CARBON ACTION: MANY BENEFITS THROUGH REGENERATIVE FARMING

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Background

The goal of the Carbon Action platform is a systemic change towards regenerative agriculture **(1, 2**). On the Carbon Action platform, farmers, advisors, researchers, companies, and decisionmakers work together. In 2022, there were 28 ongoing projects on the Carbon Action platform, totalling EUR 35.1 million. Most of the projects are research projects focusing, for example, on soil carbon and on the effects of regenerative farming. Other projects focus on farmer collaboration and international networks.

Farmers and advisors

Carbon Action is farmer-based and constantly taking shape in interaction with farmers (**3, 4, 5**). There are 100 Carbon Action farms that test practices and collect experiences. Farmers benefit directly from peer learning. For Carbon Action farmers, collaboration with researchers has been valuable, and correspondingly, researchers have received practical insights from farmers (read more).

In order to share the knowledge gained in Carbon Action with all interested farmers and other agricultural experts, the Carbon Action club (link in Finnish) was established in 2020 as an information exchange channel and network. The club has

Definitions

Regenerative agriculture is a holistic approach to food and farming systems that revitalises the entire ecosystem. In practice, this means that you are not merely aiming for a good harvest – you are also seeking to improve soil health, increase biodiversity and the soil's carbon stock, and ensure effective water management. Regenerative agriculture is much more than just carrying out individual measures, and it is not a specific practice in itself. It is not only what you do but how you do it. Regenerative agriculture offers a flexible way of applying a diverse range of adaptive farming practices, that is, picking the method that best fits the situation. The potential measures can be simplified into three main principles: maximising photosynthesis, maximising microbial activity in the soil, and minimising the disturbance of soil functions. Carbon farming is one aspect of regenerative agriculture. Carbon farming aims to increase long-term soil carbon storage and reduce greenhouse gas emissions from arable land (read more).

Soja Sädeharju

Soja has conducted a survey and interviewed Carbon Action farmers as part of her doctoral dissertation. According to preliminary observations, the transition to regenerative farming is particularly encouraged by intangible values, the most important of which are improved soil health, increased biodiversity, positive emotions, and increased meaningfulness of work. According to observations, Carbon Action farmers also make extensive use of their intuition in decision-making, are able to make quick decisions when necessary, and observe nature actively and accurately. It seems that observing nature and relying on one's own observations are key factors in successful farming decisions. The purpose of the follow-up study is to make visible the decision-making elements of these pioneering farmers.

about 1,100 members, and the number is growing. In 2022, the popular Carbon Action club's remote morning coffee was launched, at which experts give presentations on current topics. The club's activities also include science webinars for farmers, newsletters, and field days. New carbon farmers have also been gained through business cooperation by training contract farmers of companies that are on the Carbon Action platform.

Information and learning are also continuously disseminated through the free 'E-college for Regenerative Farming' (UVO). UVO has about 2,200 registered participants. The course is now only in Finnish and Swedish, but in 2024, a short version targeted especially at decision-makers, company representatives, and consumers will be published in English (read more).

The Carbon Action platform is also training agricultural advisors. Training advisors is a prerequisite for the wider adoption of regenerative farming and carbon farming. The first advisors in Finland to specialise in soil management and carbon farming completed in-depth SOIL ADVICE training in 2022. The SOIL ADVICE training concept can be copied. There will continue to be a need for this kind of training.

From the scientific work, the Carbon Action platform also produces practical papers for farmers. The latest publication is 'Weed guide' (these publications are only in Finnish and Swedish).

Researchers

An extensive interdisciplinary research network has been formed on the Carbon Action platform, with more than 100 researchers involved. Research is conducted at several levels, from soil processes (**6, 7, 8, 9**), water protection and economics of carbon farming, to climate and agricultural policies (**10**). Carbon flows and storage, as well as the effects of vegetation and soil diversity (**11**), are measured in the research fields through soil and microbial analyses, atmospheric measurements, and modelling (**12 ,13, 14**).

Markku Ollikainen, Sanna Lötjönen, and research group

According to preliminary results, carbon farming practices can improve the productivity and resilience of agriculture and thus improve the economic viability of farms. At the same time, there are costs associated with changing farming practices. The decisive factor is whether any increase in crop yield (quantity and yield value) will make carbon farming practices more profitable compared to non-introduction. If the additional income generated by the yield is not enough, the farmer must be incentivised to introduce carbon farming practices and maintain additional carbon storage.

Liisa Kulmala and research group

Various agroforestry practices could serve as important methods, especially when combined with other regenerative practices. In the case study, trees increased carbon accumulation in the ecosystem, and thus, the net emissions were estimated to be smaller than without the tree row. In addition, the tree row increased the presence and abundance of soil microbial communities (**15**).

The 100 Carbon Action farms test carbon farming and provide research material. The first samples from the Carbon Action farm test and control plots have been analysed, and subsequent samples will be taken after five years (in autumn 2023) to measure changes. Soil samples have also been taken from 30 farms to a depth of one metre. More detailed field experiments studying the impacts on carbon fluxes and sequestration have been established on 20 of these Carbon Action farms. Farmers on these farms can monitor the effectiveness of carbon farming practices at field level, and the results are published annually on a Zenodo server (keyword 'Carbon Action'). The results show how different plots react to droughts and heavy rains, and how plants grow in different plots. The results also help farmers to find ways to develop plant and soil resilience in a changing climate.

Tuomas Mattila and research group

Based on the preliminary results of the MULTA project, some carbon farming practices can have considerable positive effects on soil health and productivity. However, the potential problems with the field must be fixed first. In many Finnish fields, for example, compaction or poor drainage limits both food production and carbon sequestration (read more). More results will be gained when final samples are taken from Carbon Action farms in autumn 2023.

At long-term study sites, both changes in carbon storage at different soil layers and nutrient leaching are studied.

Helena Soinne and research group

On average, the organic carbon content of Finnish agricultural soil is higher than in Southern Europe. However, it cannot be directly concluded from the relatively high carbon content that the amount of organic carbon in Finnish agricultural soils is good or sufficient for soil health. Instead, the amount of organic carbon in the soil should be explored in relation to the soil type. High clay soils in a boreal environment need more organic matter than coarser textured soils with lower clay content to achieve and maintain a good soil structure and good productivity. Research results suggest that clay soils with a low clay/carbon ratio are more likely to produce higher yields than soils with a higher clay/carbon ratio (**6**).

Jussi Heinonsalo, Kristiina Karhu, Mari Pihlatie, and research group

The research group has studied the effects of farming practices on the persistence and accumulation of carbon in soil. Organic farming was found to increase the carbon storage of agricultural soil compared to conventional farming. In addition, the soils studied had the ability to bind more carbon in a permanent form, bound to mineral surfaces, especially below the tilling layer.

The group has also studied the effects of diverse plant species on soil biology and processes, such as phosphorus solubility and transport. Multi-species plant cover increases the efficiency of carbon use by soil microbiota, which in turn promotes carbon accumulation in the soil. With regard to phosphorus, special attention is paid to winter-time thaw-freezing situations, during which reactive phosphorus is in danger of ending up in waterways with winter rainfall. In addition to phosphorus, the group has studied the effects of mild and rainy winters on carbon stability and movement.

At the intensive study sites, atmospheric measurements and modelling are used to study the fluxes and sequestration of carbon. Through the Carbon Action cooperation, existing intensive study sites have been further developed, and new ones have been established in cooperation with the University of Helsinki. In addition, a long-term TWINWIN field experiment has been established in Viikki to study how biodiversity affects the ability of fields to store carbon.

Anna-Liisa Laine and research group

Field experiments have been used to study how increasing plant diversity in fields, for example through catch crops, affects interactions between plants and microbes and the functioning of the field ecosystem, such as carbon sequestration. According to the results, plant diversity affects the functioning and structure of soil microbial communities and promotes carbon sequestration. Above the soil, individual companion species have been found to reduce plant diseases (see more in Finnish).

Researchers on the Carbon Action platform are developing a scientifically ambitious measurement and verification system (**16, 17**). The verification system uses extensively collected data and can model and predict carbon sequestration even in areas where measurement data is scarce. A Field Observatory service has been developed to illustrate and disseminate the verification methodology (**18**). The information is publicly available, free of charge, and can

be downloaded directly from the website. On a societal level, scientific verification, openness, and transparency provide a basis for agricultural and climate policy instruments and a possible carbon credit market.

Layla Höckerstedt, Jari Liski, Åsa Stam, and research group

The Field Observatory service shows measurement and modelling results in near real time at study sites across Finland and Sweden. It illustrates the effects of carbon farming and supports the development of the carbon sequestration verification system. The Field Observatory also has an automatic daily-updating 15-day carbon dioxide binding forecast for a Qvidja intensive study site located in south-western Finland, the first of its kind in the world.

Carbon Action farms, other farms, and different study sites produce data on the impacts of land management on carbon sequestration and ecosystem functioning. Scientists use these data to develop improved management practices and better models to estimate the results and their longevity.

To make the information easier to access and to understand, a so-called citizen version of the Field Observatory will soon be published to serve everyone interested in carbon sequestration.

Companies

Companies have great potential in driving the adoption of regenerative farming. The companies on the Carbon Action company platform are changing the way in which the food chain works, to promote regenerative farming in cooperation with researchers and farmers. Companies, for example, train their contract farmers and staff in regenerative farming, create regeneratively produced products, or integrate the principles of regenerative farming into their sourcing criteria. Both food and technology companies are involved in the Carbon Action platform.

Statement by companies in the Finnish food industry

Companies are working extensively to promote regenerative farming in domestic food production. However, a comprehensive change also requires political efforts. Carbon Action business partners are calling for concrete measures from policy-makers to promote regenerative agriculture throughout the food system (read more).

Decision-makers

The work in Carbon Action has been fed into policy-making in different ways. The impact is seen, for instance, in the Finnish Common Agricultural Policy (CAP) Strategic Plan, which includes new carbon farming and nutrient recycling measures. At the EU level, Carbon Action has contributed to the policy processes and legislative proposals related to carbon markets and increasing land-based carbon sinks, including by piloting voluntary carbon credits (**20**). The work and results continue to benefit the development of methodologies for carbon farming measures.

The possibilities of voluntary carbon markets

Could voluntary markets boost climate action and support farmers in increasing carbon storage in agricultural land? This question was widely discussed as BSAG brought together approximately 250 experts and stakeholders during the EU Green Week 2022. The experts agreed that, at best, carbon farming methods, such as the use of catch crops or soil amendments, effectively improve the productivity of fields, mitigate climate change, and promote biodiversity, along with having relative benefits for water quality (read more).

International networks

Systemic change in agriculture is underway globally. Carbon Action plays a key role in interaction and co-creation with global pioneering networks.

We are, for example, active in the '4 per 1000' network. In June 2023, the first Northern Europe-wide '4 per 1000' event will be organised in Finland, coordinated by BSAG: More carbon in the soil for multiple benefits.

In 2021, the international Soil at Risk symposium, which BSAG organised in cooperation, gathered hundreds of participants from around the world and up to one million followers through social media (read more).

Collaboration among countries with similar growing conditions is especially important. Carbon Action works closely with Svensk Kolinlagring (SK). In 2022, SK visited Finland and together we organised an international session during the Finnish Agricultural Science Days (read more). In addition the E-college for regenerative agriculture is being taken to Sweden (read more).

Other interaction with stakeholders

Carbon Action also promotes soil to a wide audience and, in all senses, turns knowledge into action. Qvidja farm is a lighthouse for Carbon Action and acts both as a pilot farm and as an intensive testing area for Carbon Action research. For example, Soil defence courses

are held at Qvidja every year for key stakeholders. The course explains the importance of the soil and has aroused broad interest among groups from high-level policymakers to business and media representatives.

Conclusions

It can be concluded that there are many benefits that can be achieved through regenerative farming and carbon farming practices. The practices should always be adopted in consideration of the local conditions on the scale of the region, farm, and field. It is important to note that potential problems with the field must be fixed first. For example, in many Finnish fields, compaction or poor drainage limits both food production and carbon sequestration. The key is to find sustainable steering instruments that have a positive impact on all key objectives: producing food, increasing carbon storage, and improving the state of the environment and biodiversity, without forgetting economic and social sustainability (**20**).

Recommendations for policy-makers; we should

1. Promote carbon sequestration in agricultural soils and invest in carbon-sequestering regenerative farming and its co-creation among farmers, researchers, and other stakeholders.

2. Further develop training for farmers and advisors, which simultaneously focuses on soil health and carbon sequestration.

3. Secure funding for the development of a measurement and verification system for carbon sequestration and biodiversity.

4. In preparation for the next CAP period, pilot a results-based approach to agricultural subsidies in practice.

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