Copernicus for CAP eco-schemes

The EU's Common Agricultural Policy (CAP) introduced the idea of "eco-schemes" in its 2023–2027 reform as a central tool to promote more sustainable farming. **Eco-schemes are voluntary programs that reward farmers who adopt environmentally friendly practices that go beyond basic legal requirements. They aim to encourage a transition towards climate-smart, biodiversity-enhancing, and resource-efficient agriculture while maintaining farm income support.**

Each EU member state chooses its own set of eco-schemes within the overall CAP framework, tailoring soil health, water quality, carbon sequestration, and wildlife conservation according to local needs. **Examples of eco-scheme measures include maintaining permanent grasslands, planting cover crops, reducing pesticide and fertilizer use, establishing pollinator habitats, and practicing organic or agroecological farming. The full list of eligible eco-scheme practices are available here.**

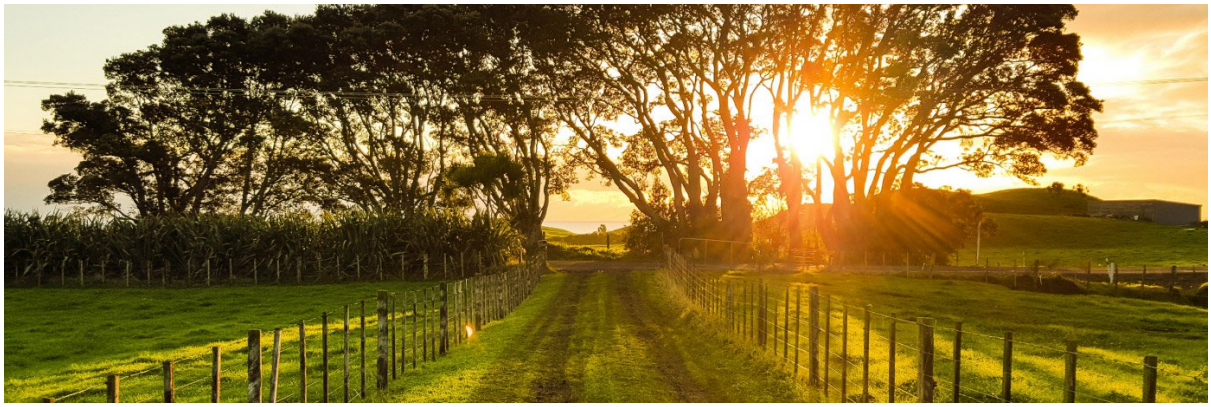

Image source: https://eu-cap-network.ec.europa.eu/index_en

Monitoring of CAP eco-schemes by paying agencies is a crucial part of ensuring that farmers comply with the environmental commitments attached to their payments. **The European Commission requires member states to have robust systems to verify that the supported practices are implemented and maintained. Paying agencies primarily monitor eco-schemes through a combination of administrative checks, on-the-spot inspections, and increasingly, digital monitoring tools such as satellite data and geo-tagged photos.** Administrative checks are often cross-referenced with geospatial data in the Integrated Administration and Control System (IACS), which includes the Land Parcel Identification System (LPIS) — a digital map database of agricultural land.

A major innovation in recent CAP reforms is the use of Area Monitoring Systems (AMS), which rely on satellite imagery from the EU's Copernicus program (and alternative data sources) to monitor agricultural activities continuously throughout the year. These systems allow paying agencies to detect practices such as mowing, ploughing, bare soil maintenance, or crop cover changes automatically and in near real time.

Image source: https://eu-cap-network.ec.europa.eu/news/estimating-climate-change-mitigation-potential-eus-cap-strategic-plans_en

This page lists all eco-scheme practices that are currently monitorable (in whole or in part) via the use of Earth Observation (EO) data. Here we focus primarily on the application of Copernicus data in eco-scheme monitoring. Commercial data sources are, of course, also applicable and can be used alone or in conjunction with Copernicus data.

For each relevant eco-scheme practice, we provide a concise overview of **the most relevant Sentinel data, indices derived from EO data, data processing techniques, markers, future Copernicus missions and common challenges experienced when applying EO data.** It should be noted that the information listed is not exhaustive, with more indices, techniques, markers etc. also being applicable. Here we try to list the most relevant and commonly used elements in eco-scheme monitoring. The eco-scheme practices themselves are grouped by common theme, as per the European Commission taxonomy.

Image source: https://eu-cap-network.ec.europa.eu/news/estimating-climate-change-mitigation-potential-eus-cap-strategic-plans_en

The information presented has been synthesised from consultation interviews with relevant stakeholders and responses gathered from various Paying Agencies via a survey which investigated common applications of EO data and challenges faced in the monitoring of eco-schemes.

	Eco-scheme practices	Sentinel-1	Sentinel-2	Sentinel-3	Normalized Difference Vegetation Index (NDVI)	Leaf Area Index (LAI)	Bare Soil Index (BSI)	Moisture Stress Index (MSI)	Normalized Difference Moisture Index (NDMI)	Time-Series Analysis	Object Based Image Analysis (OBIA)	Data/Multisensor Fusion	Phenological and Productivity Metrics	Soil Moisture Analytics	Machine Learning / AI	Land cover marker	Crop type marker	Bare soil marker	Mowing marker	Artificial surfaces marker	Tillage event marker	Burning event marker	Harvesting marker	Homogeneity marker	Copernicus Hyperspectral Imaging Mission for the Environment (CHIME)	Copernicus Land Surface Temperature Monitoring (LSTM)	Copernicus Radar Observation System for Europe at L-band (ROSE-L)	Relevant Sentinel(s)	Relevant Indices	Relevant data processing techniques	Relevant markers	Relevant Future Copernicus Missions	Typcial challenges / Minimum Monitorable Feautures, variables or activties
Organic farming practices (as defined in Regulation (EU) 2018/848)	Conversion to organic farming		✓		✓	✓	✓			✓		✓	✓	✓	✓	✓	✓						✓	✓								**Parcel Size and Shape** o Small, narrow, fragmented, and irregular parcels (<0.2 ha) are hard to detect. o Boundary detection near forests problematic, hedges, or wooden strips complicate monitoring. **Spatial Resolution Limitations** o Sentinel imagery resolution too coarse for small features and detailed practices. **Specific Activities Hard to Monitor** o Many organic practices (e.g., input use, crop protection) are not directly observable usin EO data. o Certain compliance aspects (e.g. no prohibited inputs) are difficult to monitor **Environmental and Technical Constraints** o Cloudy periods reduce data reliability. o Snow interrupts vegetation curves. o Grazing/mowing detection not reliable. o Soil monitoring limitations in case of permanent crops.
	Maintenance of organic farming		✓		✓	✓	✓			✓	✓		✓	✓	✓	✓							✓	✓								
Integrated Pest Management practices	Buffer strips with management practices and without pesticide	✓	✓		✓					✓	✓		✓	✓									✓	✓		✓					✓	**Parcel Size and Shape** o Small, narrow, fragmented, and irregular parcels (<0.2 ha) are hard to detect. o Boundary detection near forests problematic, hedges, or wooden strips complicate monitoring. o Difficulty monitoring biodiversity measures due to fragmented/irregular parcels. **Vegetation and Crop Complexity** o Complex/mixed vegetation, herb-rich grasslands, and buffer strips give inconsistent signals. **Spatial Resolution Limitations** o Sentinel imagery resolution too coarse for small features and detailed practices. **Specific Activities Hard to Monitor** o Absence of pesticide use difficult to monitor o Species composition and biodiversity value dificult to monitor directly **Environmental and Technical Constraints** o Cloudy periods reduce data reliability. o Snow interrupts vegetation curves. o Mowing monitoring not reliable o Difficulty in monitoring plant protection product, fertilizer, or enhancer application.
	Land lying fallow with species composition for biodiversity purpose		✓		✓		✓				✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓							✓	
Agro-ecology	Crop rotation with leguminous crops		✓		✓	✓	✓				✓		✓	✓	✓	✓					✓	✓	✓	✓							✓	**Parcel Size and Shape** o Small, narrow, fragmented, and irregular parcels (<0.2 ha) are hard to detect. o Boundary detection near forests problematic, hedges, or wooden strips complicate monitoring. **Vegetation and Crop Complexity** o Complex/mixed vegetation, herb-rich grasslands, and buffer strips give inconsistent signals. o Difficult to detect vegetation cover in permanent crops. **Spatial Resolution Limitations** o Sentinel imagery resolution too coarse for small features and detailed practices. o Monitoring of grazing and manure application can be dificult. o Localized agrotechincal processes difficult to monitor **Specific Activities Hard to Monitor** o Mixed croppings creates complex spectral signals, making reliable crop identification and monitoring difficult o Distinguishing between cover crop species and natural vegetation is difficult o Too short of a catch crop period may mean the presence of the catch crops goes undetected, particularly in cloudy periods. **Environmental and Technical Constraints** o Cloudy periods reduce data reliability. o Snow interrupts vegetation curves. o Soil monitoring limitations in case of permanent crops.
	Mixed cropping - multi cropping		✓		✓	✓	✓				✓		✓	✓	✓	✓					✓	✓	✓	✓							✓	
	Cover crop between tree rows on permanent crops - orchards, vineyards, olive trees - above conditionality		✓		✓	✓	✓			✓	✓		✓	✓	✓	✓							✓	✓							✓	
	Winter soil cover and catch crops above conditionality		✓		✓		✓	✓	✓	✓		✓	✓	✓	✓	✓							✓	✓							✓	
	Improved rice cultivation to decrease methane emissions (e.g. alternate wet and dry techniques)	✓	✓		✓	✓	✓			✓	✓	✓	✓	✓	✓	✓							✓	✓							✓	
Agro-forestry	Establishment and maintenance of landscape features above conditionality	✓	✓		✓		✓			✓	✓		✓	✓		✓							✓	✓							✓	**Parcel Size and Shape** o Small, narrow, fragmented, and irregular parcels (<0.2 ha) are hard to detect. o Boundary detection near forests problematic, hedges, or wooden strips complicate monitoring. **Vegetation and Crop Complexity** o Complex/mixed vegetation,trees, herb-rich grasslands, and buffer strips give inconsistent signals. **Spatial Resolution Limitations** o Dificulty in monitoring smaller landscape features (isolated trees, hedges, or wooden strips) and/or combinations of different adjacent landscape features. **Environmental and Technical Constraints** o Cloudy periods reduce data reliability. o Snow interrupts vegetation curves.
	Management and cutting plan of landscape features	✓	✓		✓					✓	✓		✓	✓			✓						✓	✓							✓	

	Eco-scheme practices	Sentinel-1	Sentinel-2	Sentinel-3	Normalised Difference Vegetation Index (NDVI)	Leaf Area Index (LAI)	Bare Soil Index (BSI)	Moisture Stress Index (MSI)	Normalised Difference Moisture Index (NDMI)	Time Series Analysis	Object Based Image Analysis (OBIA)	Data Multisensor Fusion	Phenological and Productivity Metrics	Soil Moisture Analytics	Machine Learning / AI	Land cover marker	Crop type marker	Bare soil marker	Mowing marker	Artificial surface marker	Tillage event marker	Burning event marker	Harvesting marker	Homogeneity marker	Copernicus Hyperspectral Imaging Mission for the Environment (CHIME)	Copernicus Land Surface Temperature Monitoring (LSTM)	Copernicus Radar Observation System for Europe at L-band (ROSE-L)	Typcial challenges / Minimum Monitorable Feautures, variables or activties
		Relevant Sentinel(s)			Relevant Indices					Relevant data processing techniques					Relevant markers										Relevant Future Copernicus Missions			
High nature value (HNV) farming	Land lying fallow with species composition for biodiversity purpose (pollination, birds, game feedstocks, etc.)		✓		✓	✓				✓		✓		✓	✓	✓		✓		✓	✓				✓	✓			**Parcel Size and Shape** o Small, narrow, fragmented, and irregular parcels (<0.2 ha) are hard to detect. o Boundary detection near forests problematic, hedges, or wooden strips complicate monitoring. **Vegetation and Crop Complexity** o Complex/mixed vegetation, herb-rich grasslands, and buffer strips give inconsistent signals. **Specific Activities Hard to Monitor** o Application of fertilizers difficult to detect o Detection of mowing in species-rich grasslands is difficult. o Monitoring extensive/partial grazing is difficult as vegetation changes are subtle. o Species composition and biodiversity value difficult to observe directly. **Environmental and Technical Constraints** o Cloudy periods reduce data reliability. o Snow interrupts vegetation curves.
	Reduction of fertiliser use, low intensity management in arable crops		✓		✓	✓				✓		✓		✓	✓	✓			✓			✓	✓					
Carbon farming	Conservation agriculture		✓		✓	✓				✓				✓	✓				✓			✓	✓					**Parcel Size and Shape** o Small, narrow, fragmented, and irregular parcels (<0.2 ha) are hard to detect. o Boundary detection near forests problematic, hedges, or wooden strips complicate monitoring. **Vegetation and Crop Complexity** o Complex/mixed vegetation, herb-rich grasslands, and buffer strips give inconsistent signals. **Specific Activities Hard to Monitor** o Application of manure, fertilizers, pesticides, crop yield enhancers difficult to detect o Minimum cultivation techniques (minimal tillage, residue retention) are difficult to detect and monitor. **Single-Day or Short-Term Events** o Mowing, tillage, and harvest often missed if no satellite pass that day. o Detection of grazing can be difficult (NDVI changes too small). **Environmental and Technical Constraints** o Cloudy periods reduce data reliability. o Snow interrupts vegetation curves.
	Establishment and maintenance of permanent grassland		✓		✓	✓				✓				✓	✓		✓		✓			✓	✓					
	Extensive use of permanent grassland		✓		✓	✓				✓		✓		✓	✓		✓		✓	✓		✓	✓					
Precision farming	Nutrients management plan, use of innovative approaches to minimise nutrient release, optimal pH for nutrient uptake, circular agriculture		✓		✓					✓				✓	✓							✓	✓	✓	✓			**Parcel Size and Shape** o Small, narrow, fragmented, and irregular parcels (<0.2 ha) are hard to detect. o Boundary detection near forests problematic, hedges, or wooden strips complicate monitoring. **Vegetation and Crop Complexity** o Complex/mixed vegetation, herb-rich grasslands, and buffer strips give inconsistent signals. **Specific Activities Hard to Monitor** o Application of manure, fertilizers, pesticides, crop yield enhancers difficult to detect o Monitoring precision livestock farming practices, like grazing intensity at parcel level dificult to monitor o Difficult to monitor fine-grained practices (variable-rate applications, detailed field operations). **Environmental and Technical Constraints** o Cloudy periods reduce data reliability. o Snow interrupts vegetation curves.
	Precision crop farming to reduce inputs (fertilisers, water, plant protection products)		✓		✓			✓	✓	✓				✓	✓							✓	✓	✓	✓			
	Improving irrigation efficiency	✓	✓		✓		✓	✓	✓	✓			✓	✓	✓		✓		✓			✓	✓	✓	✓			
Protecting water resources	Managing crop water demand (switching to less water intensive crops, changing planting dates, optimised irrigation schedules)	✓	✓	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓					✓	✓	✓	✓			**Parcel Size and Shape** o Small, narrow, fragmented, and irregular parcels (<0.2 ha) are hard to detect. o Boundary detection near forests problematic, hedges, or wooden strips complicate monitoring. **Specific Activities Hard to Monitor** o Optimised application of water difficult to detect o Nutrient leaching or fertilizer runoff difficult to detect **Environmental and Technical Constraints** o Cloudy periods reduce data reliability. o Snow interrupts vegetation curves.
Other practices beneficial for soil	Erosion prevention strips and wind breaks	✓	✓		✓		✓			✓	✓			✓	✓		✓					✓	✓		✓			**Parcel Size and Shape** o Small, narrow, fragmented, and irregular parcels (<0.2 ha) are hard to detect. o Boundary detection near forests problematic, hedges, wooden or stony strips complicate monitoring. **Spatial Resolution Limitations** o Sentinel imagery resolution too coarse for small features and detailed practices. o Distinguishing between permanent vegetation covers (grasses, cover crops, legumes) and wind break features is resolution-limited. **Environmental and Technical Constraints** o Cloudy periods reduce data reliability.
	Establishment or maintenance of terraces and strip cropping	✓	✓		✓		✓			✓	✓			✓	✓		✓					✓	✓		✓			