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Carbon Farming CE

REPORT ON MAINSTREAMING OF CARBON FARMING TECHNIQUES

DELIVERABLE D.1.4.1

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CONTENT

INTRODUCTION AND SCOPE OF THE TASK

Within the Carbon Farming CE project, the Activity A.1.4 is defined by the uptake of selected carbon farming practices by a minimum of 45 farmers (five farmers of each of the nine participating countries), the development of plans for mainstreaming carbon farming practices, and a demonstration of expected carbon sequestration by the uptake of carbon farming. We managed to recruit and interview 50 farmers who took up carbon farming practices.

Each country was required to prepare a Regional Report that includes all the above-mentioned points. These Regional Reports are combined in a structured way to the present Deliverable D.1.4.1.

In each country, a minimum of five individual interviews were conducted with farmers during the 2025 growing season who took up carbon farming practices. These interviews served as an important basis for the Regional Reports, provided by each participating country. The interviews with farmers included feedback on their motivation, experiences, and needs following the introduction of carbon farming practices.

We selected seven carbon farming techniques that were followed throughout the project. Farmers were able to choose one or more of these techniques to implement. The Regional Reports present the results of the farmer interviews sorted by the techniques implemented.

The respective techniques of choice were:

A.1 External organic fertilizers
A.2 Relocation of harvest residues
B.1 Additional cover crops
B.2 Diversification of crop rotation
B.4 Agroforestry
C.1 Reducing tillage
C.4 Liming/gypsum effect

The questions of the farmer interviews for every chosen technique were as follows:

- Start of implementation
- Motivations to use the practice
- Knowledge of impact on carbon sequestration and climate
- Experienced practical feasibility
- Experienced impacts on soil/yield/growth
- Experienced technical/financial/administrative obstacles
- Desired support to implement the technique

- Possible added value for the product
- Estimation of further practical implementation on farm/regional/national level
- Average rating of feasibility, impact and acceptance on a scale from 0 (very low) -10 (very high)

All the gained information of farmer interviews was collected. Furthermore, all partners provided planned regional mainstreaming activities of agricultural support organisations and expected CO_2 sequestration by technique.

This information was combined in the present and joint Deliverable D.1.4.1 Report on Mainstreaming of Carbon Farming Techniques.

UPTAKE OF CARBON FARMING PRACTICES BY 50 FARMERS IN 9 CE COUNTRIES

Overview of uptake of carbon farming techniques

Table 1: Number of farmers who took up certain carbon farming techniques in nine Central European countries.

Techniques	Austria	Croatia	Czech Republic	Germany	Hungary	Italy	Poland	Slovakia	Slovenia	Total number of choices/ farmers
A.1 External organic fertilizers		2	4	1	1	5	1	5	5	**24**
A.2 Relocation of harvest residues	1		1					4	2	**8**
B.1 Additional cover crops	2	5	5	1	2	4	1	3	6	**29**
B.2 Diversification of crop rotation	3	3	4	1	2		2	1		**16**
B.4 Agroforestry	1		2				1	2		**6**
C.1 Reducing tillage	3	5	4	2	5		3	4	4	**30**
C.4 Liming/gypsum effect		1		4			1		1	**7**
Number of farmers	**5**	**5**	**5**	**5**	**5**	**9**	**5**	**5**	**6**	**50**

So, altogether, 50 farmers (5 more than the required 45) took up carbon farming techniques. C.1 Reducing tillage and B.1 Additional cover crops were the most preferred techniques, while B.4 Agroforestry and C.4 Lime/gypsum application were the least chosen. These two will need more promotional work to be included in farm management in future.

FEEDBACK OF FARMERS FOR UPTAKE OF CARBON FARMING TECHNIQUES

This compilation of feedback from interviews with farmers in all participating countries contains a collection of opinions and experiences as well as important highlights from the farmers' statements.

A.1 Additional organic fertilizers

This technique was taken up by 24 farmers in 8 countries (**Table 1**).

- *Start of implementation*

The start of implementation of the application of different organic fertilizers (mainly compost, farmyard manure, green biomass, digestate) is described from ‘always’, ‘since ever’, to 5-10 years before the start of the Carbon Farming CE project, and to special applications like horse manure just since 2025. This refers to applications carried out on fields, on orchards, in gardens or on permanent grasslands.

- *Motivations to use the practice*

Various motivations were mentioned like decreasing production costs by replacing part of the mineral fertilizers, personal beliefs that it is the right thing to do, improving the soil quality, desire to cut the use and import of mineral fertilizers for political reasons, improving water retention and better nutrient availability, increasing soil organic matter, initial very low soil organic matter levels, importance in circular economy and sustainable production, positives effects on yields.

- *Knowledge of impact on carbon sequestration and climate*

Many farmers don’t know yet about this aspect and the implementation of these techniques was not initially considered in the context of carbon sequestration or climate change mitigation. Still, some farmers have a brief idea, understand that manure application increases humus content, and therefore C stocks. The degree of technical understanding remains uneven across farms.

Experienced practical feasibility

Positive: Farmers notice an improvement in organic matter and nutrient availability in the soil. There is also an impact on reducing soil compaction and increasing life in the soil. The amounts of mineral fertilisers and financial inputs can be reduced.

Negative: Manure needs to be ploughed into the soil, which can lead to the soil drying out too quickly in the spring. While it reduces the need for mineral fertilizers, some farmers see incorporation and labour intensity/organisation as a drawback. Machinery is expensive to purchase and maintain, and unfavourable weather can affect application to the field. Regulatory issues particularly for addition of charcoal in manure and compost were mentioned.

- *Experienced impacts on soil/yield/growth*

The overall response is positive. Estimated increases of yield (approx. by 10%) and soil fertility, improved soil structure and moisture retention have been reported, mostly after continuous application of the techniques for several years and in combination with other measures. Also, mitigation of salinity issues in coastal areas and compaction associated with certain irrigation methods were seen. Still, if applied as means of organic farming, yields tend to be lower than in conventional farms. No negative impacts have been reported.

- *Experienced technical/financial/administrative obstacles*

Serious obstacles for application were found. These include increasing costs of digestate and farmyard manure application, driven by high regional demand and limited availability of these resources (e.g. due to planned phasing-out of livestock production), necessity to buy new machinery (compost/manure spreader), and additional administrative tasks, which are required in order to keep track of the organic fertilizing on particular fields, and to calculate the total nitrogen input, when combining the organic and mineral fertilizing. Composting might also become increasingly difficult because the legal and regulatory situation is complicated and there is an uncertainty of government subsidy payments as a major constraint. Since the availability of farmyard manure directly depends on cattle farming—which has become increasingly unprofitable due to high financial costs, constant labor requirements, and various market and administrative challenges, the future use of on-farm organic fertilizer will be limited or even impossible. This poses a serious barrier to maintaining the practice.

- *Desired support to implement the technique*

Farmers expect coordinated and simple co-financing for specialized low-emission equipment and storage capacities, which are needed for reducing odours and preventing conflicts with locals. Expert guidance is requested to determine precise application rates to avoid crop injuries, nutrient losses and reduce emissions. Different schemes sometimes overlap or even conflict with each other, creating administrative burdens and uncertainty for farmers. Without financial compensation for additional labour and investments, further upscaling of this technique remains limited, especially for small and medium-sized farms. Farmers expect professional assistance from advisory services in the form of timely and concrete information. Still, some farmers argue that the goal is not to receive agricultural subsidies. If reasonable prices could be achieved for food, these measures could also be better implemented.

- ***Possible added value for the product***

Currently, 'Carbon farming' or 'climate friendly' products do not represent a selling point. But labels showing 'organic' or 'bio' quality do increase the consumer recognition. Still, organic amendments are often viewed negatively, mainly due to odour issues or associations with waste and manure. Without adequate public education, labelling products as being grown using compost or other organic fertilizers may generate mistrust rather than added value. Farmers indicate that meaningful valorisation would require structural support, including economic incentives from cooperatives or public institutions, price premiums, and labelling schemes based on verifiable carbon-sequestration data.

- ***Estimation of further practical implementation on farm/regional/national level***

In all countries, at the farm level, there are definite plans and willingness to continue and, where appropriate, expand the use of these techniques.

However, wider uptake at national level will remain limited unless labour requirements are compensated and access to organic inputs and support schemes is improved. A limited potential for broader adoption is seen, because the livestock sector is often in very poor condition, which restricts the availability and wider use of external organic fertilizers. There is also the need for clearer and more precisely formulated regulations, as current rules are often implemented superficially or incorrectly in practice. There is a stated need for the states to provide stronger support for the animal husbandry farming sector specifically to ensure the continued availability and use of organic fertilizers.

A.2 Relocation of harvest residues

This technique was taken up by 8 farmers in 4 countries (**Table 1**)

- ***Start of implementation***

Information on the start of the implementation of this technique ranges from approximately since 1995, to 'for several years' and 'always'.

- ***Motivations to use the practice***

The main motivations include the search for convenient use of harvest residues instead of often lacking farm manure and not present livestock which could use certain crops (e.g. clover grass) as feed. Moreover, experiences from pioneer farmers showed a reduction of evaporation, a protection of soil from drying out and an improved soil nutrient cycling and soil structure.

- ***Knowledge of impact on carbon sequestration and climate***

Some farmers reported that they do not really know anything about this context. Others reported learning expected impacts of this practice from the agricultural advisory service, and discussions with other farmers. Younger farmers collected knowledge practice during their agricultural studies or through literature. Still, often this knowledge is mainly based on practical experience, rather than on quantified measurements.

- ***Experienced practical feasibility***

Positive: This practice increases organic matter in soil and reduces need for mineral fertilizers. Farmers observed that in dry years, residues left on the surface prevented the soil from drying out, making cultivation easier. It also helps to reduce the use of synthetic nitrogen. Farmers reported that in dry years residues left on the soil surface improved soil workability and reduced surface crusting.

Negative: Mulching residues like corn stalks require additional energy. Incorporating straw means giving up the financial profit from its sales. Additionally, it can increase the presence of rodents in the fields. Immobilization of N can also be present. Loss of income from straw, which currently has a high market price. In the beginning, machinery posed a problem, as the older machines were not suitable for the harvest residue spreading and cutting. A successful implementation of this carbon farming technique needs proper preparation, and maybe the support of external services.

- ***Experienced impacts on soil/yield/growth***

No direct linkage to yield increase was reported by farmers. If a slight increase in yields has been reported, it is important to mention that it has been observed as a joint effect of a complex of methods and cannot be accounted solely to this technique. Still, farmers observed improved soil moisture conditions, better soil structure and more stable crop performance under stress conditions.

- ***Experienced technical/financial/administrative obstacles***

No significant administrative barriers were reported. At the beginning of the adoption of this method some organizational challenges concerning workforce and machinery appeared.

- ***Desired support to implement the technique***

In some countries subsidies or financial help were not expected (Czech Republic, Slovakia), in others, farmers do appreciate subsidies by eco-schemes to implement the technique on a wide scale (Slovenia, Austria).

- ***Possible added value for the product***

None of the farmers directly linked this practice to an added environmental value of carbon farming products. This practice could not be identified as a marketing or price-increasing factor.

- ***Estimation of further practical implementation on farm/regional/national level***

On the farm: Farmers intend to keep incorporating residues into the soil as part of their long-term soil health strategy.

On national level: Farmers believe that by time, legislative pressure will bring eventually all farmers to implement this and other similar methods anyway. Since they already started to practice them in advance, they hope to be ahead of others in the future.

B.1 Additional cover crops

This technique was taken up by 29 farmers in all 9 countries (**Table 1**).

- ***Start of implementation***

Many farmers report about a more conscious cultivation of cover crops within the last 20-25 years. Though, practice is irregular – the cover crops are sown always only on some selected fields, each field is sown with cover crops at least once in several years.

- ***Motivations to use the practice***

Generally, the farmers stressed their personal beliefs that it is the right thing to do to move towards higher sustainability and to improve the soil quality at their farms. The inclusion of leguminous species is particularly valued for their biological nitrogen fixation potential, thereby improving N availability for subsequent crops. Financial support available through incentive programs further encourages the adoption of these practices by reducing investment risks. There is also the desire for continuous learning and professional development. Also, current CAP support triggered a wider spread of cover crop practices.

- ***Knowledge of impact on carbon sequestration and climate***

Farmers' knowledge of the carbon-sequestration potential and climate-mitigation effects of cover cropping remains limited and heterogeneous. Although most interviewed farmers (approximately 70%) had actively sought information on carbon credits and climate benefits, their primary recognized benefits of cover crops relate to improved soil fertility, enhanced structural stability, and increased crop resilience, rather than substantial greenhouse-gas mitigation. Some farmers indicated special interest into this aspect, due to a participation in a carbon credit programme. Others had been included in previous climate-soil-water or regenerative agriculture programs.

- ***Experienced practical feasibility***

Positive: This works very well on heavier soil types, making them easier to cultivate in the spring. It increases the diversity of life in the soil and reduces soil erosion. Farmers also reported a reduction in weeds within cereal crops.

Negative: The success of cover crops is difficult to predict as they perform poorly in certain years (strongly weather dependent). Mechanical control of cereal volunteers before sowing the cover crops might become time-consuming. The practice can be expensive when using specialized mixtures, while cheaper mixtures can result in lower yields for greening. Termination of some of the cover crop species can be a challenge in reduced tillage (where use of glyphosate is not allowed). One of the farmers mentioned the extra administrative burden to access the state guaranteed subsidies available for cover crop implementation.

- *Experienced impacts on soil/yield/growth*

Across the interviewed farmers, cover crops were consistently perceived as supportive of soil health and crop performance, with no negative impacts on yields reported. Although quantitative data were limited, field observations indicated improvements in soil physical properties, easier tillage, enhanced crop resilience, reduced pressure from soil-borne pests, and, in several cases, increased productivity with lower reliance on synthetic fertilisers.

- *Experienced technical/financial/administrative obstacles*

Across the interviewed farmers, the main constraints to adopting cover crops were primarily technical and management related. Moreover, the success of cover crops is highly unpredictable and varies significantly from year to year depending on weather conditions. Farmers also mentioned additional seed costs and increased labour requirements. The reduction of eco-scheme funds, which initially offered incentives for farmers implementing green investments on their farms, form an administrative limitation. Still, this practice is supported by CAP from the beginning and is therefore widely spread.

- *Desired support to implement the technique*

Since the success of cover crops is weather-dependent, farmers seek continuation of subsidies that cover the cost of expensive seeds and species. They desire help from experts to identify which specific seed mixtures work best for their local soil types and in specific climate conditions. Referring support is a matter for ministries and agricultural institutes.

“Better to invest in functional soil than in water dams!”

- *Possible added value for the product*

Farmers’ opinions differ in this point. While some declare that there is no significant market for products produced using carbon-farming techniques, and buyers generally do not pay a premium for the added environmental value, others stress that approximately 90% of the farming practices meet the criteria for regenerative agriculture and there is increasing pressure from industry for regeneratively produced goods. As a result, cover cropping practices do not yet offer a clear opportunity to increase the market value of agricultural products, but long-term potential might exist.

- *Estimation of further practical implementation on farm/regional/national level*

On the farm: Most of the farmers explicitly stated that they will continue with cover crops even without future subsidies because they see clear benefits for the farm. They would be possibly even extending their use or implement new techniques.

On national level: Farmers believe the Ministry should continue supporting cover crops in CAP. The main challenge lies in the decreasing availability of external financial support, especially from public funding sources. Still, farmers expressed a slightly optimistic opinion about gradual broader acceptance of these approaches among farmers, although admitting it is rather a slow process.

B.2 Diversification of crop rotation

This technique was taken up by 16 farmers in 7 countries (**Table 1**).

- *Start of implementation*

This technique has been adopted rather recently compared to other carbon farming practices. Farmers report of adoption of highly diverse crop rotation systems by 2023 and 2024. Just a few farmers report of diversifying the crop rotations in the context of other farm changes, like the take over of the property from the parents or the conversion to organic. Also, the diversification as a gradual adjustment over the last 15 years has been reported. Farmers include many hitherto underutilized crops like buckwheat, sorghum, einkorn, emmer wheat, oats, alfalfa, lupines, peas, rye-vetch, rice and various cover crops or their mixtures.

- *Motivations to use the practice*

The interviewed farmers cited mainly economic and practical reasons for diversifying crop rotation. Their goals include reducing production and price risks, stabilizing yields, and adapting to climate change, such as more frequent droughts. Improving soil health is also a key motivation, including enhancing soil fertility, water retention, and pest and disease control. Financial incentives and policy requirements, such as agri-environmental programs, further support these practices.

- *Knowledge of impact on carbon sequestration and climate*

Farmers' awareness of the impact of crop diversification on carbon sequestration and climate varies across countries. In Poland, practices were initially implemented for economic and agronomic reasons, with climate benefits recognized only later as a secondary effect. In some countries, such as the Czech Republic and Croatia, knowledge and engagement differ significantly among farmers. Others, particularly in Germany, Austria, and Hungary, are actively involved in regenerative agriculture projects and carbon-focused initiatives. Overall, while climate mitigation is not always the primary motivation, awareness and participation in soil carbon and climate protection efforts are increasing

- *Experienced practical feasibility*

The practical feasibility of crop rotation diversification varies by context and experience. While technically possible, it often requires careful planning, learning, and adaptation to new crops and management practices. Farmers report benefits such as risk spreading, pest reduction, and successful implementation in some cases (e.g. Hungary). However, challenges include higher workload, increased production costs, and management difficulties, as seen in Poland, Austria, and Croatia. Overall, diversification is feasible but demands knowledge, flexibility, and sometimes additional resources to be successfully implemented.

- *Experienced impacts on soil/yield/growth*

The experienced impacts of crop rotation diversification on soil, yield, and crop growth are mixed but generally positive. Several farmers reported improved soil structure, fertility, water retention, and reduced compaction. Yield stabilization is frequently mentioned, with occasionally slight yield increases, although effects are often difficult to attribute solely to diversification due to overlapping measures. In some cases, such as conventional rice systems in Austria, negative soil effects were observed compared to significant yield reductions under no-till management approaches. Overall, benefits for soil health are more consistently reported than clear yield increases, which often depend on weather and management conditions.

- *Experienced technical/financial/administrative obstacles*

Farmers report a range of technical, financial, and administrative obstacles to crop rotation diversification. Technical challenges include harvesting difficulties (e.g. legumes in Poland), weed suppression in organic no-till systems (Austria), and managing grass mixtures, because it is difficult to remove them again in a controlled manner (Germany). Financial risks arise from high machinery costs, unstable yields, expensive land prices, and reduced eco-scheme subsidies, while innovative crops are often seen as economically uncertain. Administrative barriers include limited institutional knowledge and decreasing support payments (Croatia, Poland). Overall, diversification is viewed as beneficial but demanding, as one farmer summarized: “Diversity brings health!”

- *Desired support to implement the technique*

Farmers express a clear need for financial, institutional, and advisory support to successfully implement diversified crop rotation. Many emphasize that public support is justified by societal benefits such as improved soil and water retention, with one farmer stating: "Better to invest in functional soil than in water dams!" Price premiums for regenerative products are desired, but certification costs often absorb potential gains, highlighting the need for facilitated or subsidized certification schemes. Others call for targeted advisory services, access to scientific knowledge, crop insurance improvements, and support for expensive inputs such as seeds and machinery. While some farmers rely on personal motivation, many stress that financial incentives remain crucial for wider adoption.

- *Possible added value for the product*

The perceived added value of products from diversified crop rotation systems varies widely among farmers and countries. In Poland, Farmer D highlights growing industry demand for regenerative products, offering potential certification-based value. In Austria, farmgate marketing allows farmers to communicate quality and sustainability directly to consumers, emphasizing healthy food rather than maximum yield. In contrast, in countries like Slovakia, Croatia, and parts of Hungary, no clear market or price premium exists, and "climate-friendly" labels are not yet recognized as added value. Overall, potential exists where certification or direct marketing aligns with consumer awareness and demand

- *Estimation of further practical implementation on farm/regional/national level*

Farmers generally intend to continue and gradually expand diversified crop rotation at the farm level, often linking decisions to economic viability, soil health, and sustainability goals. Implementation may include experimenting with new crops, and modernizing existing systems, while balancing profitability. At the regional and national levels, broader adoption depends on market opportunities, economic conditions, supportive regulations, and public awareness. Some farmers are optimistic about gradual acceptance, whereas others warn that insufficient subsidies or weak legislation could slow progress. Overall, expansion is seen as feasible but requires knowledge transfer, incentives, and coordinated support to maximize impact.

B.4 Agroforestry

This technique was taken up by 6 farmers in 4 countries (**Table 1**).

- *Start of implementation*

This is a technique that was just established recently by farmers. The earliest report is of 2015. Others describe start of implementation of agro-silvi-cultural systems 5 years ago. In Austria the youngest set-up was reported of 10 ha area in cooperation with the agricultural district authority of 2024 and 2025.

- *Motivations to use the practice*

The main motivations for adopting agroforestry are environmental protection, climate resilience, and sustainable farm management. Farmers highlight benefits such as improved pasture efficiency, increased biodiversity, wind protection, and reduced soil erosion. In several cases, personal conviction and environmental awareness play a key role, with farmers expressing a desire to farm "as sustainably and ecologically as possible." Agroforestry is also seen as a site-adapted strategy to offset drought, wind erosion, and other climate change impacts while strengthening overall system resilience.

- *Knowledge of impact on carbon sequestration and climate*

Knowledge of agroforestry's impact on carbon sequestration differs among farmers. While some observe improved soil and vegetation structure, measurable carbon increases are not always evident. Overall, awareness is mostly based on general knowledge that trees and permanent vegetation support carbon storage and climate adaptation.

- *Experienced practical feasibility*

Agroforestry is generally considered practically feasible but requires long-term commitment, and coordination with other farm activities. Farmers report positive effects such as increased biomass yields in shaded areas and additional organic matter input, though interactions between tree species and crops (e.g. allelopathic effects) must be considered. Implementation can be technically demanding, involving specific planting, irrigation, and protection measures, and overall impacts may vary depending on site conditions and farm structure.

- *Experienced impacts on soil/yield/growth*

Farmers report mostly positive effects of agroforestry on soil and crop growth, and better moisture retention in shaded areas. In some cases, increased biomass yields were observed, particularly where tree shade enhanced plant vitality. However, results depend on site conditions and species interactions, which can also lead to specific growth limitations.

- *Experienced technical/financial/administrative obstacles*

Farmers identify technical, financial, and administrative barriers to agroforestry implementation. Technically, the system requires precise machinery use, intensive weed control, and long establishment periods, while soil carbon improvements may only become visible slowly. Financially, high production costs, uncertain long-term returns, and dependence on subsidies limit wider adoption. Administratively, legal restrictions (e.g. on mobile grazing or prohibition of on-farm slaughter) further constrain practical expansion.

- *Desired support to implement the technique*

Farmers across countries highlight the need for targeted financial and advisory support to implement agroforestry successfully. In Poland, stronger public payments, affordable SOC monitoring, and the removal of legal barriers (e.g. for mobile grazing or on-farm slaughter) are considered essential. In the Czech Republic and Slovakia, farmers emphasize the importance of external consulting services and clearer support conditions, particularly for those economically dependent on farming. In Austria, proper funding during establishment phases and more scientific field trials are seen as crucial, as insufficient support often leads to plant losses and underestimation of maintenance efforts.

- *Possible added value for the product*

Perceived added value of agroforestry products is currently limited in most countries. In Poland, farmers see potential but report no clear market demand and call for more reliable environmental footprint assessments. In the Czech Republic, only certified organic producers (e.g. EkoFarma Probio) capture added value, while others consider it unrealistic; similarly, no clear premium is identified in Slovakia. In Austria, added value may be communicated through direct marketing (e.g. wine taverns), though it remains uncertain whether this leads to higher prices.

- *Estimation of further practical implementation on farm/regional/national level*

Farm-level continuation of agroforestry is generally planned, particularly in the Czech Republic, Slovakia, and Austria, though often with a focus on maintaining existing systems rather than expanding them. Broader national uptake is seen as possible but slow, mainly constrained by insufficient financial support, and administrative limitations. In Poland, greater implementation is linked to national quality schemes and better recognition of environmental benefits.

C.1 Reducing tillage

This technique was taken up by 30 farmers in 8 countries (**Table 1**).

- *Start of implementation*

The starting point for reduced tillage varies considerably, ranging from early adoption in the early 2000s to very recent implementation in 2022-2024. While a minority of farmers have more than a decade of experience—particularly with direct seeding or no-plough systems—the majority began introducing reduced tillage within the last two to three years. In many cases, adoption was gradual, involving reduced ploughing frequency rather than completely without ploughing. Recent uptake has often been linked to investments in suitable machinery.

- *Motivations to use the practice*

Farmers across countries cite both economic and environmental motivation for reducing tillage. In Poland, time savings, improved work organization, cost reduction, and soil quality improvement were key drivers, while in the Czech Republic motivations combined pragmatism with environmental awareness, including erosion control and fuel savings. In Slovakia, Germany, and Hungary, farmers emphasized soil protection, water retention, drought resilience, and the preservation of soil life. Cost reduction—especially lower fuel use and fewer machinery passes—was frequently mentioned (e.g. Croatia, Slovenia, Hungary). Overall, reducing tillage is viewed as a practical tool to enhance soil health, adapt to climate stress, and improve farm efficiency.

- *Knowledge of impact on carbon sequestration and climate*

Farmers' knowledge about the impact of reduced tillage on carbon sequestration and climate varies. Some, such as in Poland and the Czech Republic, actively use carbon credit schemes or calculation models and view reduced tillage as part of a broader regenerative approach that enhances soil organic matter and resilience. Others report only basic or no prior knowledge, having adopted the practice initially for practical or economic reasons and recognizing climate benefits later. In countries like Germany, Austria, Croatia, and Slovenia, farmers link reduced soil disturbance to greater root biomass, humus formation, and carbon storage.

- *Experienced practical feasibility*

Positive:
Most farmers report that reduced tillage improves time efficiency, lowers fuel consumption, and reduces machinery passes, making fieldwork faster and more cost-effective. Many observed better soil moisture retention, reduced erosion, improved soil structure, and greater resilience in dry conditions. Several farmers highlighted cost savings, stabilized yields, and positive effects on soil life and organic matter. The system is generally considered feasible when adapted to local soil, climate, and farm conditions.

Negative:
Challenges include initially high weed pressure, pest and bird damage, inconsistent crop performance, and occasional short-term yield declines. Successful implementation often requires new or adapted machinery, precise timing, and additional management skills, increasing complexity and costs. Some farmers reported technical difficulties under dry or heavy soil conditions, as well as the need to compensate for the loss of ploughing's phytosanitary effects.

- *Experienced impacts on soil/yield/growth*

Farmers frequently reported improved soil structure, higher humus or soil organic carbon levels, and better water retention following reduced tillage, often resulting in more stable crop performance under drought conditions. In Austria and Germany, improved root development and soil resilience were observed when timing and management were appropriate. However, mixed or negative yield effects were noted in the Czech Republic (up to 20% yield decline in some cases) and partly in Hungary and Poland, particularly under challenging weather conditions or with specific crops. Slovenian farmers emphasized that even when yields were similar or slightly lower, reduced costs improved overall profitability.

- *Experienced technical/financial/administrative obstacles*

Farmers across countries report significant technical and financial barriers to reduced tillage. The most frequently mentioned obstacle is the high cost of specialized machinery (e.g. direct seeders, strip-till equipment), as noted in **Poland**, **Croatia**, **Hungary**, and **Slovenia**, often combined with expensive loans and reduced subsidies. Technical challenges include increased weed pressure due to restrictions on herbicides (Poland), the need for new management skills and staff training (Czech Republic, Slovakia, Germany). Overall, while feasible, reduced tillage requires substantial learning, adaptation, and financial resilience.

- *Desired support to implement the technique*

Across countries, farmers most frequently call for financial support for specialised machinery (e.g. Poland, Croatia, Hungary, Slovenia). Many also emphasize the need for targeted advisory services, knowledge transfer, and access to latest research results to optimise reduced tillage under local conditions (Slovakia, Austria, Hungary). Some stress the importance of a clear long-term policy framework or bioeconomy strategy to provide planning security (Poland). While a few farmers prefer independence from subsidies (Czech Republic, partly Hungary), overall demand focuses on investment aid and technical guidance to scale up the practice.

- *Possible added value for the product*

Across countries, farmers report limited current opportunities to obtain price premiums for products from reduced tillage. In Poland and Hungary, most see no functioning market mechanisms or viable certification schemes, although some expect growing demand from large companies for regenerative raw materials. In Germany, participation in programs such as Naturland supports certain measures and marketing quality, but without clear climate-label price premiums. In Croatia and Slovenia, added value through climate-friendly labeling is currently minimal. Overall, expectations for a future market exist, but concrete financial rewards remain uncertain or underdeveloped.

- ***Estimation of further practical implementation on farm/regional/national level***

Farmers across countries generally plan to continue and gradually expand reduced tillage on their own farms, recognizing benefits such as lower costs, improved soil health, and better adaptation to climate variability (Poland, Hungary, Slovenia, Germany). At the regional and national level, adoption is seen as possible but depends heavily on advisory support, availability of suitable machinery, incentives, and clear guidance from government or industry (Poland, Czech Republic, Austria, Croatia, Slovakia). Younger farmers and those motivated by climate resilience are more likely to adopt the practices broadly, while older farmers may be slower to transition (Croatia, Hungary). Widespread implementation is also linked to awareness-raising efforts for both farmers and consumers.

C.4 Liming/gypsum effect

This technique was taken up by 7 farmers in 4 countries (**Table 1**).

- ***Start of implementation***

Farmers in different countries state the use of lime in different forms (quicklime, carbonated lime) for many years (the longest in Slovenia for 25 years). The rather new idea of using gypsum came up in the last few years (2023 and 2025, resp., Germany). Addition of rock flour as additive for manure and slurry is applied for a long time (since 2006, Germany).

- ***Motivations to use the practice***

In Poland, liming was initially adopted to improve agronomic performance and economic efficiency, with environmental benefits such as carbon sequestration recognized only later. In Germany, gypsum application is motivated by improving soil structure, enhancing water retention, and supplying calcium or sulphur—particularly for legumes—while fitting organic farming requirements. In Croatia, liming is mainly used to improve soil chemical and physical properties and secure higher, more stable yields. In Slovenia, farmers emphasize yield and soil fertility benefits, cost reductions for mineral fertilizers, and the role of organic inputs within circular and livestock-based farming systems.

- ***Knowledge of impact on carbon sequestration and climate***

In Poland, knowledge of climate impacts is indirect: liming is mainly linked to improving fertilizer efficiency and soil structure, with limited explicit focus on carbon sequestration. In Germany, farmers show a comparatively high awareness of the role of calcium in clay-humus complexes and carbon storage, supported by advisory events and subsidy schemes (e.g., K33). In Croatia, awareness has increased through participation in carbon farming workshops, but links between calcium and carbon sequestration are not yet fully understood.

- ***Experienced practical feasibility***

Positive:

Farmers report improved soil structure, organic matter, nutrient availability, and yield stability, with long-term agronomic benefits outweighing the effort. Granulated or pelletized materials and modern spreading technology facilitate more precise and efficient application, and some practices reduce the need for mineral fertilizers (Poland, Germany, Croatia, Slovenia).

Negative:

Application can be labour- and cost-intensive, requiring significant working hours and specialized or expensive machinery. Fine or dusty materials are difficult to distribute accurately at low rates, and incorporation (e.g., ploughing in) may increase workload, depend on weather conditions, or negatively affect soil moisture (Poland, Germany, Slovenia)

- ***Experienced impacts on soil/yield/growth***

Farmers report that liming or gypsum application improves soil chemical properties, nutrient availability, and overall soil structure, leading to more stable and often higher yields (Poland, Croatia, Slovenia). Enhanced soil fertility enables cultivation of more nutrient-demanding crops and improves fertilizer use efficiency, with benefits becoming more visible over the long term (Poland). Positive effects on biological activity, including earthworm populations, and reduced compaction were also observed (Slovenia). In Germany, effects are partly indirect or crop-specific (e.g., sulphur effects in clover), with visible growth differences when application is uneven.

- ***Experienced technical/financial/administrative obstacles***

Overall, few major obstacles to liming were reported: in Poland and Croatia, the practice was considered technically feasible with existing machinery, with constraints mainly related to material availability and price. In Slovenia, additional costs for liming materials and the long time required to achieve meaningful changes in soil pH were noted. For gypsum application in Germany, challenges are primarily technical and economic, including precise spreading requirements, high investment costs for specialized machinery, and limited cooperation opportunities between farms. Administrative or regulatory barriers were generally minimal across the countries.

- ***Desired support to implement the technique***

Farmers desire financial and advisory support to implement liming and gypsum effectively, including co-financing for soil analyses, fertilization plans, and material purchases (Croatia, Germany). Guidance on best practices, cooperation for bulk material orders, and clear government or certification frameworks (e.g., carbon farming measures, CO_2 certificates) are also valued (Germany, Slovenia). Additionally, support in understanding synergies between techniques to optimize soil health, yields, and economic efficiency is considered helpful (Slovenia).

- *Possible added value for the product*

Farmers generally do not expect direct added market value from liming or gypsum application (Germany, Croatia, Slovenia). While some ideas for labeling or climate-related marketing exist for specific cases like clover grass in feed (Germany), in most cases the practice is seen as improving soil and yields rather than creating a marketable product attribute. Overall, carbon or environmental benefits are not currently reflected in product pricing or consumer demand.

- *Estimation of further practical implementation on farm/regional/national level*

Farmers generally see continued on-farm implementation of liming and gypsum as feasible and beneficial where needed, particularly if noticeable yield or soil improvements occur (Poland, Germany, Croatia, Slovenia). Broader regional or national adoption is constrained by high material and machinery costs, and challenges with uneven application on leased or neglected, acidic land (Poland, Croatia). Financial incentives, supportive policies, and targeted programs like K33 are considered essential to encourage wider uptake, while media and awareness campaigns could help highlight benefits (Germany). Overall, adoption depends on both practical feasibility on the farm and economic or policy support at larger scales.

OVERVIEW OF RATING OF IMPACT, FEASIBILITY, AND ACCEPTANCE OF CARBON FARMING TECHNIQUES

Table 2: Average rating of country averages of farmers of impact, feasibility, and acceptance after uptake of carbon farming practices on a scale from 0 (very low) -10 (very high)

Criteria	A.1 External organic fertilizers	A.2 Relocation of harvest residues	B.1 Additional cover crops	B.2 Diversi-fication of crop rotation	B.4 Agro-forestry	C.1 Reducing tillage	C.4 Liming/ gypsum effect	Average of country average scores/ total numbers of evaluation
Estimation of the positive impact on carbon sequestration	8,69	7,08	8,37	7,73	7,63	7,53	6,78	7,69
Feasibility (incl. costs and labour demand)	5,53	7,00	6,82	6,32	5,13	6,88	6,88	6,37
Acceptance (of farmers, consumers, public)	7,14	7,88	7,50	7,11	5,81	6,77	7,31	7,07
Total score (sum)	**21,36**	**21,95**	**22,68**	**21,16**	**18,56**	**21,18**	**20,97**	**21,12**
Number of evaluations	24	8	29	16	6	30	7	**120**
Countries included	Croatia		Croatia	Croatia		Croatia	Croatia	
	Germany		Germany	Germany		Germany	Germany	
	Hungary		Hungary	Hungary		Hungary		
	Italy		Italy					
	Slovenia	Slovenia	Slovenia			Slovenia	Slovenia	
		Austria	Austria	Austria	Austria	Austria		
	Czech Republic	Czech Republic	Czech Republic	Czech Republic	Czech Republic	Czech Republic		
	Poland		Poland	Poland	Poland	Poland	Poland	
	Slovakia	Slovakia	Slovakia	Slovakia	Slovakia	Slovakia		

After 120 evaluations and an average total score of 21.12, B.1 Additional Cover Crops reached the highest total score of 22.68, B.4 Agroforestry the lowest total score of 18.56. These total scores sum up all evaluations of the estimated impact on carbon sequestration, the feasibility in practice, and the acceptance of the respective carbon farming technique. The higher the total score, the better the overall value of a carbon farming technique for up taking practitioners. Moreover, B.1 Additional Cover Crops, was chosen in all participating Central European countries.

Interesting is the comparison to the cumulative evaluation (between 1-5 for impact, feasibility, acceptance each) of project partners as experts conducting field trials of all techniques, published in Deliverable D.1.2.1. Here B.2 Diversification in crop rotation had the highest total score with 10,5 followed closely by

Additional cover crops (B.1) with a total score of 10,4. Relocation of harvest residues (A.2) was ranked third with a total score of 10,0. Liming/gypsum effect ranked sixth with a total score of 9,3, while Agroforestry has the lowest total score of 8,0.

This means that the cumulative evaluation of the value of the techniques examined in terms of their impact, feasibility, and acceptance from the perspective of farmers and experts is very similar: B.1 Additional cover crops, B.2 Diversification in crop rotation, and A.2 Relocation of harvest residues show very good overall scores, while C.4 Lime/gypsum effect and B.4 Agroforestry currently occupy the last places. Nevertheless, all assessment values were quite close to each other.

PLANS FOR MAINSTREAMING CARBON FARMING PRACTICES BY AGRICULTURAL SUPPORT

The September 2025 released CE Guide for Carbon Farming (CF) Techniques includes definitions, information, explanation and tips for decisions and implementation of seven CF techniques. These techniques are 'External organic fertilizers', 'Relocation of harvest residues', 'Additional cover crops', 'Diversification of crop rotation', Agroforestry', 'Reducing tillage', and 'Liming/gypsum effect'. Besides, an automated decision matrix was provided as a hands-on CF tool for farmers and agricultural advisory services. For mainstreaming of CF practices 45 farmers took up at least one of the defined CF techniques based on the guide and provided experiences, opinions, and estimation of feasibility, impact and acceptance of every single applied technique. In the same way, the CE Guide for Carbon farming Techniques can be used by other agricultural advisors, consultants and educators.

Austria

In Austria, these consultants could be the about 50 consultants of organic farmers unions, or federal agricultural advisors, which are spread out in whole Austria, supervising farmers and guiding those who are interested to implement carbon farming techniques. Also, appropriate parts of the guide can be translated into the national language for this purpose.

The guide can in addition be offered to other agricultural advisory services and organic associations in Austria like Bio Austria, Erde & Saat, Demeter. Naturland, via agricultural magazines, the institutional website of Bio Forschung Austria and via large events gathering many farmers from outside of the consortium (e.g. Bio Austria Ackerbautage, Soil Evolution, etc.), the guide for CF techniques can be made publicly available.

Croatia

In Croatia, this role could effectively be taken on by the sales representatives and cooperants of the Agricultural Institute Osijek (AIO), who are present throughout the country. As part of their regular promotional activities, they could use the guide to offer potential customers a range of specially selected mixtures and legumes ideally suited for carbon sequestration practices, such as additional cover crops and diversification in crop rotation. In this way, farmers – the end users – would gain clear insight into the added benefits of using products from the Agricultural Institute Osijek, while simultaneously supporting sustainable farming and soil carbon enhancement.

Additionally, faculty members from the Faculty of Agrobiotechnical Sciences Osijek (FAZOS) — some of whom have already participated in various Carbon Farming CE project activities as partners of the AIO — can incorporate the guide as a valuable supplementary resource in their lectures. This would be particularly effective at the Department of Agroecology and Environmental Protection, the Department of Plant Production, and the Department of Agricultural Engineering and Renewable Energy Sources.

Other institutions to which this guide could be offered include the Croatian Chamber of Commerce, specifically the Osijek County Chamber, and the Ministry of Agriculture, Forestry, and Fisheries, i.e., the Directorate for Professional Support to Agricultural Development. Within the Osijek Chamber, the Expert Group for Crop Production and Agricultural Services is a key body in the agricultural sector of the country, bringing together large agricultural systems, cooperatives, family farms, and their producer associations, as well as scientific institutions such as FAZOS and AIO. In addition to agriculture, this group also includes processing industry activities. Among other tasks, the group participates in the implementation of autumn and spring sowing plans, where the guide could be used as a tool for advising farmers. The Directorate for Expert Support to Agricultural Development, part of the Ministry of Agriculture, Forestry and Fisheries, works closely with farmers nationwide, both in the field and administratively. Distributing the guide through this Directorate would enable its direct use in advisory work, allowing expert advisors to integrate it into regular activities, workshops, and individual consultations. This would ensure wider access to relevant information and a more uniform understanding of the recommendations among farmers with different production orientations.

Czech Republic

During the campaign led by the CFCE project partner of Czech Republic, the Agricultural Research Ltd., Trobsko, several partner institutions and subjects have been approached in order to form a cooperation focused on spreading awareness and practical adoption of carbon and regenerative agriculture among the farmers, not only in Czech Republic, but also in other European countries and the world. The main initiative in this regard can be seen in consultations and considerations of future common work with Carboneg, a leading carbon credit company in Czech Republic, which is also established in Slovakia and expanding to other countries as well, including outside Europe. As a part of their business model, Carboneg supports its clients with advisory services and numerous educational events throughout the year.

In addition, discussions are underway with the Agricultural Knowledge and Innovation Institute of the Slovak Ministry of Agriculture, which may lead to common educational events in the close future.

Germany

In Germany, these consultants could be the about 50 Naturland consultants, which are spread out in whole Germany, supervising organic farmers and guiding those who are interested to convert from conventional to organic. Also, appropriate parts of the guide can be translated into the national language for this purpose.

Furthermore, lecturers and speakers of the University of Applied Sciences Weihenstephan-Triesdorf (e.g. Prof. Rohse – Agricultural Chemistry, PD Dr. Bettina Faehnrich – external lecturer for the Public Climate School Week, Prof. Goebel – Soil Sciences) and lecturers at the University of Natural Resources and Life Sciences Vienna (BOKU) (e.g. PD Dr. Bettina Faehnrich – Crop Production) will use the guide for transfer of practical knowledge for implementation of CF techniques to agricultural students.

The guide can in addition be offered to other agricultural advisory services and organic associations in Germany like Bioland, and Demeter. Via Naturland print media 'Naturland Nachrichten', via the institutional website and via large events gathering many farmers from outside of the consortium (e.g. Ackerbautagung), the guide for CF techniques can be made publicly available.

Besides, the guide for CF techniques and the present Regional Reports on mainstreaming CF practices will give good practical input to other projects and conferences treating sustainable and climate-friendly soil management (e.g. SOIL:OurInvisibleAlly-Project; SOIL Re-Union conference).

In any case of practical knowledge transfer also the feedback of the individual target group will in return be of value for optimizing research and practice of carbon farming.

Hungary

As outlined during the preceding activities (e.g. national seminars, national roundtable) organised as part of the project, the transfer of knowledge related to carbon management is of paramount importance, particularly regarding the positive impact of various techniques on soil and increasing the resilience of farmers. Agricultural advisors play a pivotal role in raising awareness and providing practical information about carbon farming. Materials such as the guide for CF techniques have been demonstrated to have the capacity to provide substantial support for this kind of activity.

In the context of earlier activities of the CFCE project in Hungary (seminars, national roundtable), which were further validated by the results of the interviews in this report, it is evident that the primary focus should be directed towards the agrotechnical benefits of carbon farming techniques within the framework of the current service provision, including farm management and administrative monitoring assistance (this includes identifying and managing various financial incentives under different Common Agriculture Policy schemes and other sources). The attainment of successful carbon sequestration outcomes, accompanied by the accreditation of the process, can potentially lead to financial income from the sale of carbon credits. However, this income should be regarded as a supplementary benefit, rather than the primary incentive, for farmers over time.

At present, several institutions are engaged in research related to the subject of carbon farming. It is important to ensure that the knowledge produced there is disseminated to those who can apply it in practice. One of these institutions is the Innovation and Digitalisation Support Unit (National CAP Network) in the Institute of Agricultural Economics (AKI). It has the necessary expertise for carbon farming research, is fundamentally oriented towards knowledge transfer, and seeks to share knowledge on carbon farming as widely as possible. In the future, carbon farming will also be addressed in the framework of the EIP by AKI. According to the National Chamber of Agriculture (which is responsible for the registration and further education of agricultural advisors) the present training system for registered agricultural advisors (if appropriate training materials are available) could be utilised to disseminate the knowledge necessary to ensure the effective functioning of the model and to make available practical knowledge related to carbon farming.

Italy

In Italy, the guidelines will be shared by Ri.Nova Soc. Coop., which will make them available first to its members, including 54 members such as Producers' Organizations (POs), farmers' cooperatives, and other organizations and in general widespread to all agricultural sectors. This network includes technicians, agronomists, and farmers from the main POs in the Emilia-Romagna region. The guidelines will be distributed through Ri.Nova's main communication channels, particularly the newsletter and the official website, ensuring easy and timely access for all members of the professional community.

The guidelines will be incorporated into specific training courses and technical update sessions organized by Ri.Nova, targeting technicians, consultants, and agricultural operators. These activities will provide opportunities to explore Carbon Farming techniques in detail, illustrate their effective application in different farming contexts, and support knowledge transfer while raising awareness of sustainable soil management. Dedicated meetings will also be organized to discuss current and emerging regulations on Carbon Farming and potential soil quality monitoring indicators. These sessions will serve both to disseminate results and to clarify best practices and their positive impacts, as examined across various PSP and Supply Chain Projects with the University of Bologna and Ri.Nova member POs.

Ri.Nova will also provide mentoring and monitoring to support the adoption of Carbon Farming practices by farmers throughout the project and beyond. Feedback from farmers and technicians will be collected systematically, for example through surveys or structured interviews, to evaluate the feasibility, acceptance, and practical impact of the techniques. This process will enable continuous improvement of the guidance and ensure that the support provided is aligned with the real needs of practitioners.

Furthermore, Ri.Nova will strengthen the long-term uptake of sustainable and Carbon Farming practices by implementing demonstration activities, conducting field visits within other ongoing European and national projects (such as the SPIN-FERT Project, Supply Chain initiatives, OCM projects), carrying out targeted promotional actions, and actively participating in competitive funding calls with project proposals aimed at facilitating farmers' access to financial instruments supporting the adoption of good agricultural practices.

Ri.Nova researchers will further support the use of the guidelines through technical presentations and meetings aimed primarily at consultants and PO technicians. These activities will help farmers implement Carbon Farming practices by providing practical guidance based on scientific evidence, while strengthening the capacity of technicians to encourage the adoption of sustainable agricultural methods.

Poland

In Poland, the uptake and mainstreaming of Carbon Farming (CF) practices outside the project consortium can be effectively ensured through the existing national system of agricultural advisory services, public research institutes, and close cooperation with the Ministry of Agriculture and Rural Development. A key role will be played by Institute of Soil Science and Plant Cultivation – State Research Institute (IUNG-PIB), which acts as a national centre of excellence in soil science, nutrient management, climate-smart agriculture and carbon farming. IUNG-PIB maintains long-standing institutional cooperation with the Agricultural Advisory Centre in Radom (CDR Radom) and regional agricultural advisory services, ensuring direct and continuous knowledge transfer to farmers and advisors across the country.

The CE Guide for Carbon Farming Techniques, together with the decision-support matrix developed within the project, can be integrated into national advisory materials, farmer training programmes and extension guidelines coordinated by CDR Radom and disseminated through regional advisory centres. IUNG-PIB receives annual public funding dedicated to farmer training and capacity-building, which enables systematic inclusion of carbon farming topics in certified training courses, workshops, demonstration activities and advisory programmes delivered every year.

Through its cooperation with the Ministry of Agriculture and Rural Development, IUNG-PIB can also support the uptake of CF techniques at policy level, including their alignment with CAP eco-schemes, agri-environment-climate measures and national soil and climate strategies. The guide may serve as a practical reference document for policy design, advisory recommendations and result-based approaches related to soil carbon management. Furthermore, the guide can be translated into Polish and adapted to national agronomic, climatic and regulatory conditions. It can be used by agricultural advisors, consultants, educators and trainers affiliated with public advisory services, agricultural universities and vocational education centres. Elements of the guide may also be incorporated into curricula for agricultural students and lifelong learning programmes for farmers.

The guide and accompanying regional reports can be disseminated widely through national conferences, advisory seminars, demonstration farm networks, institutional websites and advisory publications, reaching farmers and stakeholders well beyond the project consortium. In addition, they can provide valuable input to other national and European projects, networks and events focusing on sustainable soil management, climate mitigation and regenerative agriculture. Finally, as in the German case, feedback collected from farmers, advisors and institutions using the guide in practice will be systematically fed back into research and advisory work at IUNG-PIB, supporting continuous improvement of carbon farming methodologies and their practical applicability under Polish conditions.

Slovakia

In Slovakia, the uptake of carbon farming practices within the project is represented by practical examples from individual farms, such as the agricultural cooperative PD Krakovany – Stráže (Ing. Robert Dohál) and the farm Záhon Rozuma (Bohuš Budaj), where selected CF techniques were applied under local conditions. These examples demonstrate practical possibilities as well as limitations of implementing carbon farming techniques in Slovak agricultural practice.

The guide and the results of Activity A.1.4, including this Regional Report on mainstreaming carbon farming practices, may serve as reference materials for advisory, educational or training activities related to climate-friendly and sustainable soil management. At this stage, no formal or institutional uptake of the materials by agricultural support institutions outside of the project consortium is assumed. In any future knowledge transfer activities, feedback from farmers and other practitioners is expected to remain an important source of information for further development and realistic application of carbon farming approaches.

Slovenia

The Slovenian Ministry of Agriculture has shown high interest in the project results. After several consultations with their representatives, they aim for new CAP iteration to offer specific support for the practices with the highest C sequestration and reduced emission, and practices that support yield stability under changing climate conditions. Uptake of our findings and transformation into practice is therefore possible. Ministry is hesitant about CRCF Carbon farming approach, however strongly supportive on CAP financing of carbon farming practices.

At the same time, the Agricultural Advisory Service is tasked with providing direct, field-based technical support, helping farmers to transition to conservation tillage and precise farming practices. Advisory service has expressed interest for workshops and results from our project to support their activities in helping farmers and Ministry.

EXPECTED CO_2 SEQUESTRATION AS A RESULT OF CARBON FARMING UPTAKE

Expected carbon sequestration will be given according to preliminary results from the two years lasting experiments on the pilot sites of the project and according to other findings. In general, long-term application will always justify higher expectations of carbon sequestration in agricultural soils than on a short-term, where seasonal fluctuations must be considered. Based on our results of the average of all tested carbon sequestration methods, a relative increase in total organic carbon (TOC) of 7.18% can be expected. Results show also that carbon sequestration is a very dynamic process, involving both the sequestration of C and the decomposition of organic matter that leads to C emissions. Adding to this are the differences in farming practices that specific farms apply and changes in growing conditions that affect sequestration. This shows that the uptake of carbon farming practices is only meaningful with a longer period of commitment with consistent practice adoption, reduced soil degradation, and stable policy support to achieve an actual improvement in SOC.

A.1 Additional organic fertilizers

The overall numerical evaluation of the development of total organic carbon (TOC) after the addition of external organic fertilizers in the form of compost or biogas digestate showed a positive change of 2.94% compared to the initial value (corresponding to 0.04% TOC of soil DM) over a period of two consecutive growing seasons. This refers to test sites in three different Central European countries. Long-term trials for which data was available showed even higher relative increases (approx. 20%). Therefore, regular addition of organic fertilizers in various forms (slurry, manure, compost, digestate, etc.) can be expected to have a positive effect on carbon sequestration on a long term, though single applications did not (yet) show a positive TOC development in the experimental period. In Slovenia, after 30 years, some practices increased SOC stocks by more than 10 t/ha in the upper 30 cm of soil.

A.2 Relocation of harvest residues

The relocation of crop residues often involves transporting plant biomass with a high legume content from one field to another (cut-&-carry system). In our two-year trials, this technique resulted in an increase in the TOC content of soil DM of +0.11% on average across three sites, which corresponds to a relative increase of 17.61% compared to the baseline value. This supports the assumption that methods for transferring biomass have a surprisingly high positive impact on carbon sequestration in the receiver field.

B.1 Additional cover crops

The use of various mixtures of cover crops or pure single species cover crops over the winter instead of fallow land showed an average positive change of 2.74% compared to the baseline value (corresponding to 0.02% TOC of soil DM). These are numerical results from four different countries in Central Europe; long-term results are not available. More favourable weather conditions would likely have resulted in a greater impact of different pea varieties on soil carbon storage. Because the year was extremely dry, peas failed to develop sufficient biomass; for this technique to be effective, at least 5–8 t/ha of dry matter needs to be incorporated into the soil. Therefore, the direct impact of this technique on carbon sequestration is expected to be neutral.

B.2 Diversification of crop rotation

Four sites with intercropping and the inclusion of underutilized crops in highly diverse crop rotations showed an average increase in soil DM TOC content of 0.19%, representing a positive change of 15.89% compared to the original TOC content. These values indicate a high potential for carbon sequestration, resulting from valuable carbon inputs from root mass, root exudates, necromass from soil microorganisms, and a high influence on mineral associated organic matter. Nitrogen input, e.g. by legumes, also appears to benefit carbon sequestration. Incorporating corn, red clover, and alfalfa increased humus content and TOC.

B.4 Agroforestry

When viewed in the short term and taking only one location into account, the agroforestry system (as the average of all parts, forestry, and agriculture) showed an absolute decrease in TOC of 0.18% and a relative TOC loss of 10.29%. Seasonal fluctuations caused greater deviations than cultivation systems. In this case, further long-term studies are strongly recommended before reliable expectations regarding carbon sequestration can be formulated. Still, positive side-effects of agroforestry for carbon sequestration are soil protection of wind erosion and shading, which generally increases soil moisture even in dry periods. And the TOC uptake in upper-ground biomass is well measurable and visible, which is an advantage for promoting this technique.

C.1 Reducing tillage

Reducing tillage can involve various methods, from shallow tillage, strip-till, non-turning Turiel methods, loosening with cultivators, to no-till methods. By reducing the intensity and frequency of tillage, these practices aim to maintain adequate soil cover, minimize erosion, and stimulate biological activity and organic matter accumulation. Still, short-term trials in four countries showed a relative TOC loss of 1.54%, which corresponds to -0.02% TOC of soil DM. An experiment with no-till farming, for which long-term data is available, showed a relative increase of 5.40% TOC. According to the available studies, an increase in organic carbon can therefore only be expected in the long term, and probably also on soil depth, varying depending on the method used.

C.4 Liming/gypsum effect

Even in the short term and including data from two agricultural sites in different countries where lime and/or gypsum was applied, the relative increase in TOC was 12.40%, corresponding to an increase of 0.16 TOC % points in the soil DM. Particularly gypsum application is therefore a promising carbon farming technique, likely due to carbon complexation with easily available Ca ions in the soil. Even within the current mainstreaming initiative on carbon farming, four out of five farmers in Germany have successfully adopted this practice. Liming is especially effective on acidic soils and should ideally be combined with organic fertilization to counteract humus loss and maintain soil health following liming.