Monitoring Crop Diversity Across the EU from Space: New Copernicus Insights for Agricultural Policy

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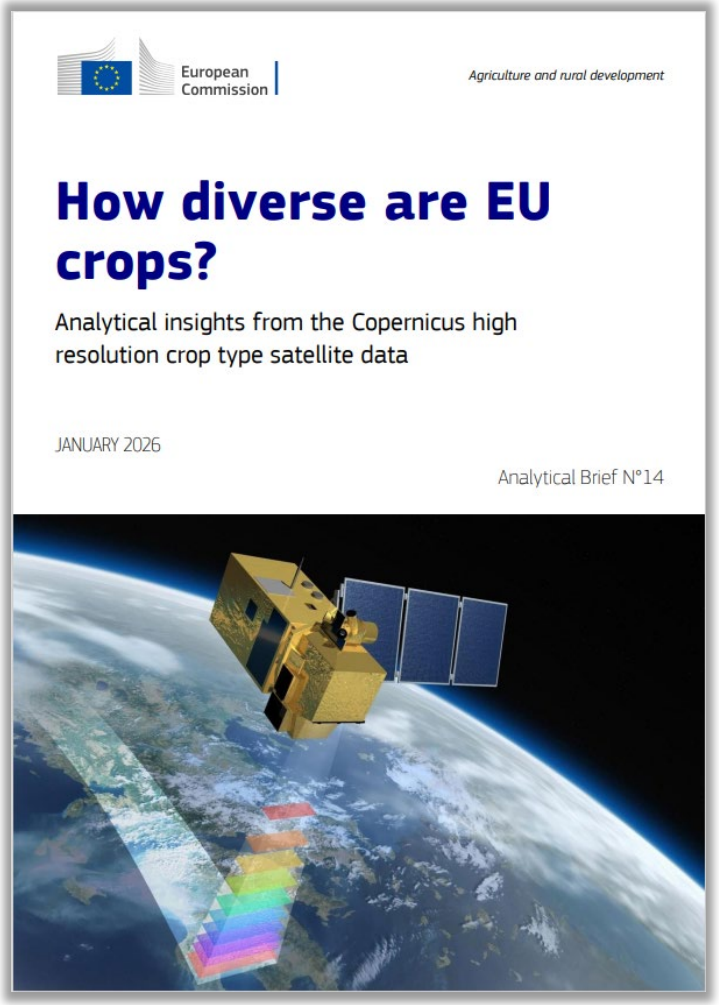
European Commission

Agricultural policy works mainly at farm level. EO brings the landscape context.

- **Crop diversity** plays a key role for stability of food production, reduce pesticide use, increase agroecosystem resilience and protect natural biodiversity in agroecosystems
- The Common Agricultural Policy mostly acts through **farm-level measures and obligations**.
- Existing crop diversity indicators rely mainly on **farm survey/statistical data**, such as the number of crops grown per holding.
- But a farm is not isolated: it is embedded in a **landscape shaped by climate, soils, markets and farming systems**.
- EO can answer a complementary question: **is a farm diverse or specialised compared with its surrounding region?**
- This is where Copernicus adds value: **turning crop maps into spatial context for policy indicators**.

A policy-relevant pilot using EO data

- Publication of the Analytical Brief N° 14: How diverse are EU crops?
- **Objective**: use Copernicus crop maps to provide a harmonised EU-wide view of crop diversity.
- Main **policy question**: where do we see diversified landscapes, specialised systems and persistent low-diversity areas?
- The work supports reflections on **CAP post-2027**, especially protective practices, crop rotation and diversification.
- Key message for StatEO: this is not only mapping, it is about **transforming EO products into policy-relevant indicators**.

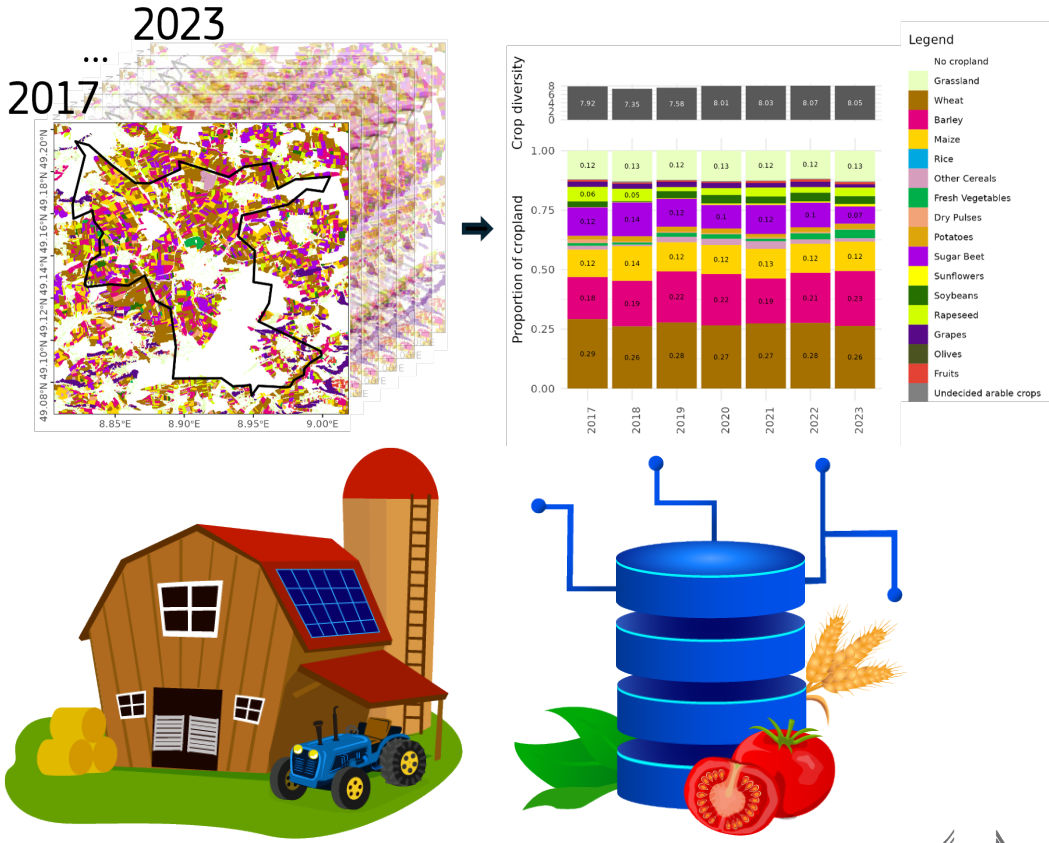


Story map

Copernicus provides the spatial layer that farm statistics survey cannot provide alone

- **Copernicus High Resolution Crop Type** layer (HRL-VLCC-CTY): EU-27, 10 m resolution, yearly data from 2017–2023.
  - Crop Type layer includes 19 crop classes, covering cereals, oilseeds, legumes, root crops, vegetables and permanent crops.
  - Grassland and herbaceous layers are added to build a wall-to-wall agricultural land mask.
- **Farm Sustainability Data Network** (FSDN) data are used to compare farm-level diversity with landscape-level diversity.

→ connect farm behaviour with regional agricultural context.



FSDN is the EU farm-level survey network, covering around 70 000 statistically representative farms that account for about 90% of EU production,

Method

- The metric is based on the effective number of crops, derived from a **Shannon diversity index**.
- It captures both crop **richness** and **evenness**: not only how many crops exist, but how dominant one crop is.
- The indicator is computed across grids and administrative units, from local to regional scale
- This allows comparison between **farm-level** diversity and l**andscape-level** diversity.
- Important distinction: this measures landscape crop diversity, not crop rotation on individual farms.
- Apply the same method to **FSDN farm-level data**

Alpha diversity (α) = local diversity

Gamma diversity (γ) = regional diversity

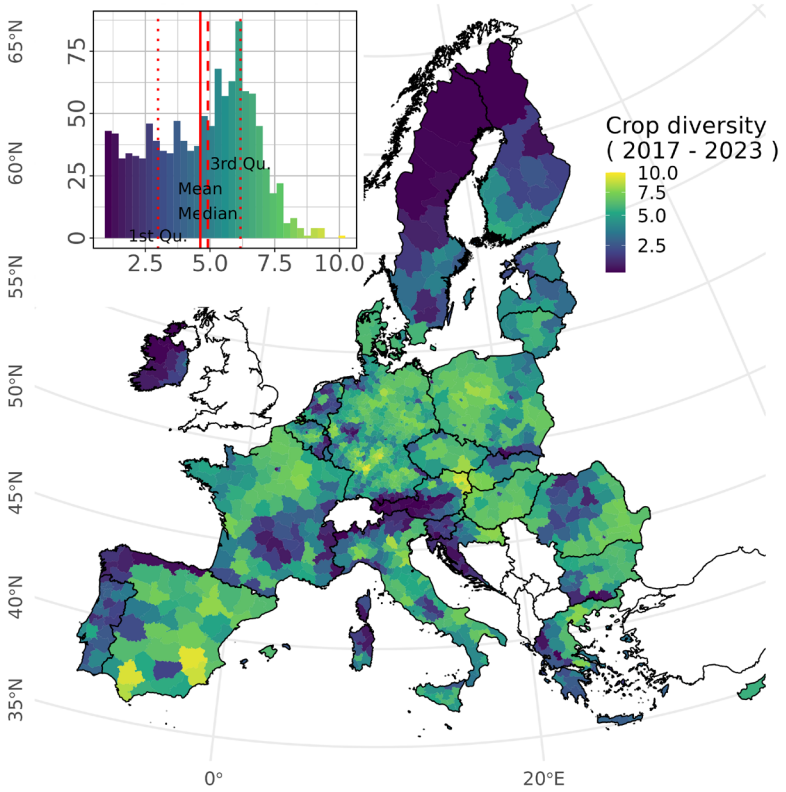
Beta diversity $(\beta) = \frac{\gamma}{\alpha}$

Inter-ecosystems diversity

Following Machefer & Zampieri et al., 2024; extended to 7 years and 19 crop types (Iordanov et al., in prep.).

EU crop diversity is moderate, but spatially very uneven

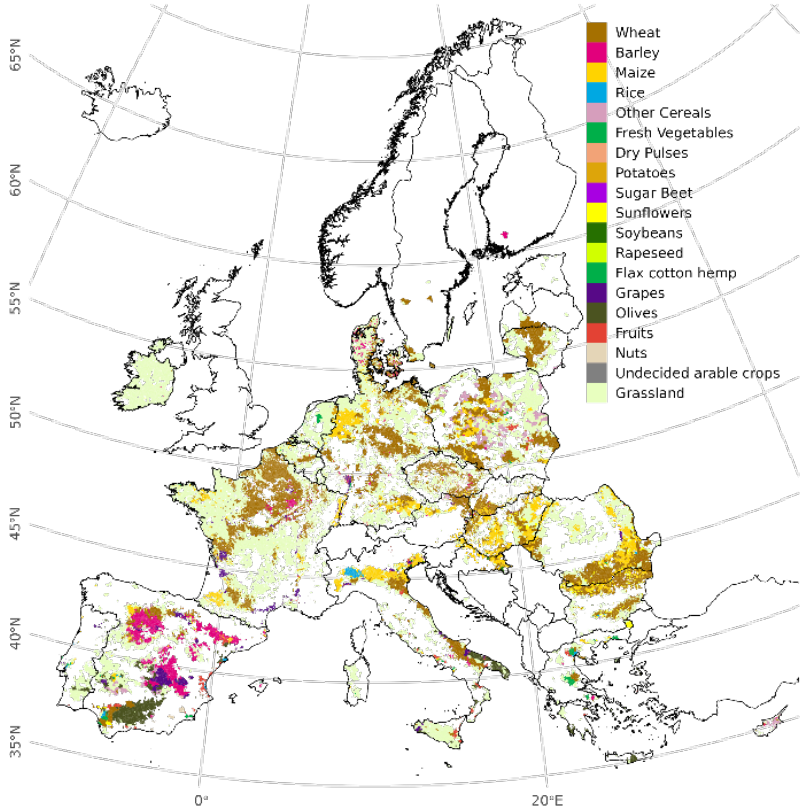
- Across NUTS3 regions, average crop diversity is about **4.6 effective crop types**.
- Higher diversity is found in areas such as **South-East France, Central Italy, North-East Spain, southern Germany and western Poland**.
- Lower values appear in more specialised regions, including **grassland-dominated, mountain or permanent-crop systems**.
- Low crop diversity does **not automatically mean poor environmental performance**.
- Interpretation requires context: **grassland, olives, vineyards and arable monocropping tell different stories**.



Crop diversity distribution across NUTS3 (2017–2023 average)

Grassland and cereals are the most represented crops

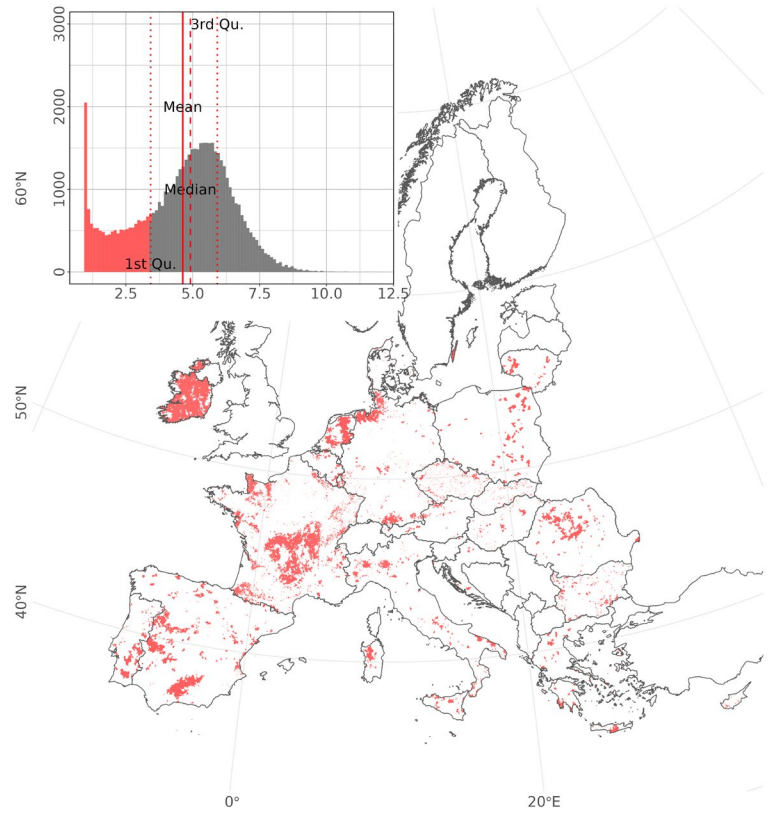
- At local level, **grassland is the dominant land use in around half of agricultural municipalities**.
- Cereals dominate many arable regions, especially **wheat, maize and barley**.
- Permanent crops such as **grapes and olives** create strong regional specialisation in southern Europe.
- The dominant crop map helps distinguish **natural specialisation** from **potentially problematic simplification**.
- This is essential for policy: the same diversity value can mean **very different agricultural realities**.



Map of Most Represented Crop (MRC) which is the dominant crop in the region

The policy challenge is to distinguish risk areas from legitimate specialisation

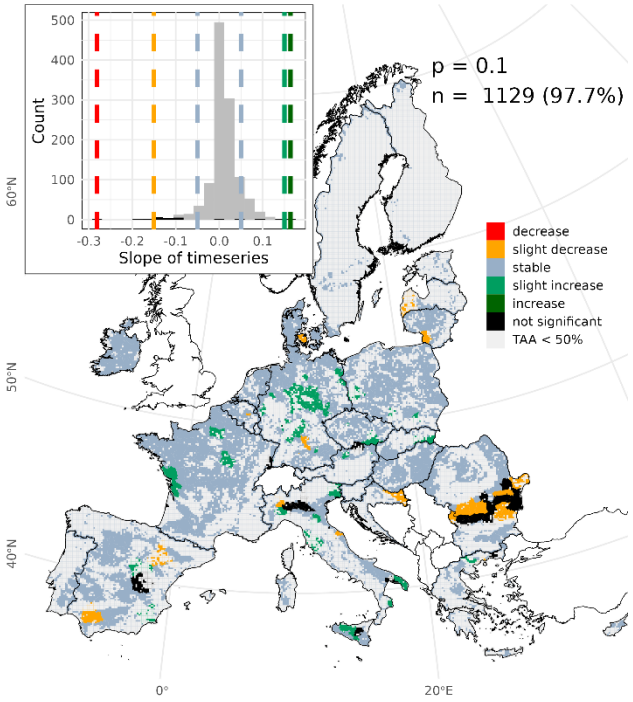
- Low-diversity landscapes include both **grassland/permanent-crop systems** and **large-scale arable systems**.
- In grassland regions, low crop diversity may reflect **valuable livestock landscapes and ecosystem services**.
- In arable regions, low diversity may point to **limited rotation, pest pressure, soil risks or lower resilience**.
- EO helps identify where low diversity is **persistent, spatially concentrated and potentially policy-relevant**.
- The key is not to label all low-diversity areas as “bad”, but to **target interpretation and action**.



LAUs with fewer than 3.4 crop types in 2023, indicating low crop diversity

Low diversity areas are decreasing

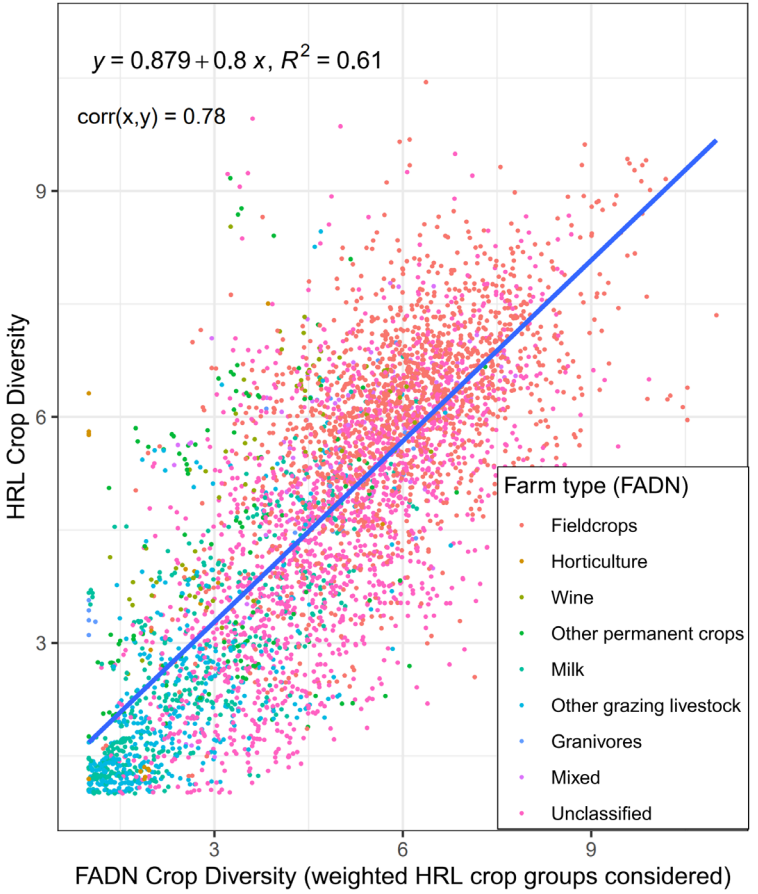
- From 2017 to 2023, low-diversity agricultural areas decreased by about **2.8% at EU level**.
- Most regions remain relatively stable, but local hotspots of increase and decrease are visible.
- Changes may reflect **markets, climate shocks, structural change or policy incentives**.
- Example: drought can temporarily modify crop choices, as seen in specialised systems such as rice areas.
- This shows why policy indicators need **consistent historical EO time series**, not only one-off maps.



Change in crop diversity at NUTS3 level (2017–2023), classified into five trend categories

Linking landscape diversity with farm-level data

- **Strong overall alignment** between EO landscape-level diversity and farm-level FSDN crop diversity aggregated at regional level.
- Differences are expected and useful: Copernicus captures the **mix of crops in the surrounding landscape**, while FADN/FSDN captures **what farms actually grow and manage**.
- Some divergences appear in specialised systems (**vineyards, horticulture and permanent crops)**
- The evolution from **FADN to FSDN** opens new opportunities to analyse not only economic performance, but also **environmental and social dimensions of farm sustainability**.
- Interoperability with **IACS geospatial data** could allow farm-level records to be linked with parcel and landscape indicators, creating a powerful bridge between **farm management, spatial context and policy monitoring**.



Relationship between crop diversity from landscape-level data (Copernicus) and farm-level data (FADN), by NUTS3 region

Perspectives

Sharpening the indicator: ongoing JRC research *(Iordanov et al., in prep.).*

- Grassland split into **temporary vs permanent** fractions
- **Linear Mixed Models** to disentangle trends and drivers
- **Structural stability**: persistently high/low diversity from a 3-year rolling window
- **Taylor's power law** linking diversity to its inter-annual variance
- **β-diversity** repurposed as a national spatial heterogeneity index

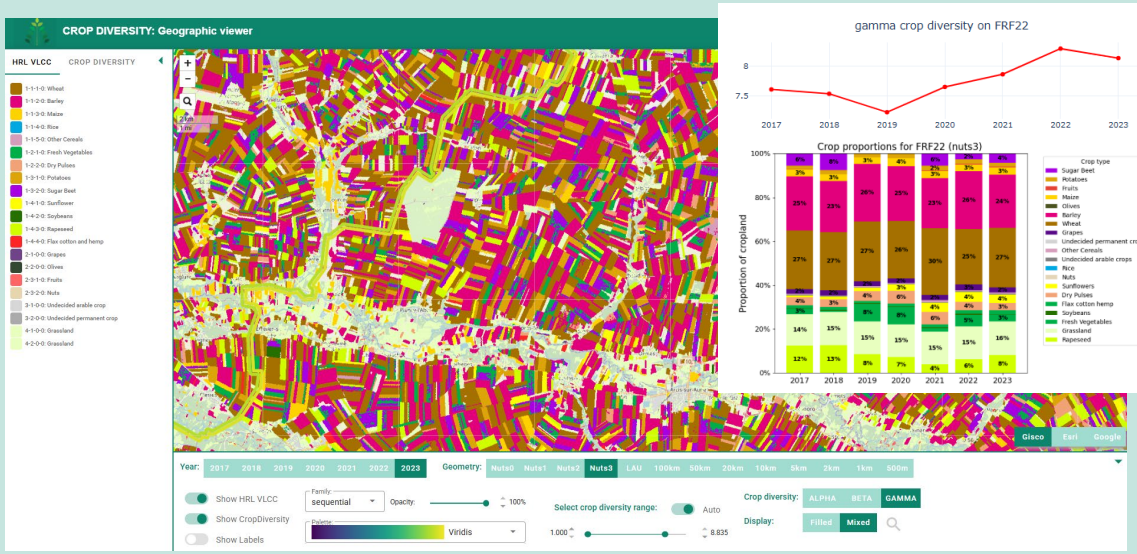
What is needed to move from pilot analysis to operational indicators?

- **Stable time series**: reprocessing historical years is essential when product quality improves.
- **Methodological standards**: scale, aggregation, crop grouping and grassland treatment must be harmonised.
- **Integration with farm statistics**: EO should complement, not replace, survey and administrative data.
- **Clear governance**: who produces, validates and maintains EO-derived policy indicators?

Conclusions

- Copernicus enables the first **harmonised, multi-year, EU-wide view of crop diversity at landscape scale**.
- EO adds the missing context to farm-level policy indicators: **where a farm is located matters**.
- The indicator helps identify **diverse landscapes, specialised systems and potential low-diversity hotspots**.
- Its policy value depends on **quality, stability, standards and governance**.
- Final message: **maps become powerful when they become trusted indicators for decisions**.

Thank you



[Data dashboard]

[Story map]