220	18,991	−9.3
Peach (organic = 14, conventional = 128)	17,678	22,868	−22.7
Pear (organic = 16, conventional = 61)	19,181	21,884	−12.4
Apple (organic = 18, conventional = 41)	27,426	29,921	−8.3
Other fruits (organic = 15, conventional = 100)	10,966	11,501	−4.7
TF 362 Citrus (organic = 18, conventional = 212)	24,701	27,552	−10.3
Orange (organic = 10, conventional = 173)	25,313	28,420	−10.9
Lemon (organic = 10, conventional = 30)	27,038	21,940	23.2
Other citrus (organic = 6, conventional = 88)	18,709	24,281	−23.0
TF 363 Nuts (organic = 63, conventional = 58)	682	752	−9.4
TF 364 Tropical fruits (organic = 14, conventional = 69)	34,257	37,772	−9.3

The impact of organic farming on economic performance is heterogeneous

(e.g., positive for nut farms, negative for citrus farms, and non-significant for other fruit and tropical fruit farms)

This inspired …

Objective 1: Performance changes in organic farms.

2. Literature review

Scope: Literature using FADN / RECAN data

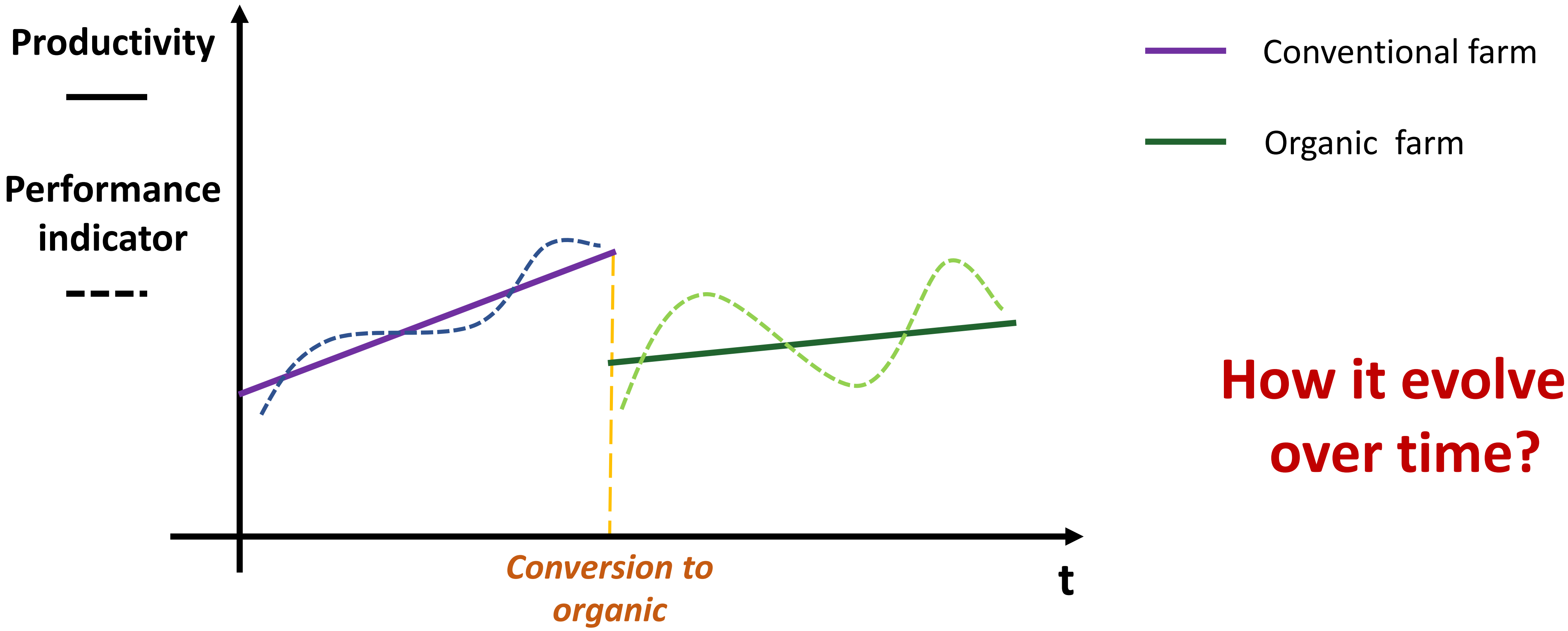
- Luigi, B. and Simone, S. (2022) Can Machine Learning discover the determining factors in participation in insurance schemes? A comparative analysis. arXiv:2212.03092.
- Martinho, J.P.D. (2023) Fertiliser cost prediction in European Union farms: Machine-learning approaches through artificial neural networks. Open Agriculture 8: 20220191.
- Coderoni et al. (2024) How Differently Do Farms Respond to Agri-environmental Policies? A Probabilistic Machine-Learning Approach. Land Economics 100 (2): 370–397.
- Esposti, R. (2024) Non-monetary motivations of the EU agri-environmental policy adoption. A causal forest approach. Journal of Environmental Management 352: 119992.

This inspired …

Objective 2: Potential ecological transformation.

3. Performance changes in organic farms

- **Klinnert et al. (2023)**: Landscape features supporting natural pest control can help farms to experience lower productivity losses in a context of reduced synthetic pesticides use.



How it evolves over time?

3. Performance changes in organic farms

- **Difference-in-difference (DID) estimator.** Advantages respect to methods based on matching or Heckman procedures.
  - Control for potential self-selection bias due to observed and unobserved characteristics.
  - Control for the presence of time-invariant confounding characteristics.
  - Identification of progressive evolution in time of the dependent variable.
- **Two-way fixed effect model** (individual and time fixed effects in panel data).
- *Additionally*: **Total Factor Productivity Changes** (Koiry and Huang, 2023).

3. Performance changes in organic farms

- **Empirical model**

$$FP_{it} = \beta X_{it} + \alpha_i + \lambda_t + \gamma_t Org_{it} + u_{it}$$

Where:

– FP_{it}	Farm performance indicator for farm *i* in time *t*
– X_{it}	Control variables
– β	Partial effects of control variables
– α_i	Farm fixed effect
– λ_t	Time fixed effect
– Org_{it}	Dummy variable that takes value 1 when conversion to organic starts
– γ_t	Conversion effect over time
– u_{it}	Error term

3. Performance changes in organic farms

- **Farm performance indicators** (Martín-García et al., 2024)

Indicator (acronym)	Formula	Formula based on RECAN data	Units
Profitability			
Farm Net Income (FNI)	$\frac{FNI}{UAA}$	$\frac{SE420}{SE025}$	€/ha
Return On Assets (ROA)	$\frac{EBIT}{Total\ assets}$	$\frac{EBIT}{SE436}$	%
Viability			
Long-term viability (LT_VB)	$\frac{FNI}{Total\ Opportunity\ Costs}$	$\frac{SE420}{OC_{land} + OC_{labor} + OC_{non-land\ assets}}$	Dimensionless
Short-term viability (ST_VB)	$\frac{FNI}{OC_{labor}}$	$\frac{SE420}{OC_{labor}}$	Dimensionless
Resilience			
Coeff. Variation of FNI (CV_FNI)	$\frac{\sigma_{FNI_t}}{\overline{FNI_t}}$	$\frac{\sigma_{SE420_t}}{\overline{SE420_t}}$	%
FNI resistance (RES_FNI)	$Min\left[\frac{FNI_t - \overline{FNI_t}}{\overline{FNI_t}} \forall t\right]$	$Min\left[\frac{SE420_t - \overline{SE420_t}}{\overline{SE420_t}} \forall t\right]$	%
Independence			
Revenue dependency (REV_DEP)	$\frac{Total\ CAP\ subsidies}{Total\ revenue}$	$\frac{SE605}{SE131 + SE605}$	%

3. Performance changes in organic farms

- **Control variables**
  - FADN/RECAN: Direct costs (e.g., fertilizers, pesticides), labour costs, machinery, other costs (energy, water), type of location (LFA), farm size, region, specialization, subsidies, etc.
  - Biophysical data (NUTS3, *coordinates?):* climate, soil.
- **Organic farms in FADN/RECAN**

Código	
1	En la explotación no se aplican métodos de producción ecológicos
2	En la explotación se aplican exclusivamente métodos de producción ecológicos en todos sus productos
3	En la explotación se aplican métodos de producción ecológicos y de otro tipo
4	La explotación está reconvirtiéndose a los métodos de producción ecológicos

Conventional (1)

Organic (2)

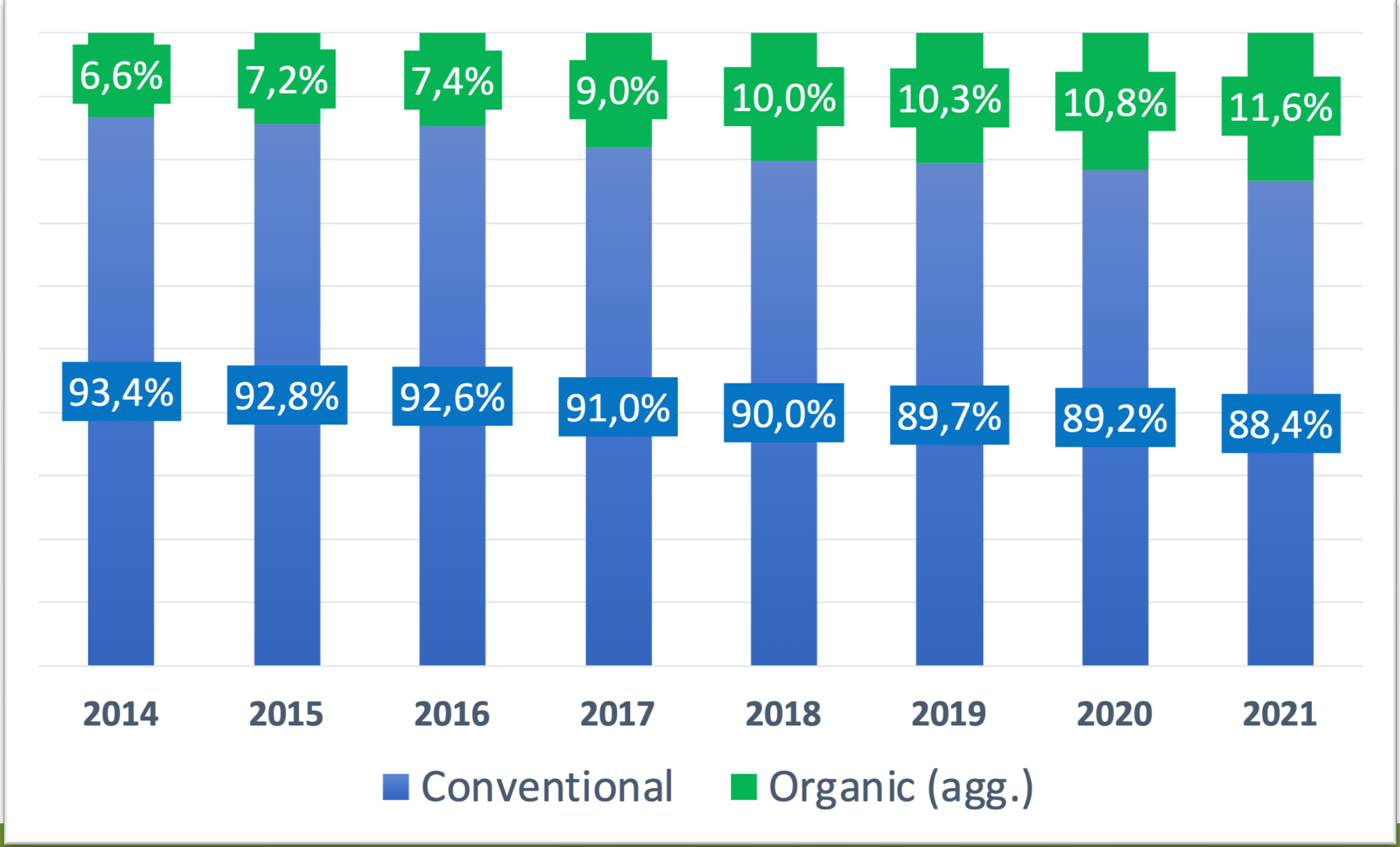
Combined (3)

Conversion (4)

3. Performance changes in organic farms

DATA

	2014	2015	2016	2017	2018	2019	2020	2021
Conventional (1)	93,41%	92,80%	92,60%	90,96%	89,95%	89,69%	89,15%	88,37%
Organic (2)	4,77%	4,77%	4,62%	5,52%	0,50%	0,48%	0,61%	0,62%
Combined (3)	1,66%	2,17%	2,39%	3,05%	9,38%	9,70%	10,13%	10,86%
Conversion (4)	0,15%	0,26%	0,39%	0,47%	0,16%	0,13%	0,11%	0,15%



Share of farms

Source: FADN/RECAN

3. Performance changes in organic farms

- **DATA (n = 12 678)**

Farms that do not change from first to last recorded year

	Nbr farms	%
Conventional (1)	11242	88,67%
Organic (2)	178	1,40%
Combined (3)	415	3,27%
Conversion (4)	18	0,14%

PERIOD 2014-2021, BUT…

WARNING! UNBALANCED PANEL DATA!

Farms that change from first to last recorded year

	Nbr farms	%
From 1 to 2	11	0,09%
From 1 to 3	391	3,08%
From 1 to 4	10	0,08%
From 2 to 3	341	2,69%
From 2 to 4	0	0,00%
From 3 to 4	1	0,01%
From 2 to 1	35	0,28%
From 3 to 1	8	0,06%
From 4 to 1	2	0,02%
From 3 to 2	6	0,05%
From 4 to 2	3	0,02%
From 4 to 3	17	0,13%

Source: FADN/RECAN

3. Performance changes in organic farms

DATA

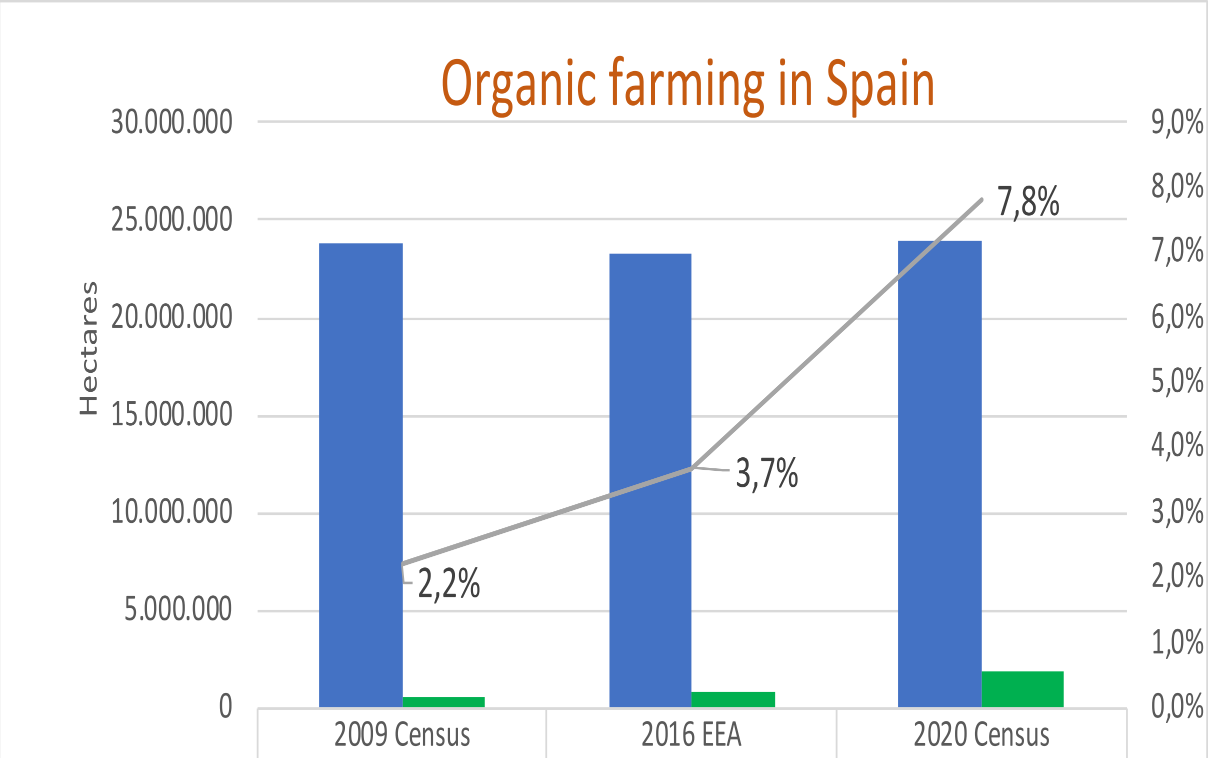
- (15) Specialist COP
- (16) Specialist other fieldcrops
- (20) Specialist horticulture
- (35) Specialist wine
- (36) Specialist orchards - fruits
- (37) Specialist olives
- (38) Permanent crops combined
- (45) Specialist milk
- (48) Specialist sheep and goats
- (49) Specialist cattle
- (50) Specialist granivores
- (60) Mixed crops
- (70) Mixed livestock
- (80) Mixed crops and livestock

Source: FADN/RECAN

Crop farms	n	%
not conversion 1 1	6964	54,90%
not conversion 2 2	123	0,97%
not conversion 3 3	316	2,49%
not conversion 4 4	13	0,10%
conversion 1 2	9	0,07%
conversion 1 3	276	2,18%
conversion 1 4	9	0,07%
conversion 2 3	265	2,09%
conversion 2 4	0	0,00%
conversion 3 4	1	0,01%
conversion 2 1	24	0,19%
conversion 3 1	4	0,03%
conversion 4 1	3	0,02%
conversion 3 2	3	0,03%
conversion 4 2	2	0,02%
conversion 4 3	16	0,13%
Total	***8028***	***63,3%***

Livestock farms	n	%
not conversion 1 1	4273	33,69%
not conversion 2 2	54	0,43%
not conversion 3 3	99	0,78%
not conversion 4 4	5	0,04%
conversion 1 2	4	0,03%
conversion 1 3	115	0,91%
conversion 1 4	2	0,02%
conversion 2 3	77	0,60%
conversion 2 4	0	0,00%
conversion 3 4	0	0,00%
conversion 2 1	12	0,09%
conversion 3 1	3	0,03%
conversion 4 1	0	0,00%
conversion 3 2	2	0,02%
conversion 4 2	1	0,01%
conversion 4 3	2	0,02%
Total	***4650***	***36,7%***

4. Potential ecological transformation



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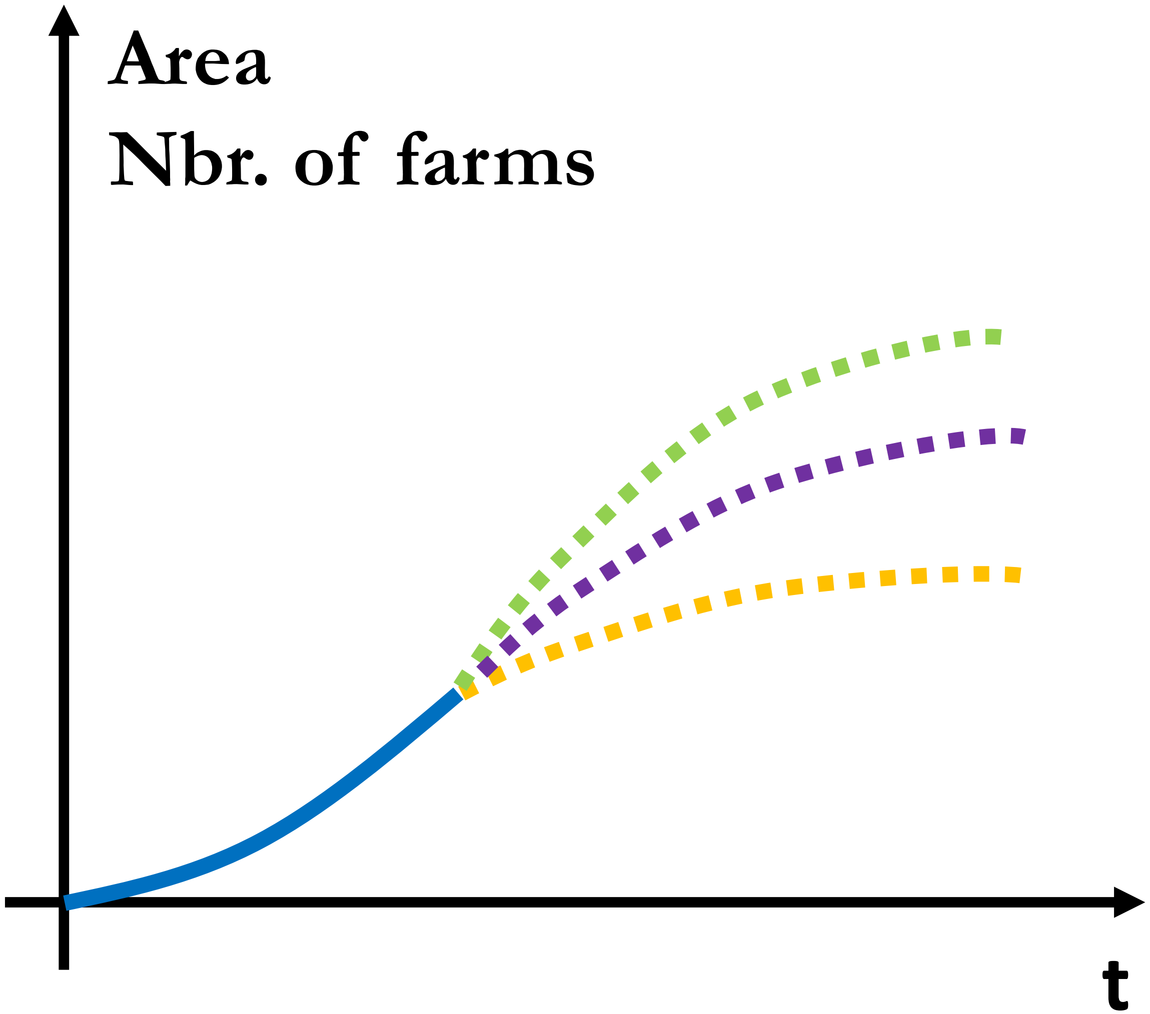

4. Potential ecological transformation

Two papers in progress:

- Paper 1: Forecast which farms will transition from conventional to organic/combined farming.
- Paper 2: Forecast the economic performance of farms transitioning to organic/combined.

First steps: Crop farms (period 2014-2021).

Supervised Machine Learning will be used for forecasting.

Forecasting methods: LASSO and RIDGE regression models.

THANKS FOR YOUR ATTENTION

Jesús Barreiro-Hurlé [1]
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[1] European Commission - Joint Research Center (Jesus.BARREIRO-HURLE@ec.europa.eu)
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