EU CAP Network Focus Group

'Regenerative agriculture for soil health'

Mini Paper 4

Value creation through regenerative agriculture

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1. Introduction and motivation

The advantages of regenerative agriculture[1] are described in literature and recognised as having a significant and positive environmental impact, especially on the increase and conservation of soil organic carbon and on the subsequent physical, chemical and biological properties of soil (e.g. soil fertility, water storage capacity, resilience to climate change, biodiversity protection, carbon sequestration and water retention). So far, despite its advantages, regenerative agriculture is not widely adopted. For instance, agricultural practices focusing on soil conservation are practiced solemnly on around 10% of arable areas, but it is growing. In past years, multiple examples throughout the world have shown that regenerative agriculture moved from an elusive concept to being a proven solution, and a solid answer to the future of farming.

Many farmers take the decision to change their management most often based on the expected monetary cost-benefit balance. But so far there exists still a lack of systematic evidence on such cost-benefit balances for regenerative agriculture, covering different types of farms and bio-physical as well as socio-economic contexts.

The challenge for our future is to provide economic benefits for the application of regenerative agriculture to make it more competitive or profitable compared to conventional agriculture. This paper gives an overview on the costs avoided by farmers farming in a regenerative way, the new potential markets opened by environmental benefits as well as ideas for further research and innovative projects / actions..

2. Overview on key issues

While ecological benefits are well documented, the value created, cost reduction and new benefits for the farmer are little known and measured. This slows down the attractiveness for and diffusion among the rest of the farmers. There may also be risks and losses for the farmer in the first period after that change of their production system. These can be related with reduction of productivity or the difficulty of mastering new techniques as well as additional workload linked to training and new purchases (new materials, new seeds, etc.). The environmental and economic cost-benefit analysis should be done all the way through from the start of the transition to the phase where there is a new relative stable state in the farm, although the improvement is a process which will continue even after achieving this first relative stable state.. In practice, we need to analyse the first 10 years of the transition. In that way, we will be able to identify the financial support farmers need to engage in a safe transition.

The value generated by regenerative agriculture must be weighted against the risk of the transition for the farmer. The value generated must also increase in profitability of regenerative agriculture - and the interest raised among the farming community and the actors that interact with this community.

Furthermore, regenerative agriculture should be supported by society as it provides common goods (e.g. clean water, store carbon, cool the climate).

[1] See definition in the Final report

3. Potential drop in profitability in the first years after implementation

When a farmer adopts a regenerative farming approach, he relies more on the bio-services provided by nature as he starts working with natural processes instead of regulating them by using external inputs (e.g. pesticides, mineral fertilisers and deep ploughing). Therefore the transition may cause a temporary drop in profitability.

This drop could be traced to:

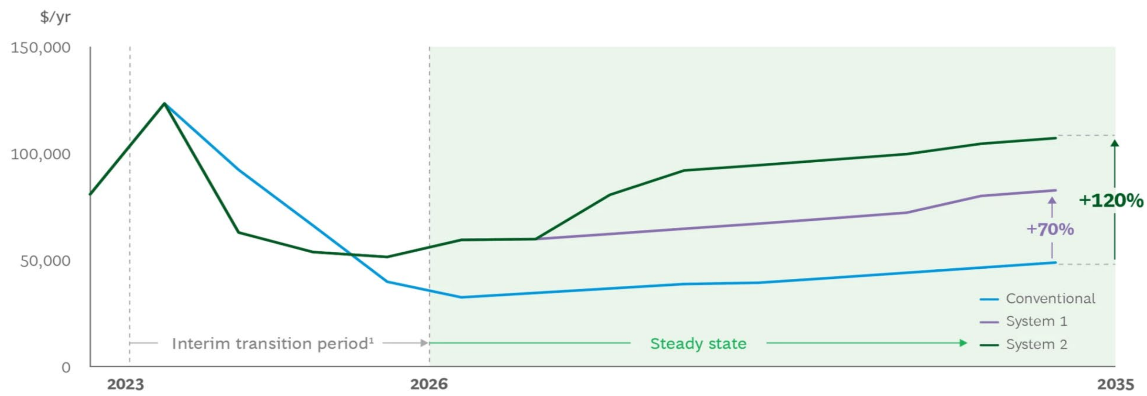
(1) The learning curve: farmers need to learn how to manage their farm differently. It means that they are experimenting, failing, learning, and improving. The failures that are inherent in the learning process cause yield and profit losses.

(2) The duration of the soil fertility regeneration process: soil which has for a long time been mechanically loosen, chemically fertilised and treated with pesticides need time for (a) create a stable structure favourable to root growth, (b) accumulate organic matter which will retain and provide water and nutrients as well as help improving soil structure, (c) regenerate biological communities which can support crops in accessing nutrients as well as resisting to pest and diseases.

(3) The investments needed: regenerative farming often requires new types of machinery (e.g. direct seeding machine). Investing in this costly equipment without completely mastering the new production system and lower yields in first years after the transition generate profit losses which may be difficult to handle.

Exhibit 1 - Farmers Embracing Regenerative Agriculture Can Expect Significant Financial Gains

Profit by farming system for average 780-acre Kansas wheat farm ($/year)



Sources: OP2B and BCG analysis.

Note: System 1 is the basic/intermediate phase that includes cover crops, less-frequent tilling, intercropping, mulching, and the reduced use of crop protection chemicals, among other practices. System 2, which includes more diversified crop rotation, formal livestock integration practices, and other landscape changes, carries the transition through to completion.

[1]Declines in profit due in part to wheat prices returning to long-term average.

The Boston Consulting Group (BCG) describes the profitability gap and return on investment well in its report on "Cultivating Farmer Prosperity

Investing in Regenerative Agriculture" (for details have a look on this document as well as the full report). One of the main messages is that within the first years of implementing regenerative agricultural practices farmers are likely to see a decline in profits of up to 60% or more, due to lower crop yields and the added cost of seeds and new machinery. Over time, however, and once farmers reach a relatively steady state of regenerative practices and increased soil fertility, existing data indicates a positive long-term business case for farmers, resulting in between 70% and 120% higher profitability and a return on investment of 15% to 25% over 10 years compared to conventional farming.

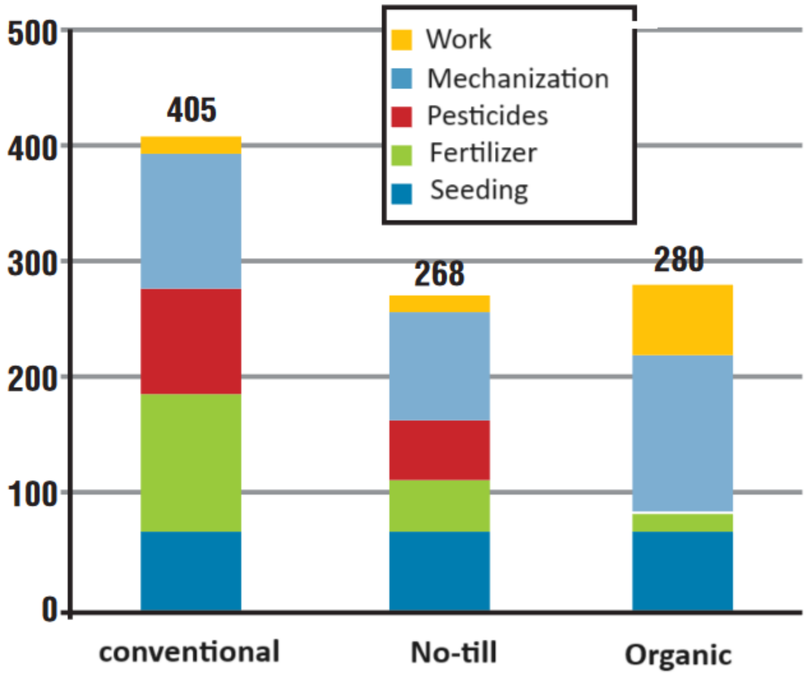
❖ 3.1 Added value of soil conservation

❖ Machine and fuel

The farmer will need to have access to a new type of seeder, by renting or purchasing it. These seeders allow the seed to be placed in the soil without tillage, being the tillage replaced by the work of (cover crop) roots. The use of this type of seeders makes it possible to reduce the overall mechanisation load.

When a farmer switches to a soil conservation system, his soil structure will be improved by (cover) crop's roots. He will sow a diversified cover crop (e.g. phacelia, fava beans, peas, radish, rye, etc.) whose roots will structure and crack the soil. When this cover is terminated, the roots of the plant cover will die, creating preferential paths for the roots of the following crop and for biology.

As the figures in TCS magazine explain, a farmer who switches from ploughing to direct seeding has to part with some of his equipment. He needs less powerful tractors and reduces his use of tillage equipment. **The average number of tractors per farm is reduced by a third.**



Comparison of production costs of three farming approaches in a cruising situation.

Diesel consumption per hectare is also greatly reduced. It's halved. The farmer goes from an average of 52l/Ha to 26l/ha.

A French farmer, Julien Senez, estimated that after 10 years, he reduced the costs on his farm by 110€/ha, mainly through fuel and machine cost reduction, which is consistent with the estimations from Toque et al. (2010) in Labreuche et al. (2010). In parallel, he increased yield and added carbon credit benefits (42 euros), leading to a 270€ net margin increase due to less costs.

- Nutrients and fertiliser saved

Soil conservation also prevents nutrient loss through erosion. The main elements leached are N, Ca, P, K and Mg. In a tropical environment the savings can go up to 567 EUR. according to the CIRAD (165 kg N per ha = 129€, 453 kg K per ha = 181€, 514Ca+Mg kg per ha = 257€. Total 567€). In temperate area, cover crops can typically store 80kgN, 25kgP and 185kgK.

By preventing part of nutrient loss from leaching, thanks to the plant cover which recycles the elements, the farmer will reduce the amount of fertilizer needed. This represents up to 225 €.[2]

3.2 Added value of regenerative grazing

A farmer who includes in his farm ruminant rotational grazing reduces the production costs, as this technique improves grass growth and meadow productivity. It also makes livestock farming compatible and complementary with intercropping soil cover practices. Moreover, during the pasture period the animals collect their feed without mechanisation. Grazing even reduces the need for additional fertilisers, as animals fertilise the ground with manure. In the end, carrying out rotating pasture management on the farm reduces the total mechanisation needs over the year. Moreover, grazing increases carbon sequestration in the soil.

4. Provision of public goods through regenerative agriculture

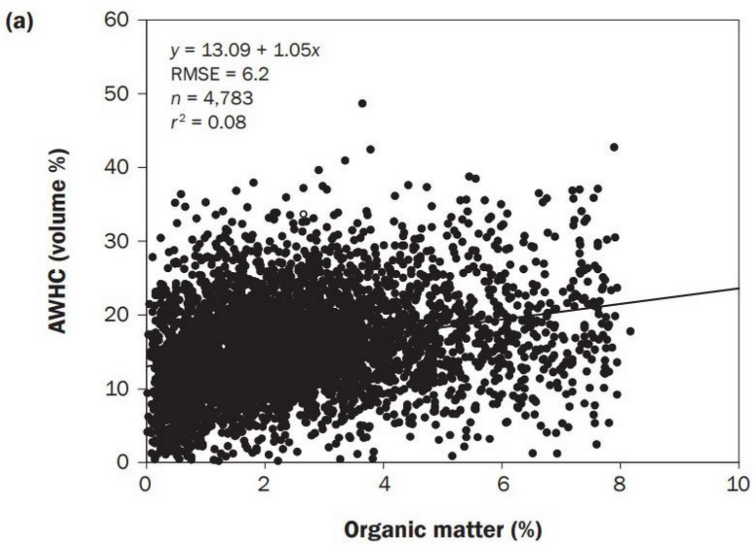
4.1 Water quality and sequestration in soil

Many elements contribute to infiltrability like vegetation by its diversity, its regularity over the year and its quantity, direct seeding and residue retention on soil surface. The plant cover breaks the kinetic energy of the droplets which do not create a crust on the surface and infiltrate better into the soil. It also helps reduce water loss from the soil through evaporation. The higher the percentage of organic matter, the more capable the soil is of infiltrating rainwater and storing water for crops. Soil conservation practices enable farmers to save water. These elements show how the regenerative agriculture approach can reduce the risk of erosion and flooding through better infiltrability.

Regenerative agriculture and vegetation cover play a major role in protecting soils against heat and drought and therefore the crops as well. First of all, regenerative practices - especially by improving the level of organic matter - allow soils to retain more water and keep plants in a state of non-hydric stress for longer.

[2] Estimation done by the Agricultural chambers of Dordogne in Nov. 2013 (France), using the MERCI method.

Figure 6
Soil available water-holding capacity (AWHC) versus soil organic matter (SOM) for (a) 0% to 8% range and (b) 0% to 100% range of SOM.



Relation entre teneur en O des sols et réserve faicilement utilisable (Libohova et al. 2018)

Measuring the results of these practices with an adapted risk assessment approach could help reduce insurance costs for farmers who engage in good practices and present fewer risks of crop dryness. For example, insurance could be 30% cheaper.

❖ Insurance against climate risks linked to floods paying for flood damage.

This involves developing value transfer mechanisms for farmers to reduce the risk incurred with the transition. The more agriculture damages the rate of soil infiltration, the greater the risk of flooding. We can therefore suggest that the opposite is also true. The more the soil can infiltrate water, the less likely flooding will occur and cause damage. **Payment thresholds could be imagined by insurance to protect watersheds from flooding by improving practices for better water infiltrability**.

❖ Avoid pollutants in water

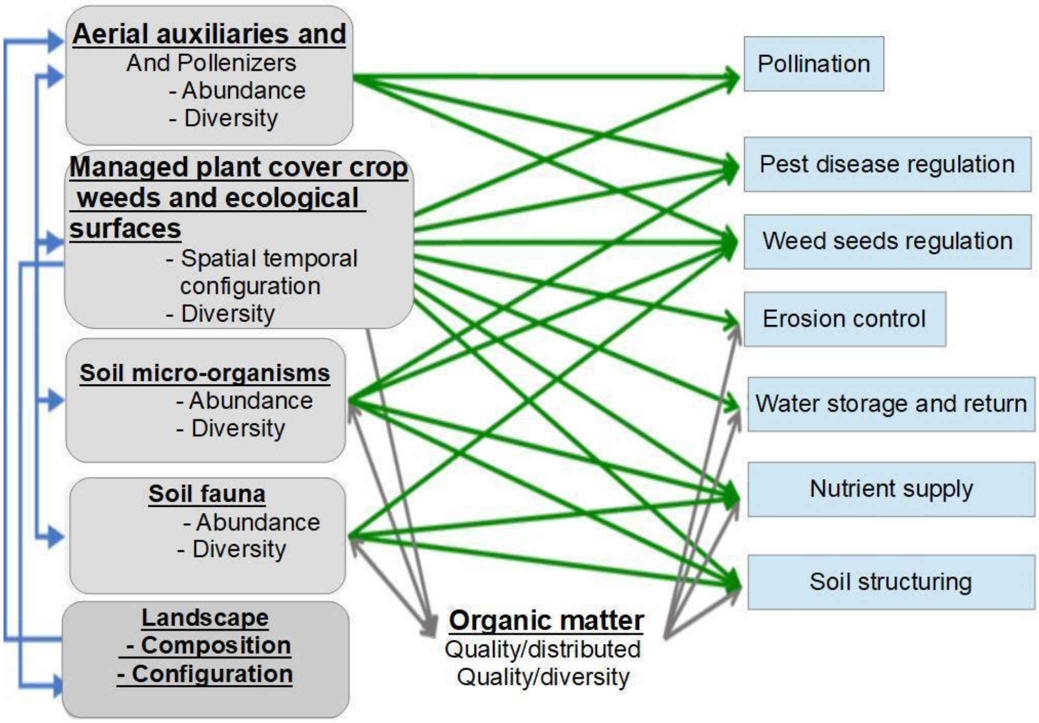
These value transfers already exist in catchment areas. Farmers are paid in protection zones and supported to work organically and avoid the use of pesticides on the main infiltration points.

❖ 4.2 Improvement of biodiversity better yield and avoid cost

❖ Ecosystem service for better yields

Regenerative agriculture provides food and shelter for a large part of the trophic chain. This type of agriculture, which favors cultivated biodiversity and preserves habitats, helps to develop biodiversity. Agro-ecological infrastructures (hedges, trees, wetlands, etc.) are encouraged, developed and maintained in this form of agriculture.

With the diversity in singular elements, e.g. the components of the agro-ecological infrastructures (hedges, trees, wetlands, etc), also the landscape benefits (HDLF), as the landscape level mosaic becomes more heterogeneous. The preservation of linear elements as riparian corridors and hedgerows in cultivated fields, and in general the heterogeneity in the landscape results in a reduction in erosion risks (deriving from wind as well as water). It also means higher resilience of crops in relation to pest and diseases, due to the biotope effect of the singular elements, which also act as shelter for wild animals.



Main relationships between the components of biodiversity and soil organic matter and ecosystem services (ES) provided to the farmer i.e. underlying agricultural production (adapted from Therond et al., 2017c*).

Main relationships between the components of biodiversity and soil organic matter and ecosystem services (ES) provided to the farmer i.e. underlying agricultural production (adapted from Therond et al., 2017c*). For reasons of readability, the feedback loops between ES and biodiversity and ES and organic matter is not represented. Only the ES analyzed in this study are represented here.

The cost of the loss of pollinating insects in France is estimated by the WWF at 15 billion euros over the next 25 years. This cost is linked to the failure of entomophilous plants to pollinate. We could imagine investing 600 million euros a year to provide more ecological niches and food for pollinating insects.

❖ 4.3 Better nutritional value of final product for consumer

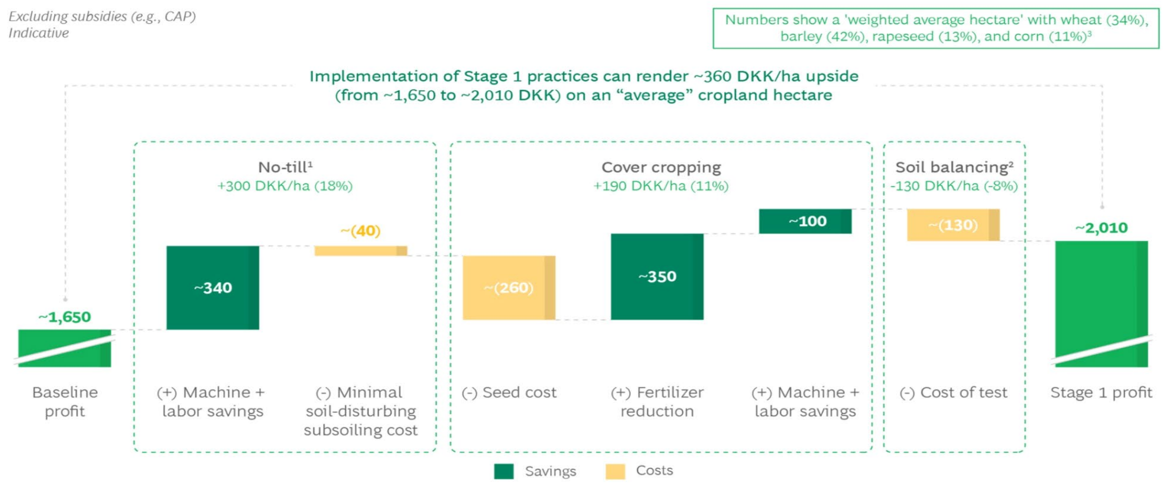
Regenerative agriculture provides better soil, increasing better plant nutrition and greater plant nutrient richness. Mongomery's study explains the links between regenerative agriculture and plant nutrition. Healthier soils from regenerative agriculture contain more trace elements. The plants growing on it are more balanced and healthier. It also produces more vitamins and antioxidants. **Soil health for plant health for human health** (it also works for animal health).

Animal nutrition also plays a role in health. For instance, in France, there is the blue white heart (bleu blanc coeur) association, which guarantees a better presence of antioxidants in milk and meat.

5. Remunerating farmers for common goods

As described above, the main values added by regenerative agriculture for society that go beyond the provision of high quality food are the sequestration of carbon, the increase of soil fertility, the increase of water storage and retention capacity, the reduction of soil erosion potential and the support of (soil) biodiversity. The pending question is how to make a business case for farmers out of these additional services in order to accelerate the transition towards regenerative agriculture. Companies and private initiatives have the potential to play a key role in value creation either through providing private payments for public goods (5.1) or through providing a price premium at farm gate for regenerative products (5.2). Public payments are also playing a role, either through action-based payments or result based payments (5.3)

Exhibit 2 - Stage One Regenerative Practices Could Increase Farmers' Direct Profits by Up to 20%



Sources: SEGES; Statistics Denmark; expert interviews; BCG analysis.

Note: Excluding subsidiaries & only considering yield revenue + direct costs (for example, seeds, labor, machine, etc.).

¹Including minimally disruptive subsoiling.

²Test for mapping microorganisms.

³Based on Danish cropland distribution between the crops.

❖ 5.1 Value creation for regenerative agriculture via private payments of public goods - the example of the carbon market

Markets for the products/services connected with regenerative agricultural practices as well as improvement of soil health and productivity in agricultural soils need to be developed in order to push the transition. Markets for carbon credits are being developed as illustrated by subsequent examples.

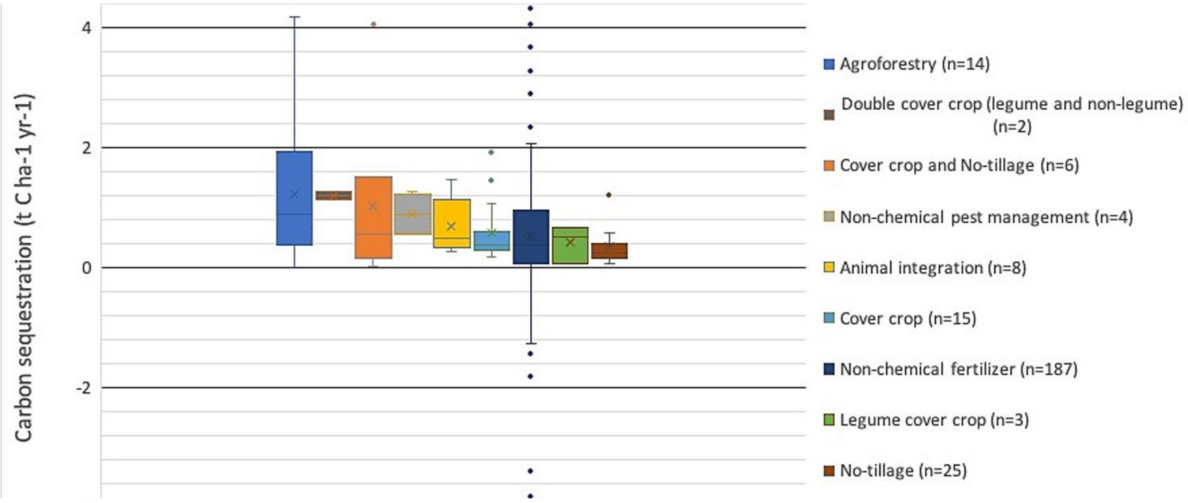
❖ 5.2 Value creation by decreasing greenhouse gas emissions (GHG)

Regenerative farming models use less synthetic fertilisers which have a high greenhouse gas impact. This form of agriculture is also more fuel-efficient (see previous section). These emission reductions are accounted for in the GHG emissions of farms that commit to such transition schemes. The calculation of GHG emissions is important for the agri-food industry. These sectors need to reduce their carbon footprint as well as the carbon footprint of their value chain due to legal requirements on GHG reporting (Scope 3 in GHG protocol emissions from suppliers of suppliers). Agri-food chains are sometimes willing to pay for emissions measurement, as well as setting up chain premiums on low-emission products. The goal for all companies is to achieve carbon neutrality.

In Austria for example the dairy company "Berglandmilch" recently launched a programme where it helps its farmers who sell their milk to Berglandmilch in generating additional income via selling of certificates (based on Verified Carbon Standard (VCS)) which they can generate when the demonstrably reduce the GHG emission of their farm (e.g. methane reduction due to specific feed additives). Similar programmes or projects could be taken into consideration, developed and implemented for regenerative agricultural practices.

The counting of carbon stored through measurement must be separated from the evaluation of GHG emissions. Separating the reduction in emissions and sequestration in a carbon credit makes it possible to enter into the notion of credits of different values. The food sector can encourage the reduction of emissions through sector premiums and the farmer can sell the sequestration carbon credit in addition. This also makes it possible to segment the source of value for the farmer. No private or public actor can provide the level of value necessary to finance the transition alone.

❖ 5.3 Value creation via Carbon Sequestration in soil



Below-ground C sequestration rates for regenerative practices on arable land. Boxplots represent the 25th–75th percentile of data, the "x" represents the mean, and horizontal lines represent the median. Each dot represents averages calculated in one independent study, with the total number of studies for each practice shown in the legend. Positive values represent a below-ground carbon sink, while negative values represent C emissions. Source: Villat J and Nicholas KA (2024) Quantifying soil carbon sequestration from regenerative agricultural practices in crops and vineyards. *Front. Sustain. Food Syst*. 7:1234108. doi: 10.3389/fsufs.2023.1234108

The carbon sequestered in the ground belongs to the farmer, who can choose his/her customer (price market)

Regenerative agriculture produces more humification than mineralization. Therefore the amount of organic carbon in the soil increases overtime. Carbon stored in soils could be bought by companies to compensate for scope 3 reporting requirements or sold as an environmental contribution for corporate offsetting. For example, Microsoft buys "soils based" projects with proven methodologies.

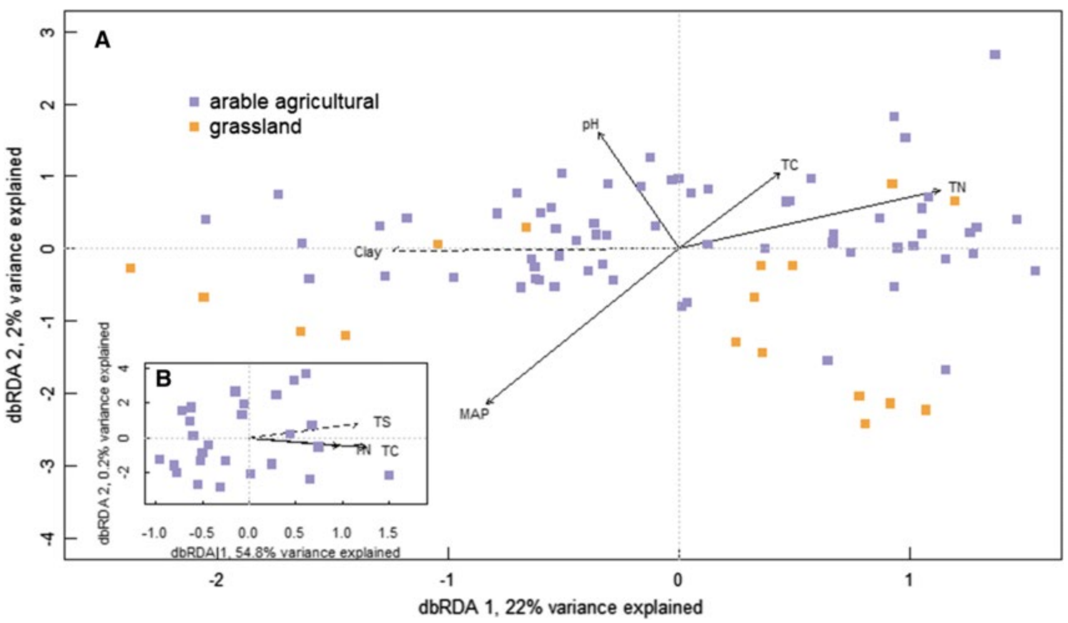
In mechanisms for transferring value or creating new sources of value, measurement is a key element. The market needs proof. The more vague the evidence, the greater the risk of greenwashing. **The more verifiable and transparent the proof of environmental benefit, the more legitimate the justification for value transfer and remuneration**.

❖ Importance of measuring and not modelling for proof of impact

For a carbon credit buyer, several elements are important. The robustness of the MRV (measurement, reporting, verification) is important but also for the overall credibility of agricultural carbon credits. This market must progress if we want it to become a tool for financing the transition. Proof of the reality of the existence of this credit, the robustness of acquisition of this evidence as well as the verification of this evidence are crucial for the transparency and credibility of this market.

Therefore the proof of the result must be based on measurement. Modelling on most aspects, such as soil organic carbon, presents high risks of approximation and error. Humification and mineralization mechanisms depend on biological parameters and physico-chemical balances that are impossible to control in detail and therefore must be considered and measured with in-situ sampling.

Therefore the carbon stored in soils must be measured, not modelled. For example, in the following study we can see variations of more than 50% on non-modeled elements. In agricultural systems, stoichiometrically balanced nutrient addition to Fresh Organic Matter can increase C transfer to Soil Organic Matter by 6 to 52% and importantly reduce the mineralization of pre-existing Soil Organic Matter by 24 to 50%."



Dissimilarity ordination of microbial detritus contribution to soil Carbon in arable agricultural and grassland soils MAP = mean annual precipitation, TN = total soil nitrogen, TC = total soil carbon, TS = total soil sulfur. Source: Coonan, Elizabeth & Kirkby, Clive & Kirkegaard, J. & Amidy, Martin & Strong, Craig & Richardson, Alan. (2020). Microorganisms and nutrient stoichiometry as mediators of soil organic matter dynamics. Nutrient Cycling in Agroecosystems. 117. 10.1007/s10705-020-10076-8.

This is only part of the margin of error found on the models on some elements. The risk of a greenwashing scandal for models with unproven carbon compensation can weaken the entire private agricultural environmental contribution mechanism.

On the other hand, it is also important to take into account the possibilities of the market and the transfer of value to define sampling grids compatible with the financing restitution capacities for the farmer. The entire value does not have to be spent on performing the measurement. **A major part of value must go back to the farmer**.

The best existing tools/systems to provide new value based on regenerative agriculture is **measurement of benefits over time**.

A measurement (sampling and laboratory analysis by loss on ignition, and soil density measure) on a specific GPS point gives a comparable value of this point in time.

For example, to measure organic carbon stock in soils, the FAO and the Verra Standard recommend using the ESM Method (in detail): crossing density and concentration at several depths).

Furthermore, **the models do not allow for the inclusion of innovative practices** and link real results to them (use of biostimulants, use of microorganisms, permaculture, relay cropping, associated crops, rotational grazing, use of humic acids or compost extracts).

❖ Overview of private value creation initiatives

- Zukunft Erde: This project of the company Raiffeisen Ware Austria rewards cereal farms if they increase the soil humus content. Therefore soil samples are taken and targeted fertilisation and cultivation recommendations are derived. If the soil humus content has increased in the control periode the farmer earns money from the sale of CO2 certificates to companies that want to declare themselves to be climate neutral. By 2023 around 100 farmers took part in the programme.
- Genesis; measure biodiversity, carbon, fertility, water but does not generate carbon credits and value for farmers
- Indigo; **model** and **measure** a few samples to learn the model (but no in europe)
- Humus + Modell Ökoregion Kaindorf: Humus formation programme started in 2007 in which almost 400 farmers throughout Austria are currently taking part. Its main aim is the incorporation of CO2 into the soil. Participating farmers have to take soil samples and build up humus within a period of five to seven years and can obtain carbon certificates for trading
- ReGeneration **measures** the impact of agricultural practices on soil **carbon**, **biodiversity** and **water** resources. Generates a carbon certificate including these three parameters (Triple C) with international standards VM0042 (for carbon). **They also support farmers with an individual agronomist.**
- Agreena; **Models** the carbon, using the cool farmtool and satellite.
- Climate farmers; **Models** the carbon, at the same time, they have an associative network for sharing knowledge
- Klim is certifying and selling carbon credits from removals and emission reductions in the agricultural sector by **modelling**. They are mainly performing it within a given supply chain, hence seeking to reduce Scope 3 emissions from food companies, such as Nestlé or Lorens (in-setting). Yet (1) the positive effect on climate change of emission reduction certificates sold to compensate other emission is highly questionable, (2) the way the emission reductions as well as the carbon storage is **calculated** is still far from the field reality
- SoilCapital, **models the carbon** footprint of farms using the cool farmtool and DNDC models. They thus sell the reduction in the footprint of products for the agri-food sectors

❖ Other groups in area of regenerative agriculture

- ReGeNL; a 240 million EU societal programme to be launched in 2024 in NLD to set in the agricultural transition towards regenerative practices. Government, value chain actors, universities and farmer organisations are participating.
- European Alliance for Regenerative Agriculture (EARA) is a recently founded group of European farmers intent on claiming regenerative practices and adding value to the definition and practice.
- CREA Road4Schemes A combined database for more than 160 schemes in the EU, with a business model for carbon storage within forestry and agriculture.
- SAI A platform for over 170 major companies and organisations within agriculture and food.

- OBC is an organisation which attempts to build a **biodiversity** certificate and biodiversity credits for ecosystems including agriculture

❖ Value creation via supply-chain integrated approaches

Another promising approach for value creation would be the development of premium price concepts as regenerative agriculture has a great story to tell - products based on these practices help to fight climate change, make the agricultural system more resilient, improve soil fertility and biodiversity and contain more trace elements, vitamins and antioxidants (see previous sections). Companies like Nestle, Bel, Mars, Mac Donald or Rabobank and FrieslandCampina for example are committed to supporting the transformation of their supply chain.

An inspiring best practice example on how to achieve value creation for an agricultural practice different to conventional farming is the hay milk production in the alpine region, mainly in Austria. Farmers renounce to produce and feed silage to their cows and therefore receive a higher price for their milk. The association ARGE Heumilch started to collaborate with retailers very early and the retailers on the other hand used the environmentally friendly and romantic way of hay production (cows on pastures, flowers in the hay, herbaceous smell of hay instead of sour smell of silage, etc.) as marketing asset. Therefore, while less than 3% of the milk produced in the EU fulfils the criteria of hay milk, hay milk accounts for more than 15% of milk delivery in Austria. A similar approach could also be implemented for regenerative agriculture in order to accelerate the uptake of regenerative agricultural practices due to a price premium provided by the market as regenerative agriculture also comes along with topics ideal for marketing (soil fertility, flouring cover crops, earthworms, etc.).

The agri-food group will be able to sell a more virtuous product (for which proof of virtue is the measure of results) at a higher price. The cost will be borne by the consumer. We must be vigilant to ensure that the farmers sell their product more expensively (industry premium). Regenerative agriculture must not become a market standard without providing value to the farmer.

❖ 5.4 Value creation via public payments

❖ Action based payments

All EU Member States incentivize regenerative agricultural practices (like erosion protection, cover crops, minimum tillage, and grassland ploughing prohibition) via action-based payments under the CAP. For the 2023-2027 period, the main interventions are eco-schemes (Article 31 of Regulation (EU) 2021/2115) and agri-environmental and climate commitments (Article 70 of the same regulation).

❖ Results based payments

This CAP support approach pays farmers for achieving specific results rather than following prescribed practices. This method allows farmers to use their expertise to meet agreed targets. The website of the EU CAP Network provides some good examples, though it does not cover all CAP 2023-2027 measures. Most current results-based payments in the EU focus on biodiversity. However, due to legal requirements (Article 70(4) of Regulation (EU) 2021/2115), these payments are still based on compensating additional costs and income foregone, most likely associated to the achievement of the results not the value of the service provided to other sectors or society.

6. Conclusions

The existing data and evidence shows largely the advantages of regenerative agriculture for the environment as well as for society and farmers themselves but in some cases they could arise only after a transition period with increased investments and management costs as well as decreased yields, especially within the first years.

The agronomic and economic benefits that could prompt farmers to make the transition are tangible. But the pending question is how to generate a visible income flow and agronomic support to farmers that implement regenerative agricultural practices. On the other hand, many farmers do not want to change their practices as regenerative agriculture comes along with additional dependencies on natural processes. Risk aversion is increasingly important for European farmers. Overall indebtedness and costs are on the rise, as is climate risk.

Therefore agronomic support and economic incentives will be key to successfully transforming farms from a conventional system to regenerative agriculture. This agronomic support responds to two obstacles. The first is that farmers are not alone in the face of local societal pressure. They share these doubts and obstacles. The second is that they acquire agronomic knowledge. They are making progress on technical itineraries adapted to these new schemes.

On the economic side, regenerative agriculture needs to prove its virtue. Socially, it must become a response to the challenges of the future. Measuring the benefits of regenerative agriculture is the basis for the possibility of comparison of regenerative agriculture with other farming practices as well as remuneration of its implementation. Farmers in these new schemes can therefore boast of the environmental benefits achieved thanks to measurement. The implementation of value transfers linked to the environmental benefits detailed above would To make this new form of agriculture more competitive, the value resulting of the environmental benefits (described in previous sections) should be transferred across the food chain towards the farmers level

Measurements are more credible and robust than modelling for environmental results. The combination of the measurements and modelling could reduce costs of acquisition of data on regenerative agriculture. The goal is to finance farmer transition and not just the measurements and certification. The credibility of programs depends on the real environmental value created by and the level of financial support associated with the implementation of regenerative agricultural practices. All this with the aim of avoiding greenwashing scandals which penalise the whole situation like what has already happened in the renaturation of tropical ecosystems.

7. Research needs

General issues

Impact of regenerative agriculture an all three pillars of sustainability

So far the research on regenerative agricultural practices is mainly focused on the ecological dimension of sustainability. More research is needed on how the transition to regenerative agriculture affects the social and economical dimension of sustainability as well as on the advantages/disadvantages/trade-offs of all three dimensions of sustainability in different types of farms (arboriculture, market gardening, field crops, livestock) at the different stages of transition within different socio-economic and biophysical contexts.

Applicable to all types of farms that apply or want to apply regenerative agricultural practices. Relevant mainly for farmers and farm advisors.

Impact of climate change on regenerative agricultural practices

The accelerating climate change will have an impact on regenerative agricultural practices. Promising approaches that have been implemented within the last years may not be fit for the near future shaped by higher temperature and weather uncertainty due to climate change (e.g. due to mild winters, longer vegetation periods, etc.). Data is needed to understand the impact of climate change on regenerative agricultural practices.

Applicable to all types of farms that apply or want to apply regenerative agricultural practices. Relevant farmers as well as farm advisors but it varies due to the variety of impacts of climate change on agricultural production.

Technical issues
Investments in regenerative agriculture - initial hurdle or overrated?

The implementation of regenerative agricultural practices comes along with a need of new machineries, tools and methods. Purchasing for example a new seeder or min-tillage machinery is a huge initial hurdle for many farmers. Research is needed on low input investments to make implementation of regenerative agriculture less cost intensive.

Applicable to all types of farms that apply or want to apply regenerative agricultural practices but e.g. dry regions will face other investment needs compared to humid regions. Relevant farmers as well as farm advisors and agricultural machinery manufacturers.

Make organic no-till systems the number one choice

Organic direct seeding comes along without the use of pesticides and synthetic fertilizers which allows the accumulation of a broad variety of environmental benefits. But so far more understanding is needed on understanding of interactions between regenerative practices and organic production systems. The aim is to combine benefits of organic farming and regenerative agriculture based on better understanding of interactions between these two agricultural practices.

Applicable to all types of farms that apply or want to apply regenerative agricultural practices in combination with organic practices. Relevant mainly for farmers and farm advisors.

Long term comparability of soil samples

Across the EU and even within Member States different methods are used for soil sampling. In order to increase the knowledge on the soil quality and soil dynamics the quality and comparability (between regions but also between years) need to be increased, especially if long term comparisons are pursued.

Applicable to all of the EU agricultural area and very high relevance to RA but also to other agricultural systems or compensation programs that make use of soil sampling.

Ecological performance
Impact of regenerative agriculture on the environment

There is a significant need for better and consolidated access public data on the environmental benefits of regenerative agricultural practices (humus, water, air and biodiversity) based on measurement in different agricultural regions and farm types. This information is highly necessary for communicating the value added towards consumers/society, demanding higher product prices from downstream supply chain partners and monetizing the environmental services provided by implementing regenerative agricultural practices.

Impact of regenerative agriculture on the water cycle

There is still research needed in order to identify the impact of and interactions between regenerative agricultural practices and the water cycle. More knowledge is needed on the infiltrability of water in soils, link between vegetation and groundwater, the levels of evapotranspiration of different crops as well as the impact of regenerative agricultural practices on infiltration, retention and water availability.

Applicable to all types of farms that apply or want to apply regenerative agricultural practices. Relevant especially for arable farmers in dry regions with reduced (ground) water availability as well as farm advisors.

Safeguard soil fertility in times of accelerating climate change

The climate has a crucial influence on soil fertility. As human-induced climate change is accelerating knowledge is necessary on how it affects soil fertility of agricultural land (e.g. due to heavy rainfalls, drought, etc.). It is not enough to increase soil fertility in the short term but to keep it high in the long term although external factors like climate are changing. Knowledge is needed on how to achieve this state.

Applicable to all of the EU agricultural area and very high relevance to RA but also to other agricultural systems that rely on soil fertility.

Maintenance of already high humus content in soils

In several agricultural areas of the EU (especially in areas with a long tradition of organic farming or reduced tillage and catch crops) a high/optimal humus content has already been reached. What needs to be considered in the management of those agricultural areas in order to maintain the high humus content, which management practices fit the most? How can maintenance of high humus content be incentivized?

Applicable in regions with high humus content, e.g. regions with long tradition of organic farming. Relevant mainly for arable farmers.

Economic performance
Data on farm performance as leverage for success

In order to accelerate the implementation of regenerative agriculture technical and economic data of farms and its in-depth analysis are needed (risk aversion, debt dependence, willingness to invest in regenerative agriculture, etc.). Such data will also make it possible to precise potential gains and losses linked to the transition as well as reductions and increases in costs, productivity and investments.

Applicable to all types of farms that apply or want to apply regenerative agricultural practices. Relevant farmers as well as farm advisors.

Generate value added for regenerative agricultural practices from supply chain

Regenerative agriculture has a great marketing potential for downstream supply chain partners which so far is widely unused. In order to accelerate the uptake and implementation of regenerative agriculture in the EU concepts are necessary on how to increase revenue for farmers applying regenerative agricultural practices and communicate the benefits of those practices towards consumers.

Applicable to all of the EU agricultural area where RA practices are implemented. Relevant for farmers as well as downstream supply chain businesses like mills, bakeries, retailer, etc..

Regenerative practices impact on productivity

There is still not enough information available if and how and under which conditions regenerative agricultural practices reduce or increase productivity as well as yield per hectare compared to conventional farming practices. How could lower yield/productivity be reduced and how could higher yield/productivity be increased.

Applicable to all of the EU agricultural area and relevant for all approaches of RA in the different regions of the EU.

Cost and time efficient practices for mechanical removal of catch crops

By now the most "efficient" practice for the removal of catch crops and its residues is the use of chemical herbicides (e.g. glyphosate) which come along with a lot of disadvantages for the environment like harm to non target species. In order to make regenerative agriculture more sustainable alternative practices for removal of catch crops need to be developed that aren't harmful for environment but also economically attractive.

Applicable to all of the EU agricultural area and very high relevance to RA but also to other agricultural systems that contain catch crops as well as companies that produce organic plant protection products or machineries for mechanical removal.

8. Ideas for further actions / innovative projects

○ New technical itineraries

- Climate change necessitates adapting farming techniques and increasing risk management.
- Farmers learn new methods: few tillage/no-tillage, plant cover, biostimulants, biomass production, agroforestry.
- Knowledge sharing between farmers and training of farmers through agronomic support and territorial groups are crucial for transitioning.

○ Public data on environmental performance evolution

- Private companies' measurements form the basis for value transfers, potentially centralized by the European Commission.
- The Agri-food data portal of EC could offer anonymized data access, especially on agro-ecological practices and precise environmental analyses of CAP implementation.
- Mapping European soils with this data helps link practices to environmental outcomes, enhancing local societal pressure for sustainable practices.

- **Soil Organic Content (SOC) measurement**
  - SOC measurement helps characterize European soils, tracking carbon content and its evolution.
  - Data on water infiltrability, consumption, and biodiversity performance aids in comparing trends over time.
  - Reliable measurements inform strategic agricultural policy, potentially funded by the European Commission.
- **Satellite data integration**
  - Plot-level data (water, carbon, biodiversity, cover crops) combined with satellite images (albedo, NDVI) reveal agrosystems' radiative effects.
  - This comprehensive data could refine indicators for measuring agriculture's climatic impact, beyond CO_2, CH_4, and N_2O.
  - Different agrosystems' seasonal impacts on radiative effects of water vapor can be considered.
- **Marketing strategies for regenerative agriculture**
  - Regenerative agriculture offers marketing potential with increased soil biodiversity and sustainable practices.
  - Collaboration among farmers, processing companies, and retailers can create premium markets for regenerative products.
  - Projects need to highlight visible regenerative agriculture's benefits like increased earthworms, flowering cover crops, and rich humus soil.
- **Potential EIP-AGRI Operational Groups**
  - Pilot projects with 3-5 transformed farms measure social, environmental, and economic impacts in a territory.
  - Combining agronomic approaches, environmental/energy externalities, and innovative legal structures to test the feasibility of regenerative models.
  - Funding pilots should involve various stakeholders for environmental benefits, such as biodiversity, water resources, and carbon sequestration.
- **Comparison of environmental results from different models**

- Comparing regenerative, organic, and conventional agriculture in similar contexts can reveal the real value of each model.
- Measuring environmental, social, and economic results in territories helps approximate the effectiveness of different agricultural systems.
- Insights from these comparisons can guide better agricultural practices and policy decisions.

9. Thanks

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