Gens

Biodiversity and carbon sequestration in grazing systems

An outlook on ecosystem service payments

Euroopa Liit maaelu arenguks

Euroopa Maaelu Arengu Põllumajandusfond: Euroopa investeeringud maapiirkondadesse

The importance of grasslands

Grasslands cover 20 % of the EU surface and represent the main feed resource for livestock.

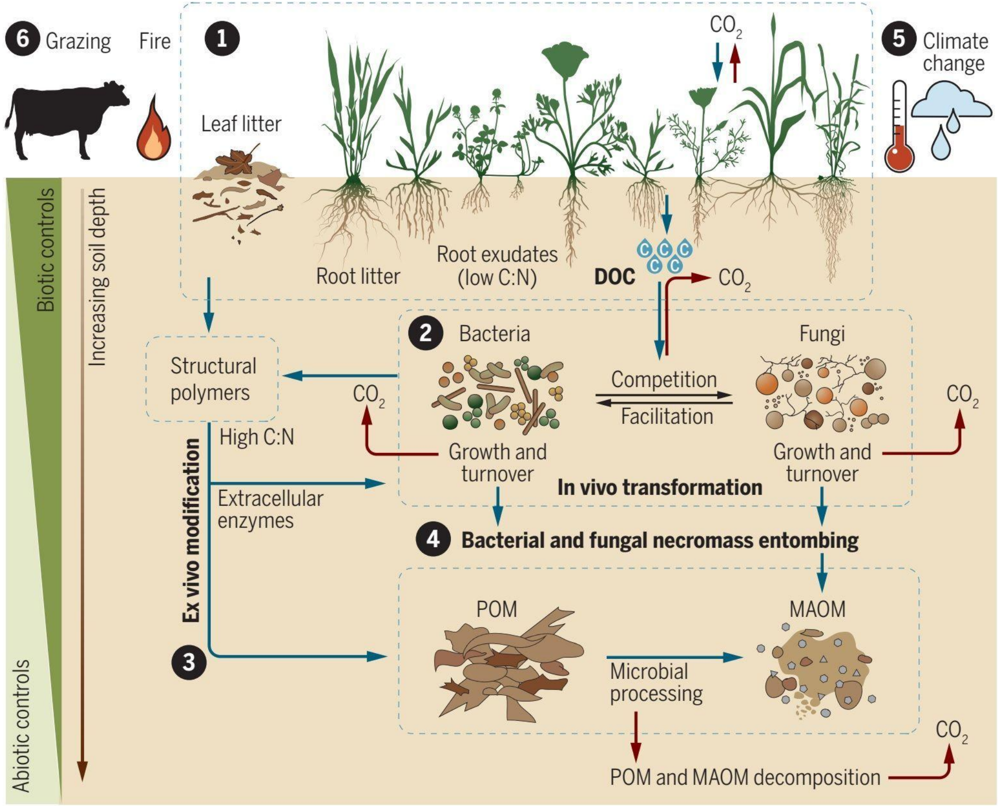
Grasslands can support biological diversity, water cycling nutrient cycling and other ecosystem services such as cultural heritage landscapes. They also have a large potential for carbon sequestration.

Researchers found that 80% of European grasslands are below saturation of carbon storage, indicating unmet potential in carbon sequestration.

Need to regenerate grasslands

(Bai et al., 2022))

Carbon sequestration in grasslands



Photosynthesis is the main driver of carbon sequestration. The plants contribute carbon to the soil through grazing and manure deposition, leaf litter, root litter, root exudates and soil microbiology.

The majority of organic carbon in the soil is either particulate organic matter (POM) coming from broken down plant and microbial matter, or mineral-associated organic matter (MAOM) which are molecules that leached from plant residue or come from root exudates. MOAM contributes most to long-term carbon sequestration.

Higher levels of biodiversity are necessary for carbon storage, microbial diversity increase stabilization efficiency of POM but reduces that of MAOM. There is more MAOM found in grasslands compared to savannas, shrubland and forests.

(Bai et al., 2022))

Importance of carbon in grasslands

Carbon in a key component of soil health. Higher carbon content is generally correlated with better soil structure, water-holding capacity and can provide more nutrients to plants. This has a positive influence on production costs given an increase in grass production, a better health condition for cattle and in general supports more biodiversity on the land.

When cattle is managed in such a way that it restores and enhances the overall grassland ecosystem function, increases in soil carbon will lead to larger and more diverse populations of soil microbes, which in turn increase carbon sequestration and also oxidize methane (CH_4), reducing emissions.

With livestock management focused on building soil health, grazing animals can create C negative budgets, with more carbon entering the soil than is emitted indirectly or via ruminant emissions.

(Bardgett and McAlister 1999; Jamali et al., 2014; Janzen 2010; Teague et al., 2013)

Biodiversity in grasslands

Biodiversity is key for stable and resilient ecosystems. European natural grasslands have a rich flora and are among the most biodiverse in the world. An Estonian natural pastures has achieved the second highest vascular species density (76 species/m²) in the world, second after the shortgrass dry mountainous pasture in Central Argentina.

High plant biodiversity often leads to high animal and fungal diversity, thus supporting a healthy ecosystems. As mentioned before, a high diversity in plants supports a high diversity in soil microbiology, which in turn support carbon sequestration leading to more nutrients available and better plant growth.

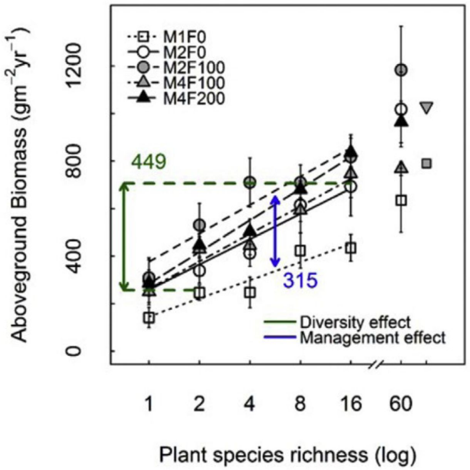
Managing for a diversity of forage species enables cattle to select a diet that benefits their nutrition, health and welfare, whilst reducing the negative environmental impacts caused by livestock production systems.

Biodiversity in pastures can decreases with grazing practices that allow for overgrazing of specific species, bare spots and compaction and by fertilizing of pastures.

(Cantero et al., 1999; de Deyn et al., 2003; Distel et al., 2020;   Knops et al., 1999; ; Provenza et al., 2009; van der Heijden et al., 1998;Villalba et al., 2014)

Biodiversity in grasslands

High diversity pasture



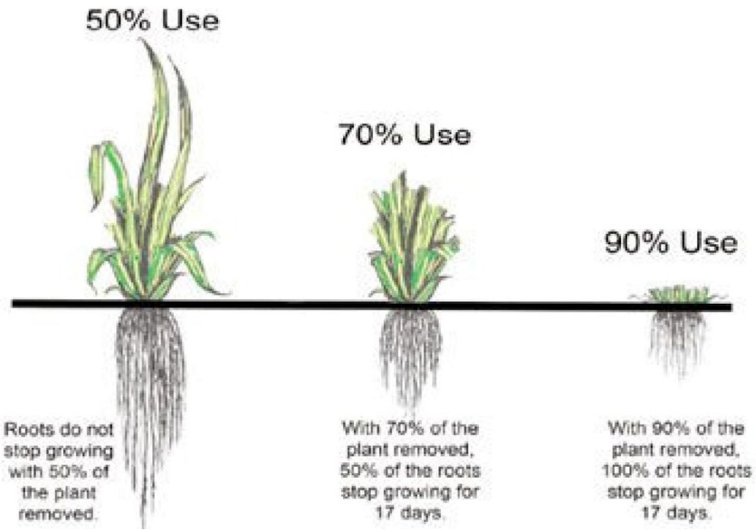
Grazing cover crops or temporary pasture

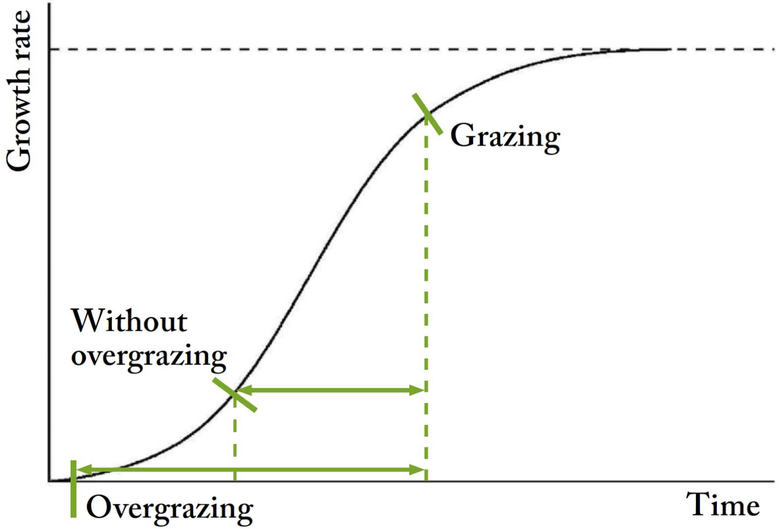
Benefits: high diversity pasture produces the same biomass as high fertilized (200 kg N) monoculture pasture, grazing cover crops or temporary pasture increases the amount of feed available (grow more animals).

(Weigelt et al. 2009; Weisser et al. 2017)

Managing for carbon and biodiversity

Avoid overgrazing, it reduces productivity and can lead to compaction. Overgrazing = grazing before the plant has fully recovered. (growth 3 days after grazing, recovery periods varies throughout season and plant species (In Estonia: 20 - 60 days). To optimise pasture production avoid eating more than 50% of the biomass.





Benefits: Produce up to 42% more feed in a season compared to overgrazing or cutting. Avoiding overgrazing leads to deeper roots, more photosynthesis, more carbon sequestered, more energy in the plant, higher average daily gains

(Nunes et al. 2019; Jones 2018)

Managing for carbon and biodiversity

Ensure adequate grazing pressure, move animals dynamically to avoid overgrazing. Low grazing pressure is inefficient.

Low stocking density results in patchy grassland, overgrazing of areas and with low diversity

Higher stocking densities result in even grazing pressure and more species diversity in pastures

(Barnes et al. 2008; Oñatibia and Aguiar 2018; Teague et al. 2013; Teague and Barnes 2017)

Managing for carbon and biodiversity

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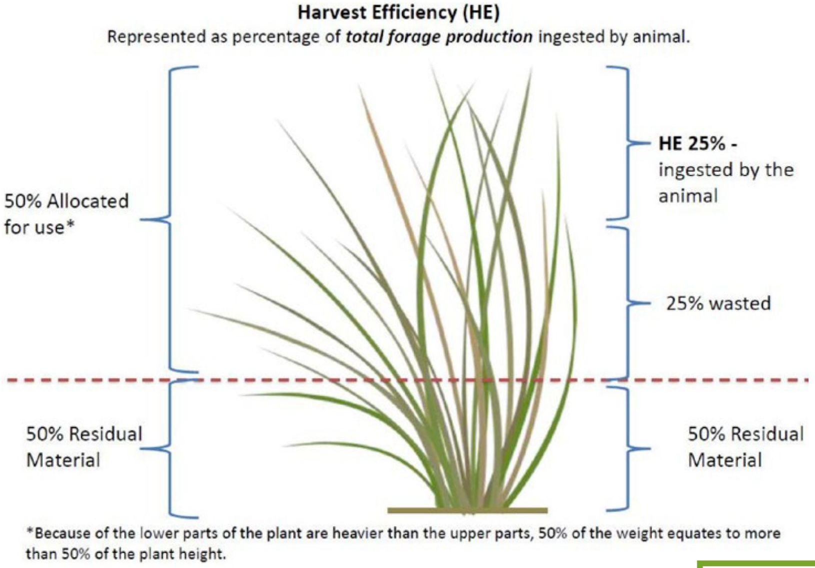
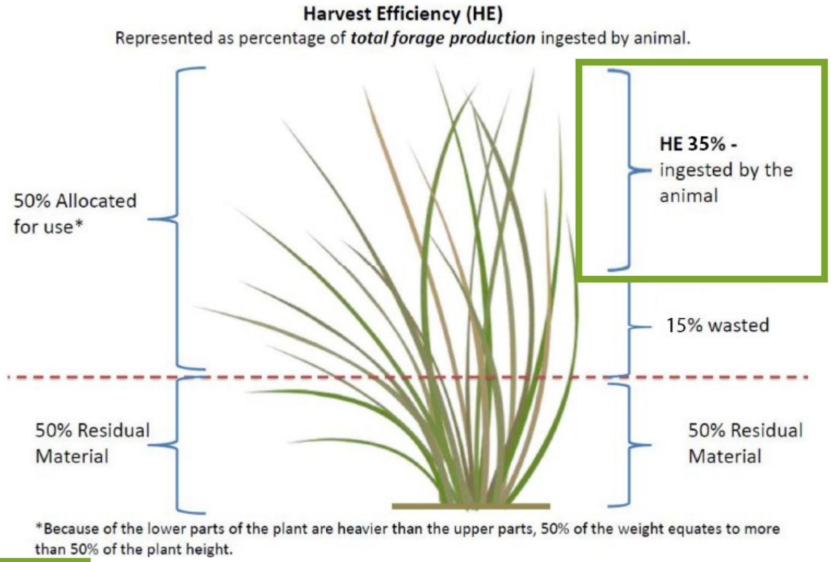




	basic grazing scenario	
50%	25%	50%
	high stock density scenario	
50%	35%	70%

(Green and Brazee 2012; Martz et al. 1999)

C-sequestration rates grazing management

There is a wide variety of carbon sequestration rates associated with grazing. This is due to the large variety in management, climate, soils and plants species. Of those factors, management is the one that farmers can influence the most and as mentioned before the amount of plant material eaten, grazing pressure and respecting recovery periods are key components to work with.

There are many names for such grazing practices: Holistic Planned Grazing (HPG), Adaptive Multi-Paddock Grazing (AMP) or Management Intensive Rotational Grazing (MIRG). Common principles are having multiple paddocks, moving cattle regularly, matching stocking rate to available forage, ensuring adequate grazing pressure and respecting the recovery times of the plants.

Through these practices, sequestration rates of between 1.76 - 13.17 t CO_2/ha/yr have been reported. This large gap shows the large variability due to management, climate, soils, plant species, etc. At present no specific data for Estonia.

By comparison, continuous grazing systems where overgrazing occurs have been shown to reduce the amount of carbon in the soil.

(Conant et al., 2017; Delgado et al., 2011; McSherry and Ritchie 2013; Stanley et al., 2018; Teague et al., 2011;)

What are ecosystem service payments?

Ecosystem service payments are a tool to incentivize land managers to restore and maintain ecosystem services. These ecosystem services are crucial for the stability and resilience of the natural ecosystem and our economies.

Ecosystem service payments span a wide variety of financial arrangements where beneficiaries of ecosystem services (carbon sequestration, water protection, forest conservation, …) rewards those whose lands provide these services with subsidies or market payments.

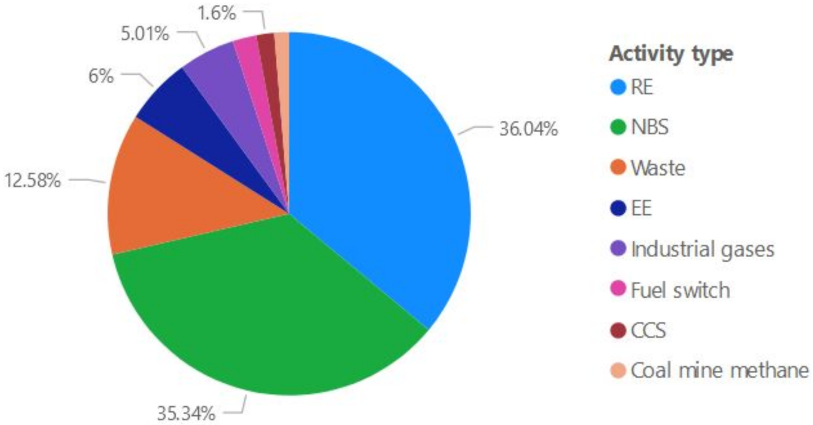
The most known and widely used ecosystem services at this point are carbon offsets which are part of the Voluntary Carbon Market. Carbon offsets are not the same as carbon credits that are a part of the mandatory cap-and-trade scheme by which carbon emissions rights are sold and purchased.

Carbon offset and the VCM

Carbon offsets are part of the Voluntary Carbon Market, where offsets credits are sold that represent a reduction or removal of CO_2. Each offset credits represents one metric tonne of CO_2, or any equivalent amount. The purchaser of an offset credit can "retire" it to claim the underlying reduction towards their own GHG reduction goals.

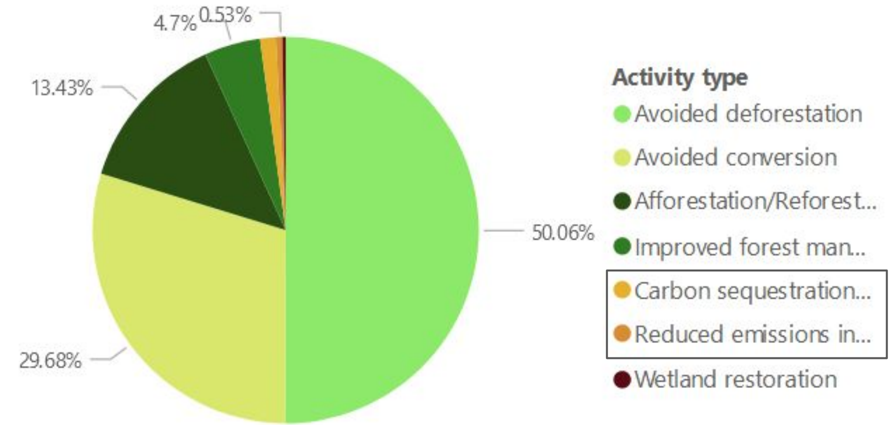
A variety of actions across different industries are used to create offset credits. The most common categories are:

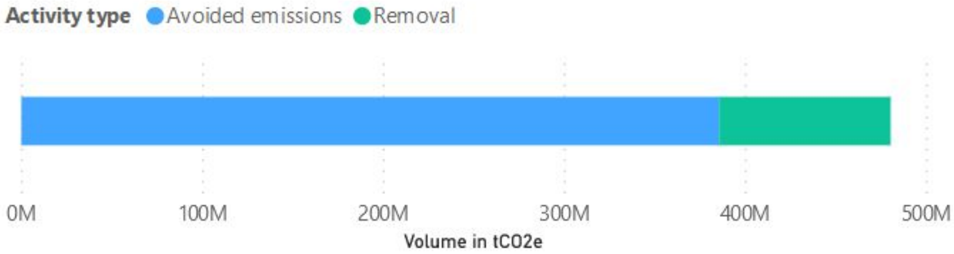
- Renewable energy (RE)
- Nature based solution (NBS)
- Improved waste management
- Energy efficiency
- Reducing industrial gases
- Switching fuels
- Carbon capture and storage
- Coal mine methane reduction

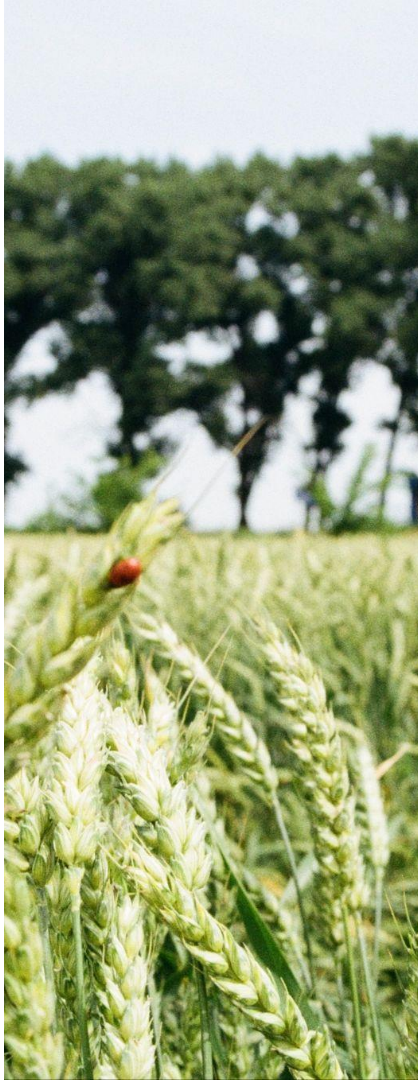


Nature based solutions

Only a tiny portion of offset credits comes from agriculture at this point (C-sequestration 1,3%, Reduced emissions reduction 0,53%)

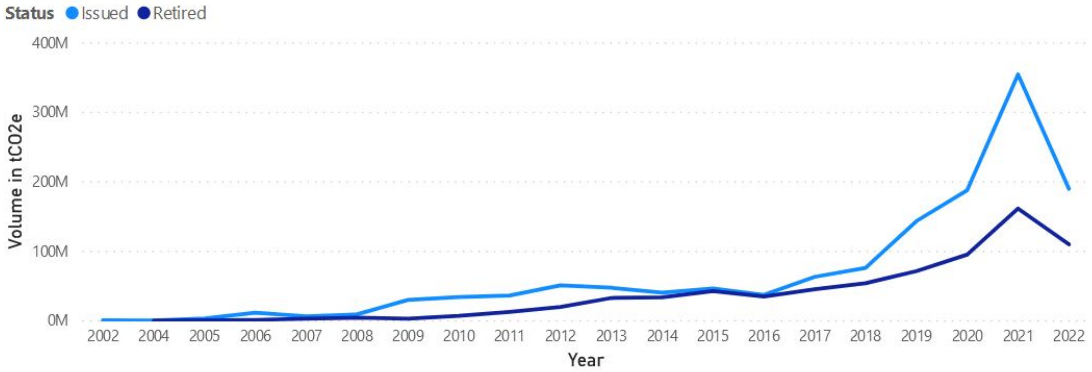




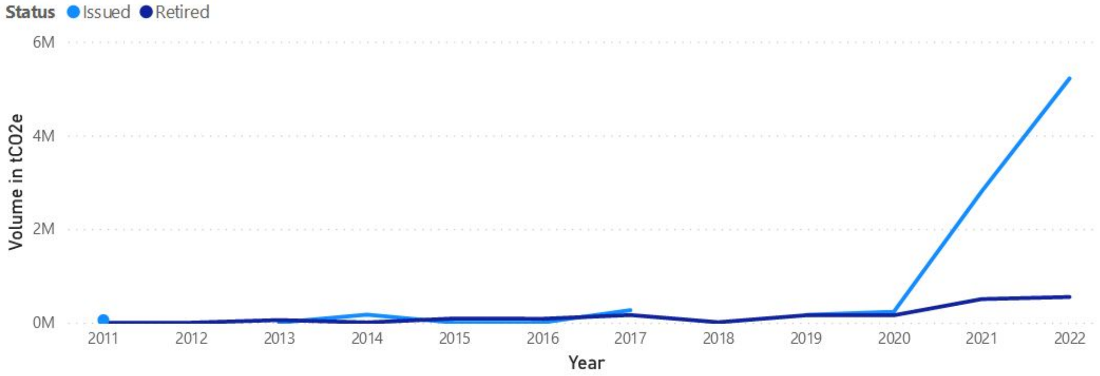


Carbon offset credits evolution

In general the offset market took a dive in 2022



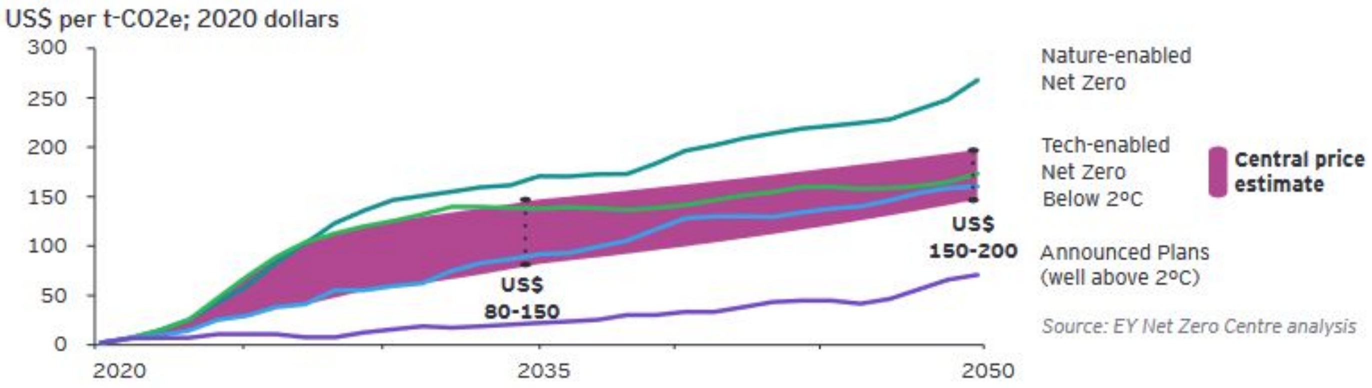
While for NBS from agriculture, the market really only began in 2021



Carbon offset prices

Offset prices can vary widely depending on quality of the offset, available supply and co-benefits such as biodiversity of social impacts. Average prices ranges for NBS from €15-25 per tCO_2-eq. However, high quality credits can already sell for over €50+ per tCO_2-eq.

Several expert groups and consultancies project that the VCM offset prices will rise sharply over the coming years to averages of €80-150 per tCO_2-eq by 2035.



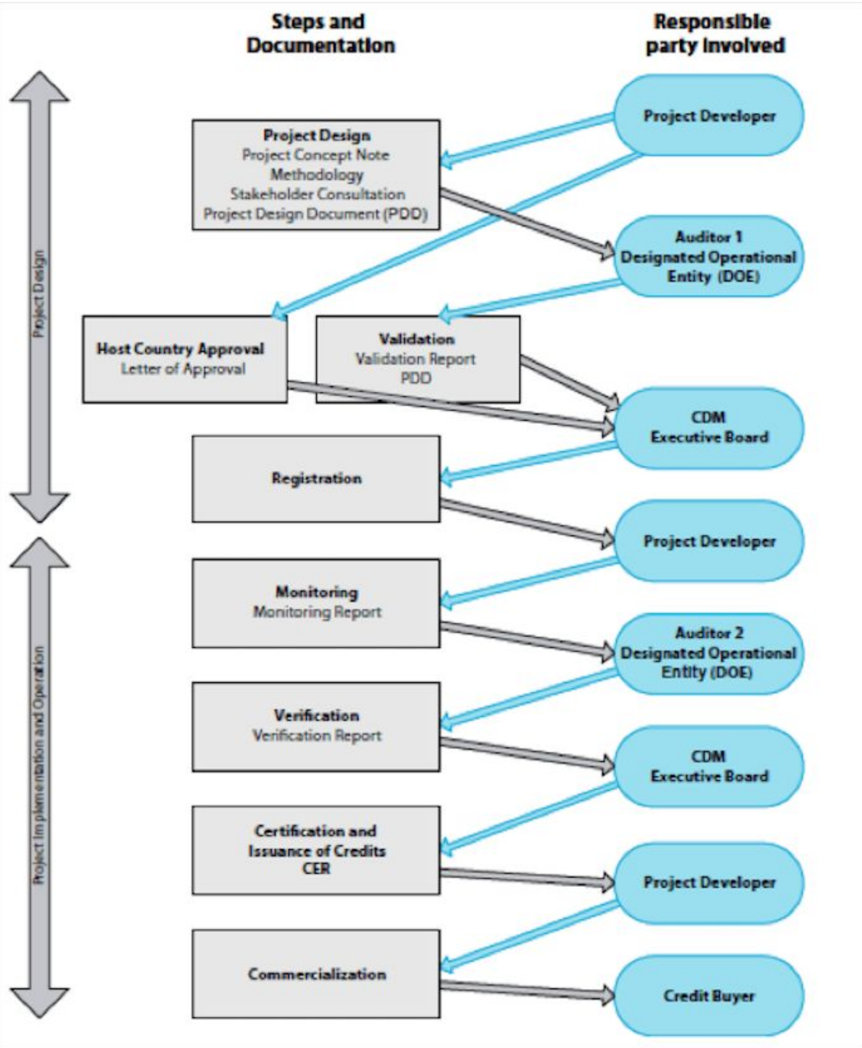
Challenges to overcome

However, there are key challenges that need to be overcome for agriculture related carbon offset to scale.

The whole process of setting up a carbon offset project is elaborate, takes time and is relatively costly.

For agriculture related carbon offset the measurement of the carbon sequestered on the soil can be particularly labor intensive and expensive given the need for extensive soil testing.

Together this means that in many projects, farmers only receive a portion of the offset price, with the rest going to cover the expenses of setting up, implementing, measuring and verifying the offsets.

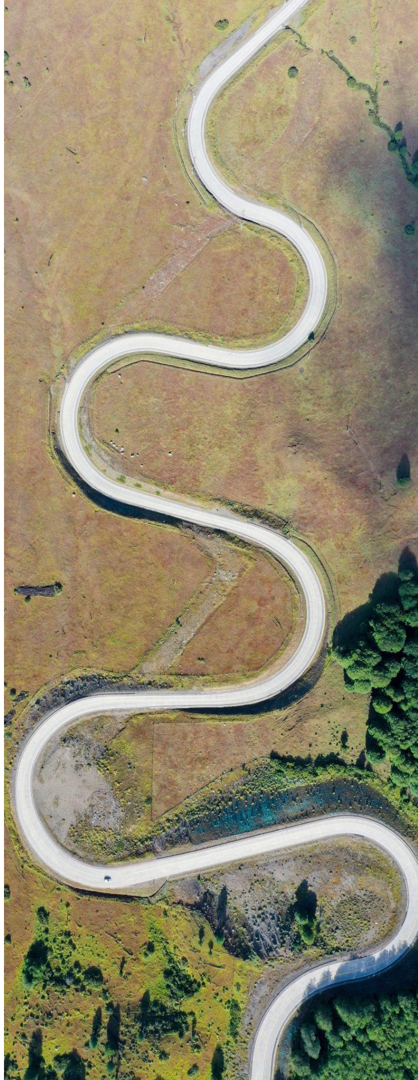


Challenges to overcome

Another key challenge for many agriculture related projects is the principle of additionality. This principle requires that the GHG reductions are additional and they would not have happened without the financial support of offset credits.

This means that if the practices or management that leads to carbon sequestration is financially attractive enough to be implemented without carbon offset credits, and the landowner will implement the changes anyway, the carbon offset is not additional and thus cannot be eligible for offset credits.

Given the financial benefits of managing for carbon in the soil, this can be a challenge for many of the agriculture related carbon emissions or avoidance. At present this is a grey area. The EU is still working on the exact regulations for the voluntary carbon market, hopefully more clarity will come one published.



Challenges to overcome

Another core principle is permanence, which requires the carbon sequestered in the soil to remain there for a long time ranging between 25-100 years. This can be a challenge, especially on rented land.

The last challenge for agriculture related carbon offsets is that of defining the system boundaries. The goal is to achieve a net reduction, which requires taking into account all the activities associated with avoiding or sequestering carbon, compared to a scenario where nothing would change.

The interactions in nature are complex, and not all of them are understood. In grazing the challenge of methane emissions is a key example. It is practically impossible to accurately measure methane emissions on pasture for each farm. Drawing the system boundary at the farm level is also not necessarily correct seeing plant respiration creates moisture in the air that gets oxidized by sunlight into hydroxyl ions, which are free radicals that breakdown methane instantly in the atmosphere. At present, we are limited by what is feasible to measure (or model).

Grazing based carbon offset projects

Portuguese Carbon Fund (2008-2014) rewarded installation and maintenance of sown biodiverse permanent pastures rich in legumes through a system of payments for carbon sequestration. These pastures have also been shown to sequester approximately 5 t CO2 per year per ha (Teixeira et al., 2011). With these projects, the area of this pasture system increased by 48.491 hectares (spread between 1095 farmers).

The US-based Chicago Climate Exchange (CCX), a voluntary GHG emissions reduction program, issues offset contracts for soil C sequestration due to improved rangeland management practices, such as the use of sustainable stocking rates, rotational grazing, and seasonal use in eligible locations. US Senate and the US House of Representatives may recognize C sequestration on grazing lands as valid offsets, as long as they will be systematically and accurately measured, monitored, and verified.

Grazing based carbon offset projects

The Emissions Reduction Fund (2012 - now) in Australia is a voluntary scheme that provides incentives for farmers and land holders to adopt new practises and technologies to reduce Australia's greenhouse gas emissions (Emissions Reduction Fund 2017). Soil carbon stored must be maintained until the end of the permanence period (25 or 100 years).

- Converting from continuous cropping to pasture
- Undertaking pasture cropping
- Managing pasture by implementing or changing pasture irrigation, applying organic or synthetic
- Fertiliser to pastures, or rejuvenating pastures, including by seeding
- Managing grazing by changing stocking rates or altering the timing, duration, and intensity of grazing.

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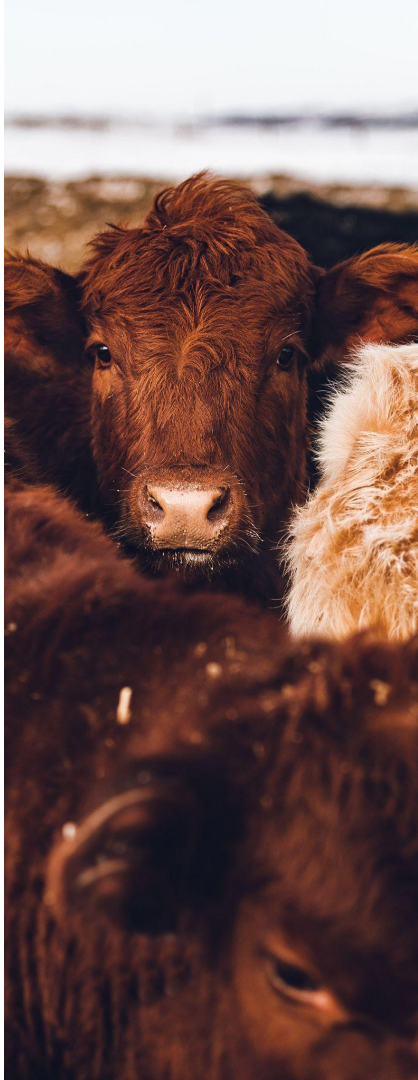
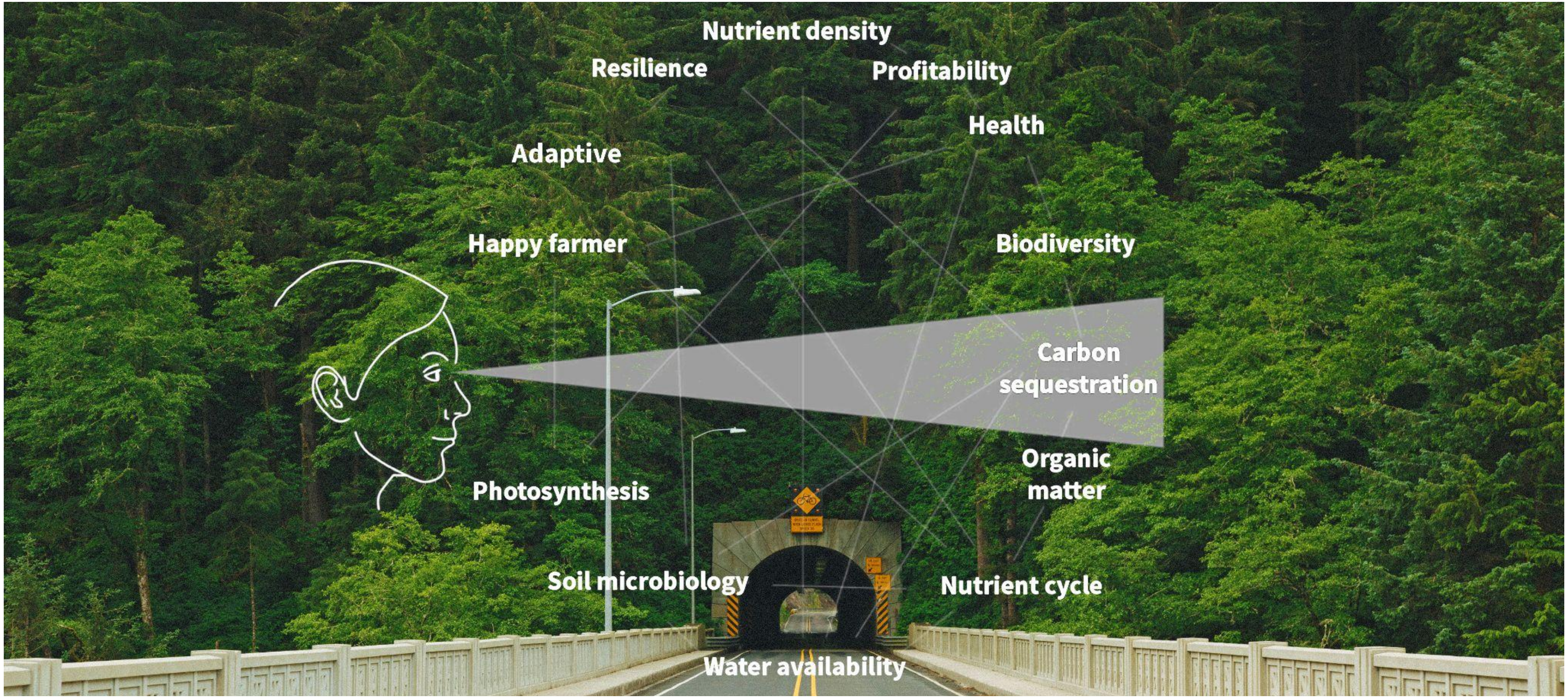


Carbon tunnel vision, don't miss the real benefits

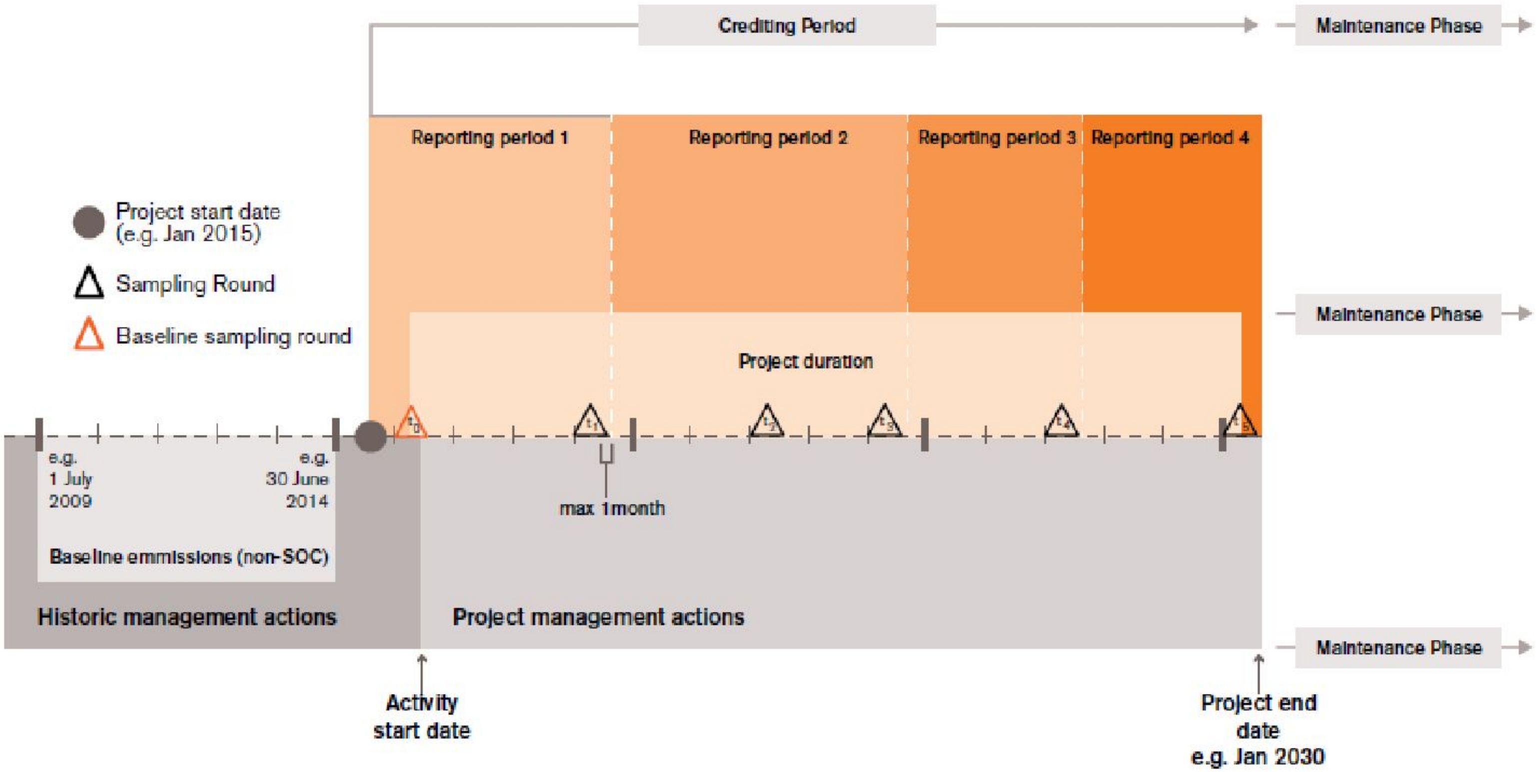


On average, farmers can save up to 20% of their cost dependent on improved grazing and grasslands (EIP-AGRI, 2018)


Gens
Thank you
info@gens.eu

Extra

Australia



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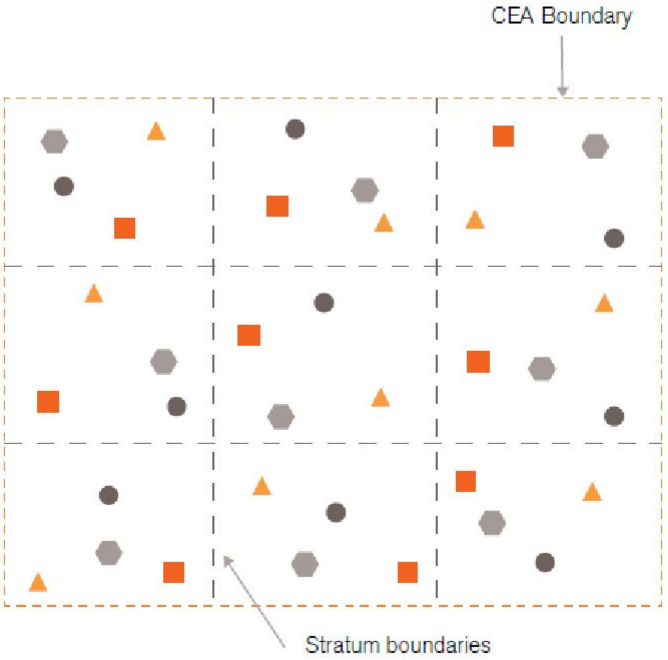

Australia
Land is divided into CEA (Carbon Estimation Areas) based on soil types, management …each area that could have a different way or rate of sequestering carbon.

Each CEA is subdivides into a number of zones, in this figure 9, in each zone 4 samples are taken. Each of the individual samples per zone is combined with their respective counter part from the other zones to form 4 composites.

Soil samples collected at minimum depth of 30cm, if deeper sampling, separate into 0-30cm and 30cm+.

Sampling needs to take place during the same time of the year. Interval between sampling between 1 - 5 years. Atleast 5 sampling rounds over a 25-year crediting period.

Carbon Sequestration - Systems boundary