Approccio integrato all'agricoltura di precisione nella moderna azienda cerealicola pugliese
Acronimo: AdP4Durum

Modulo 4 LA SOSTENIBILITÀ AMBIENTALE ED ECONOMICA

Incontro 1 Uso di indicatori di sostenibilità: dati necessari per ottenere valutazioni utili a quantificare l'eco-sostenibilità delle produzioni

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Technical Guidance Handbook

Setting up and implementing result-based carbon farming mechanisms in the EU

Action-based carbon farming: a scheme where a farmer or landowner receives a payment for implementing defined management actions, independently of the resulting impact of those actions.

Result-based carbon farming: a scheme where a farmer or landowner receives a payment for reducing net GHG fluxes from their land, whether that is by reducing their GHG emissions or by sequestering and storing carbon. A result-based approach requires a direct and explicit link between the results delivered (e.g. GHG emissions avoided or carbon sequestered) and the payments that the land manager receives. It differs from the more familiar action-based schemes, where the farmer is paid for complying with very specific farming practices or technologies, which have been selected by the managing authority for the assumed climate mitigation benefits.

Farm carbon audit tool (audit tool): a computer model that calculates a farm's Greenhouse Gas (GHG) emissions and/or carbon sequestration based on input data that summarise the farm's management others. They can also calculate other outputs, including sustainability indicators such as nutrient runoff or emissions intensity.

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Result based payments richiedono misure e indicatori

EU farmers have long been offered incentives to improve their farming practices and safeguard the environment, for example through agri-environment-climate payments and environmental investment support co-financed by Pillar 2 of the CAP. These incentives are commonly *action-based payments* for compliance with very specific farming practices or technologies which have been selected by the managing authority for the assumed environmental benefits. Few schemes or projects have offered *result-based payments*, where the incentive payment is linked to measured outcomes on the farm, irrespective of the precise farming practices that are applied.

5.4. Monitoring, Reporting and Verification (MRV)

Monitoring, reporting, and verification (MRV) refers to how participants' climate actions and GHG emissions are reliably measured, how they are required to report these to authorities, and how authorities verify their accuracy. MRV is integral to result-based carbon farming schemes, as it is the step that quantifies the impact of climate actions, i.e. the result.

Monitoring refers to the quantification of GHG emissions or removals, and includes collection of data as well as calculation methods.

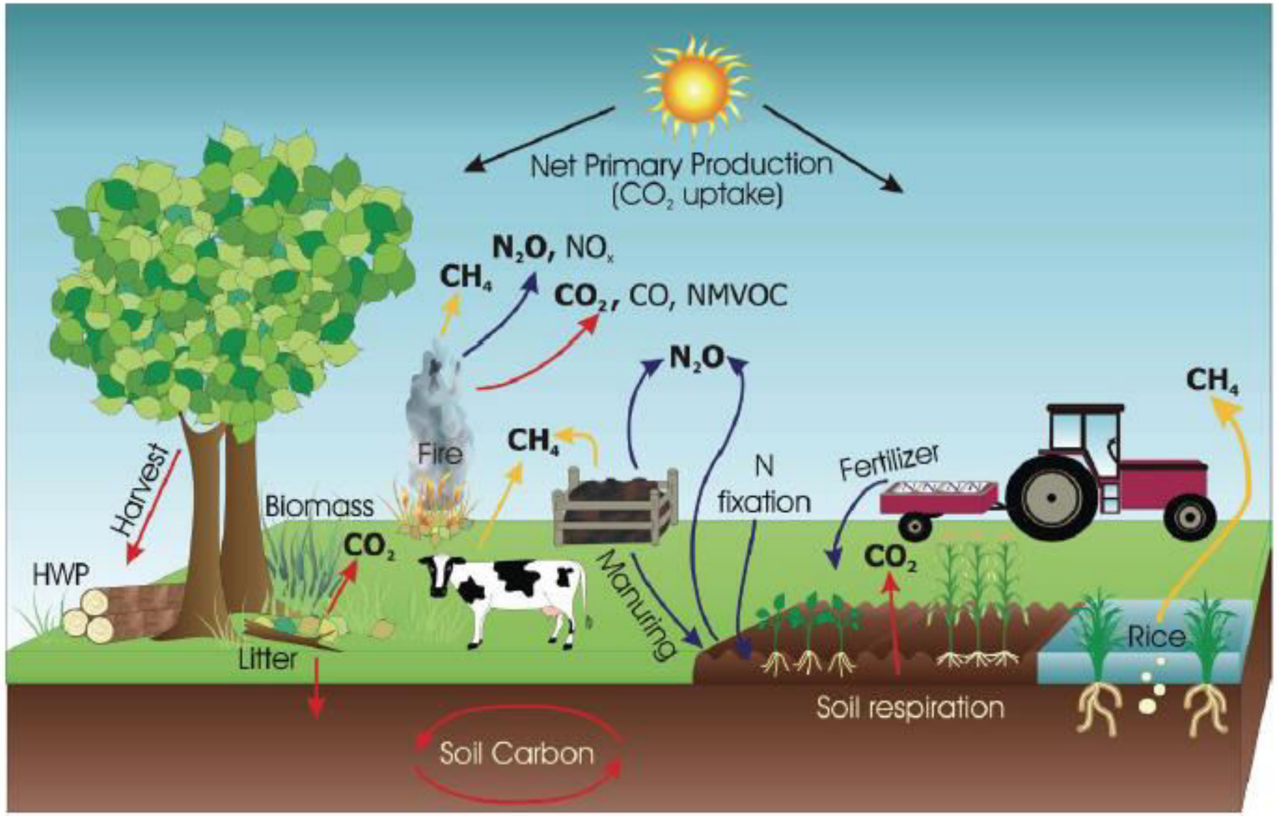
Reporting establishes how participants are required to record and communicate monitoring data to relevant authorities and/or government entities.

Verification refers to the process of establishing the truthfulness and accuracy of reporting.

2.1. What is carbon farming?

Carbon farming refers to the management of carbon pools, flows and GHG fluxes at farm level, with the purpose of mitigating climate change. This involves the management of both land and livestock, all pools of carbon in soils, materials and vegetation, plus fluxes of carbon dioxide (CO_2) and methane (CH_4), as well as nitrous oxide (N_2O) (which is included among relevant fluxes of GHGs in the agricultural sector by the Intergovernmental Panel on Climate Change (IPCC) and therefore is considered part of carbon farming). This is illustrated in Figure 1.

Figure 1 The main greenhouse gas emission sources/removals and processes in managed farmland



Non-methane volatile organic compounds (NMVOC) emissions

Misurare attività di carbon farming

Alongside the scale of climate mitigation benefits, this study has identified a series of other factors that should be considered when assessing potential carbon farming schemes. These are:

- **permanence** of the carbon pool and GHG emission reductions (and level of reversal risk through changes in land management or catastrophic events such as fire);
- **additionality**, which is particularly important when emission reductions are used as offsets. Additionality means that the scheme produces desirable results that would not have happened without it;
- **risk of carbon leakage** or displacement of an activity or land use that is limited by a scheme to another location, where it leads to increased emissions;
- **uncertainty** of the accuracy or reliability in the measurement of results due, for example, to errors, lack of data, modelling assumptions or estimations of future values.

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Dove fare carbon farming

The case studies examine five key thematic areas, analysing the potential for using result-based carbon farming payments in an EU context: peatland restoration and rewetting; agroforestry; maintaining and enhancing soil organic carbon (SOC) in mineral soils; managing SOC on grasslands; and livestock farm carbon audit.

Type of scheme	**Proxy measures**
Grasslands	Registered farm activities for which the potential for increasing carbon storage is known – basing the estimated carbon storage of these activities
	Enhanced biodiversity
	Increased water holding capacity
	Permanent ground cover
	Non-disturbance of soil and ground cover
Peatlands	Water table height, e.g. centimetres below surface
	Vegetation, i.e. abundance and status of certain peatland specific species
	Land use, e.g. grazing, arable, fallow, paludiculture, forest
	Subsidence (mainly used in tropical settings)
Agroforestry	Above ground biomass of woody vegetation (which in turn has to be estimated from simpler measurements such as tree diameter at breast height)
Livestock farm carbon audit	Different carbon audit tools require different input data, which together are used to calculate the climate mitigation impact. These input data generally include the following: ▪ Number and type of animals ▪ Herd management practices ▪ Type and amount of feed ▪ Fuel and electricity inputs ▪ Manure management practices ▪ Crop management practices

Azioni per fare carbon farming

Table 1 Examples of mitigation actions at farm level to manage carbon and GHG fluxes, identified to be relevant within the EU context

Group	Mitigation actions
Land Use	Conversion of arable land to grassland to sequester SOC
	New agroforestry
	Wetland/peatland conservation/restoration
	Woodland planting
	Preventing deforestation and removal of farmland trees
	Management of existing woodland, hedgerows, woody buffer strips and farmland trees
Cropland Management	Improved crop rotations
	Reduced and minimum tillage
	Leaving crop residues on the soil surface
	Ceasing to burn crop residues and vegetation
	Use of cover/catch crops
Livestock Management	Livestock health management
	Use of sexed semen for breeding dairy replacements
	Choosing breeds with lower methane emissions
	Feed additives for ruminant diets
	Optimised feeding strategies for livestock
Nutrient and Soil management	Soil and nutrient management plans
	Improved nitrogen efficiency
	Biological N fixation in rotations and in grass mixes
	Improved on-farm energy efficiency

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Problemi strutturali e metodologici carbon farming

Table 2 Applying the initial feasibility assessment process to the five carbon farming case studies

Case study	Peatland restoration and rewetting	Agroforestry	Maintaining and enhancing SOC in mineral soils	Livestock farm carbon audit	Managing SOC on Grasslands
Climate mitigation potential	At EU level, mitigation potential of between 0.3 and 3 $GtCO_2eq/yr$ from restoration and conversion of drained, degraded peatlands. Potential per ha is high.	Potential varies widely with type of system, soil/climate, tree species and density, and other local factors. EU level estimates range from 8 to 234.85 million tCO_2eq/yr.	EU farmland stores approximately 51 billion tCO_2eq in topsoil (equivalent to >10 times the annual EU emissions). Potential for additional C sequestration and need to maintain current stocks.	The livestock sector is responsible for 81% of EU agricultural emissions. Applying climate actions on EU livestock farms could potentially reduce their emissions by 12-30% by 2030.	Potential for additional C sequestration higher on degraded, overgrazed grasslands
Potential for result-based payment	Existing mechanisms all use avoided emissions as a metric. Land use, water table and vegetation are relevant indicators to classify land and estimate emission factors.	Indicators of carbon stored above ground in woody biomass available (e.g. Woodland Carbon Code). Measuring C below ground is difficult.	Two main approaches to monitoring SOC changes: measurement by sampling and estimation by modelling.	Farm Carbon Audit tools are suitable for result-based payments, but accuracy depends on parameterising tools to local conditions and on reliable input data (e.g. regarding farm management).	Two main approaches to monitoring SOC changes: measurement by sampling and estimation by modelling. Changes in biomass are subject to high fluctuations.
Cost-effective MRV	Yes, for land use, water table and vegetation indicators, using ground and/or aerial survey	Yes, but only for above ground woody biomass.	Not yet. Current costs of sampling and modelling are high and a key barrier to feasibility. Uncertainty of modelling at a granular scale is also high. Developments anticipated to reduce costs in future.	Yes, but scheme designers and participants must accept some degree of environmental uncertainty in the estimated emission reductions.	Not yet. Current costs of sampling and modelling are high and a key barrier to feasibility. Uncertainty of modelling at a granular scale is also high, due to spatial variations in SOC

Problemi strutturali e metodologici carbon farming

Case study	Peatland restoration and rewetting	Agroforestry	Maintaining and enhancing SOC in mineral soils	Livestock farm carbon audit	Managing SOC on Grasslands
Scalability	Result-based payment schemes not yet established, but potential mitigation benefits per ha are high.	Result-based payment schemes at pilot stage, but potential for adoption on all farming systems (except drained peatlands).	Costs and uncertainty of MRV for SOC undermine the cost- effectiveness of large scale result-based schemes.	On-farm climate actions can cost-effectively reduce livestock GHG emissions.	Costs and uncertainty of MRV for SOC undermine the cost- effectiveness of large scale result-based schemes.
Co-benefits	Biodiversity is greatest from full peatland ecosystem restoration. Flood peak reduction and improved water quality	Climate adaptation, biodiversity, soil health, water infiltration and income diversification	Soil health, water holding capacity, stability of yields, economic. Significant climate adaptation effects.	Depend on specific actions implemented but may include reduced N run-off, climate adaptation, lower costs.	Biodiversity, water quality and soil productivity.
Concerns	Potential carbon leakage, due to possible displacement of agricultural production; also concern about permanence, due to the reversibility of the changes.	Potential carbon leakage, due to possible displacement of agricultural production and also permanence, due to the reversibility of the changes.	Major concern is the high reversibility of any gains in SOC in mineral soils.	Negative externalities can also arise, with some specific actions. Scheme design should discourage these.	Reversibility of any gains in SOC, and timescale before significant changes can be detected. Arable conversion to grassland has potential risk of carbon leakage, due to possible displacement of production.

Indicatori per misurare impatto carbon farming

More detail on indicators and monitoring regimes is provided in sections 5.3 and 5.4 but at the initial feasibility stage it is useful to consider whether there is a methodology for measuring the impact of a carbon-farming scheme on net GHG emissions (measured in tonnes of CO_2eq) that could meet the following criteria for indicators used in result-based schemes.

Indicators used to reward land managers in result-based payment schemes should be:

- directly and robustly linked to the desired outcome at farm/plot scale;
- consistently measurable using a simple methodology;
- sensitive to changes in agricultural management within a reasonable time frame, but otherwise stable;
- unlikely to be influenced by external factors beyond the control of the land manager.

If there is an indicator or potential indicator that meets these criteria, then it is worth considering a result-based scheme.

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Indicatori e loro valore scientifico

A robust result indicator or set of indicators and the ability to monitor it/them in a cost-effective manner are central to the design of any result-based carbon farming scheme. A set of indicators can include both climate mitigation and co-benefit indicators, but the focus here is on indicators of climate mitigation because this is the main purpose of carbon farming.

a. CO_2eq reduction indicator(s) and data needed to operate these

Initial criteria for identifying a potentially suitable climate mitigation indicator are set out in section 3.3.1. If one or more indicators have been identified that meet these criteria, then at this stage they are worth investigating further. Questions to which it is desirable to find answers include:

Does the potential set of indicators measure the climate mitigation benefit in mtCO_2eq?

It should do so in accordance with current IPCC guidance, respecting the IPCC land categories and using the current IPCC Global Warming Potential (GWP) values relevant to each greenhouse gases, while taking note of any country specific or modelled emission factors.

Does the set of indicators also allow for measurement of the gas-specific impacts of the scheme (i.e. changes in mtCO_2, mtN_2O and mtCH_4)?

The EU is concerned about the impact of GHG emissions over a long period (100 years). Since different gases persist in the atmosphere for different periods, they may have different long-term impacts. Although a powerful greenhouse gas, the majority of atmospheric CH_4 dissipates relatively quickly, whereas CO_2 and N_2O do not.

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Does the indicator allow the emission intensity of agricultural output to be measured?

The EU wishes to maintain levels of food production, whilst reducing greenhouse gas emissions, so it is desirable to be able to measure the reduction in CO_2eq per unit of production, as well as the absolute level of reduction.

Can the cost-efficiency of mitigation be measured?

It is desirable to be able to evaluate the cost efficiency of the scheme in terms of €/mtCO_2eq. Ideally, this measurement should include both the costs of implementing the project and any change in income for farmers.

Can the climate mitigation benefits of the scheme be measured at farm level and aggregated?

Farm level measurements are central to any result-based carbon farming scheme, and it is desirable that they can be aggregated to the level of the scheme as a whole, and have a clear relation to regional and Member State level datasets required by the 2014-20 CAP Common Monitoring and Evaluation Framework and the proposed 2021-27 CAP Performance Monitoring and Evaluation Framework.

Indicatori e i loro costi (denaro e tempo)

Can any direct measurements needed at the farm level be done cheaply and reliably?

It is not often possible to directly measure changes in GHG emission at farm or land parcel level in a way that is cost-effective, so models are often used to convert measurements that can be made at farm level to changes in GHG emissions or carbon sequestration. It is important that any farm level measurements that are needed, for example the area over which management has been changed, or changes in levels of inputs, can be done cheaply and reliably and without unrealistic expectations of the farmers or their advisers. Such measurements may be done in the field, but the potential of remote sensing technology to supply these measurements is worth investigating.

How much time farmers will be prepared to use to measure and record the data required to calculate changes in GHG emissions will be influenced by many factors, including how much they are being paid. An unpublished study of farmers participating in a result-based biodiversity conservation pilots in the UK suggests that any time commitment greater than a total of one week per year is likely to be an obstacle to their participation.

Indicatori basate su stime e previsioni

How accurate, consistent, relevant and reliable are the models used to estimate changes in GHG emissions and sinks?

Where (as is often the case) direct measurement of changes in GHG emissions is not practical, then it is vital that the models used to convert the indirect or proxy measures to emission or sequestration impacts are consistent, reliable and have been calibrated and/or ground-truthed for the context in which they will be used. Modelling will almost always involve a compromise between certainty and cost. The quality of the data fed into the model and how accurately the model reflects conditions on each participating farm (granularity) will in large part determine the level of uncertainty in the results it produces. This may in turn affect the types of funding that it is possible to use.

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Misurare effetti secondari positivi del carbon farming

b. Co-benefit indicators

Some information on the potential co-benefits and any possible adverse impacts of the carbon farming scheme will have been gathered at the feasibility stage (see section 3.3.2). At this stage it is worth considering whether it is practical to extend the result-based approach to the co-benefits, or to assure these in other ways. For example, the scheme could be designed in a way that minimises negative externalities, eligibility requirements or conditions could be placed on participants, or the scheme could be linked to a separate scheme focused on co-benefits, such as biodiversity.

Many of the same considerations applying to climate mitigation indicators also apply to broader sustainability indicators.

Misurare effetti secondari positivi del carbon farming

3.3.2. Assessing co-benefits

It is also important to consider co-benefits at an early stage, since the response to climate change needs to be fully integrated with that to other pressing environmental and social issues, most notably the continuing decline of biodiversity across Europe and the need to adapt to climate change. As an example, Box 2 lists the main co-benefits identified for agroforestry and the retention of woody landscape features.

Box 2 Co-benefits identified in the agroforestry case study

Reduced soil erosion and nutrient leaching
Improved soil functionality and water infiltration
Diversified income streams for farm businesses
Improved animal welfare (shade and shelter)
Pollination services

In the case of long-established features and systems, the conservation of biodiversity and landscape character

EUROPEAN
COMMISSION

Brussels, 30.11.2022
COM(2022) 672 final

2022/0394 (COD)

Proposal for a

REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

establishing a Union certification framework for carbon removals

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Carbon farming - carbon removal

For the purposes of this Regulation, the following definitions apply:

(a) 'carbon removal' means either the storage of atmospheric or biogenic carbon within geological carbon pools, biogenic carbon pools, long-lasting products and materials, and the marine environment, or the reduction of carbon release from a biogenic carbon pool to the atmosphere;

Quantification

A carbon removal activity shall provide a net carbon removal benefit, which shall be quantified using the following formula:

Net carbon removal benefit = $CR_{baseline} - CR_{total} - GHG_{increase} > 0$

where:

(a) $CR_{baseline}$ is the carbon removals under the baseline;

(b) CR_{total} is the total carbon removals of the carbon removal activity;

(c) $GHG_{increase}$ is the increase in direct and indirect greenhouse gas emissions, other than those from biogenic carbon pools in the case of carbon farming, which are due to the implementation of the carbon removal activity.

In the case of carbon farming, $CR_{baseline}$ and CR_{total} shall be understood as net greenhouse gas removals or emissions in accordance with the accounting rules laid down in Regulation (EU) 2018/841.

Quantities referred to in paragraph 1, points (a), (b) and (c), shall be designated with a negative sign (-) if they are net greenhouse gas removals and with a positive sign (+) if they are net greenhouse gas emissions ; they shall be expressed in tonnes of carbon dioxide equivalent.

Carbon removals shall be quantified in a relevant, accurate, complete, consistent, comparable and transparent manner.

Carbon credits

How generete carbon credits?

1) **Decrease GHGs emission** with respect to a baseline scenario
2) **Stock C in soil** as stable organic matter
3) **Stock C in plant biomass**

How do it?

1) **DSSs** optimizes crop inputs & decreases GHGs emission
2) **Regenerative actions** increase soil carbon stock and biomass.

To get certified carbon credits, GHGs saved and C sequestered by regenerative actions must be compared with a standard cropping system (baseline), which is supposed to have deteriorate performance in terms of carbon cycle.

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Carbon credits (CCs) – How to exploit them

1. **Compensate emission of ETS Market** (sectors with mandatory emissions offset) → (CER – Certified Emission Reduction)
2. **Communicate commitment** to the environment
3. **Sell CCs** through international platforms

A carbon trade platform is a real or virtual room where buyers and sellers exchange CCs. Buyers, sellers and CCs record in a register.

Processes and costs involved:

1) Application of GAPs (DSS and regenerative agriculture);
2) Calculation of CCs;
3) Certification of the Project;
4) Registration on the CER exchanging platform.

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Carbon credit – Certification

Carbon markets can be broadly divided into two segments:

1. **Compliance markets**: driven by binding emission reduction targets (e.g. ETS) or other types of regulation (e.g. tax)
2. **Voluntary markets**: corporate or individual companies, which wish to offset their emissions ("voluntary offsetting")

Agriculture is currently involved into the voluntary credit market → **VER (Verified Emission Reduction).**

Carbon credit – Certification

- ✓ Projects to save/fix CO_2 must comply with ISO 14064 and be certified by a third-party certification body.
- ✓ Carbon credits generated by the Project are usually commercialized on the VER market through exchange platforms; VERs are used by organizations that voluntarily want to decrease/neutralize their carbon footprint. One VER is the equivalent of one ton of CO_2 equivalent reduction/stockage.
- ✓ A third party verifies if farmers actions are in compliance with project submitted and the CCs are real and permanent.

Carbon credit – Certification

CCs deriving from the Project must have following requirements:

✓ **Real**: its benefits in environmental terms are quantifiable and verifiable;

✓ **Permanent**: the effects in terms of reducing GHG emissions must not be temporary or transitory;

✓ **Attributable**: unambiguously attributable to the Project promoter;

✓ **Additional**: addition to the common (i.e., conventional) scenario.

Carbon credit – Regenerative agriculture

Regenerative actions to stock CO_2 in soil:

- use of cover/catch crops (as relay cropping/intercropping, double cropping);
- foster death mulching with crop and pruning residues;
- minimum (i.e., strip-till) or no-tillage;
- no inter-row tillage (in ochards)
- apply long rotation system (min. 4-year rotation);
- add pulses in rotation systems (i.e., chickpeas, lentil, peas, etc.);
- add organic improvers/biochar;
- agroforestry;
- complete grassing (in ochards).

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Carbon credit – Regenerative agriculture

Cover-crops

Ogni cover crop è studiata al fine di capire le sue **capacità ad ottenere un determinato obiettivo:**

1) Sequestrare **carbonio e aumentare la sostanza organica**
2) Fornire **azoto organico alla coltura successiva**
3) Riduzione **lisciviazione dell'azoto nei mesi in cui la coltura principale è assente**
4) Favorire il **drenaggio del suolo per evitare ristagni idrici**
5) Mantenere il **terreno ben strutturato e facilmente transitabile anche in mesi umidi**
6) Ostacolare la perdita di suolo per **erosione**
7) Limitare lo sviluppo delle **infestanti nei mesi in cui è assente la coltura principale**
8) Favorire la presenza di **specie vegetali mellifere per insetti impollinatori**
9) Produrre **foraggio tra due colture principali (ricaccio)**
10) Produrre biomassa in terreni ad alto livello di **salinità**
11) Preservare **l'umidità del suolo grazie all'effetto copertura garantito dai residui colturali**
12) Attività **biocida**
13) Adattabilità alla **trasemina**

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Carbon credit – Regenerative agriculture

Cover-crops

AREALE

Le cover crop non si prestano ad una coltivazione in tutti gli areali.

Ad ogni cover crop è stato attribuito un **areale in cui sarà raccomandata.**

EPOCA

Ogni specie è inoltre suddivisa a seconda del **ciclo (annuale o perenne) e alla tolleranza al freddo.**

Specie:

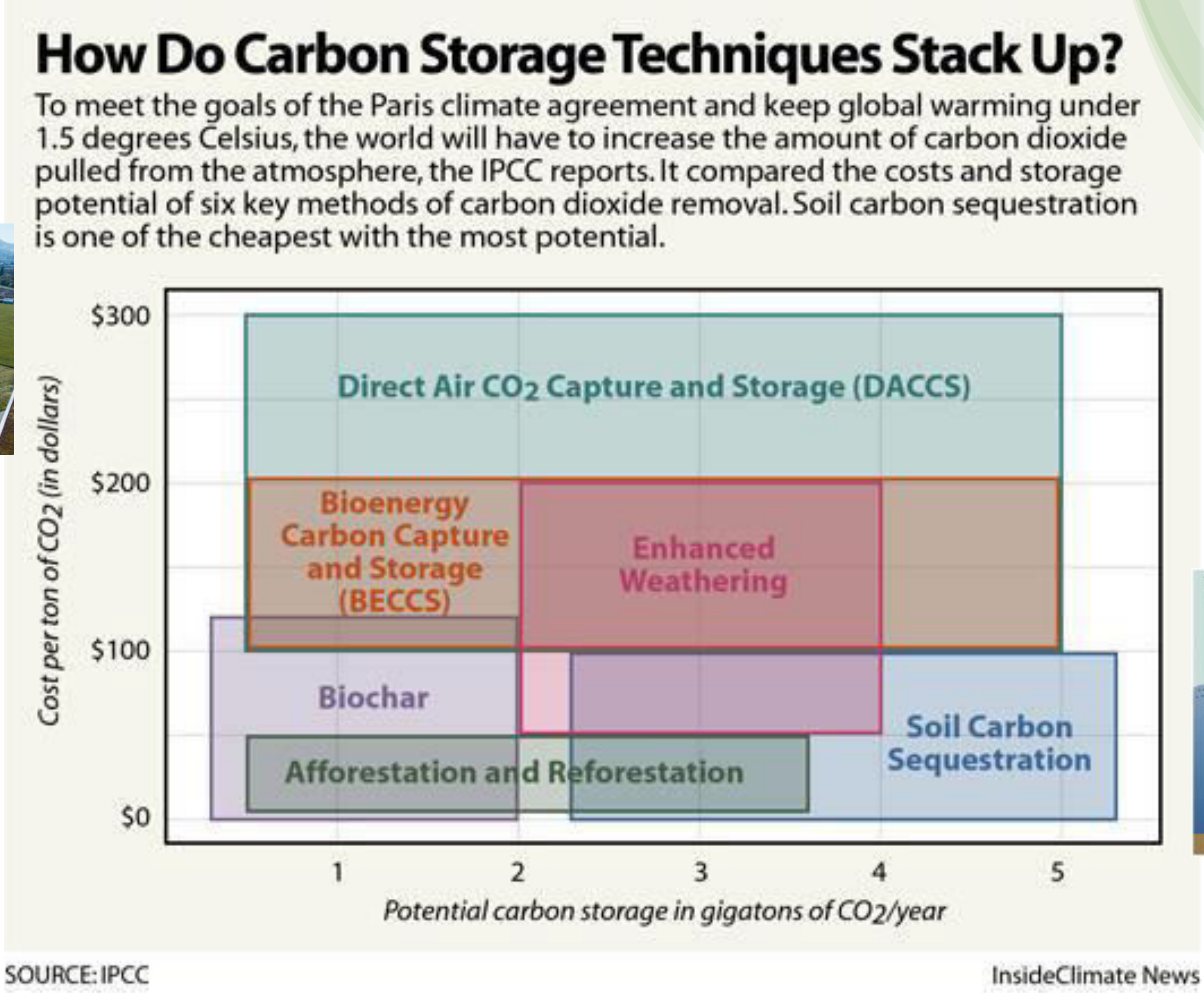
1. perenni

2. a ciclo prevalentemente autunno-invernale

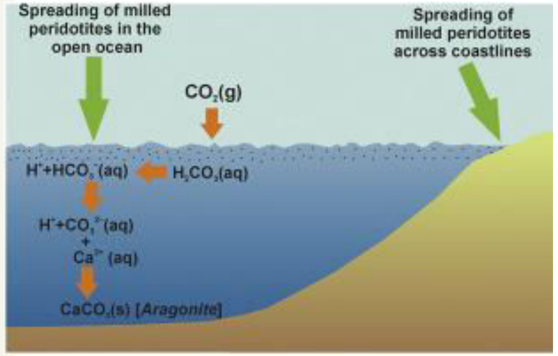
3. a ciclo primaverile-estivo

Carbon credit – Issues

- **Only long-term soil carbon sequestration has a value in the CC market.**
- **European carbon farming legislation under revision**
- Value of VER in the voluntary market is affected by **Project dimension and attractiveness**.
- In arable crops, **long-term carbon accumulation is often affected by soil tillage**.
- **CCs belong to who generated them** (i.e., farmers); since CCs coming from a small farm is very low, agreements are needed to transfer CCs to a **third party that works as an intermediary** (e.g., a cooperative, an agro-industry, etc.).
- In arable crops, **CCs** generated by regenerative actions **belong to the whole crop rotation** and project overlapping is not possible.



Enhanced Weathering: Diffusione in fondo al mare e sulla superficie terrestre di roccia di silicato finemente macinata che reagisce con la CO_2 gassosa e si creano minerali di carbonato di calcio e di sodio



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Grazie per l'attenzione

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