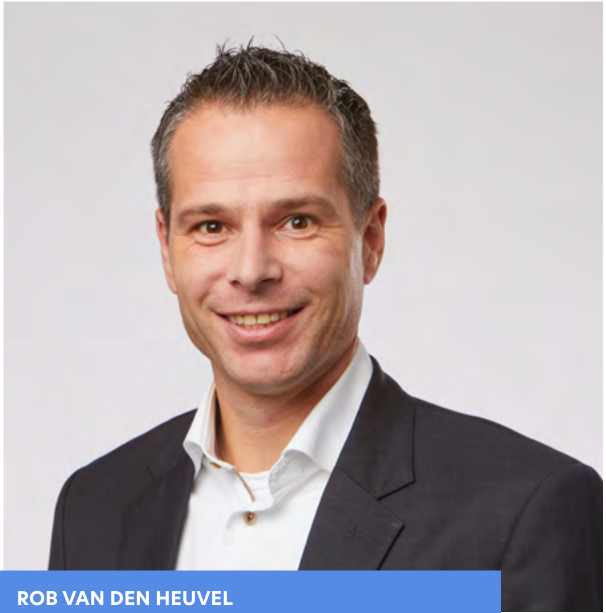
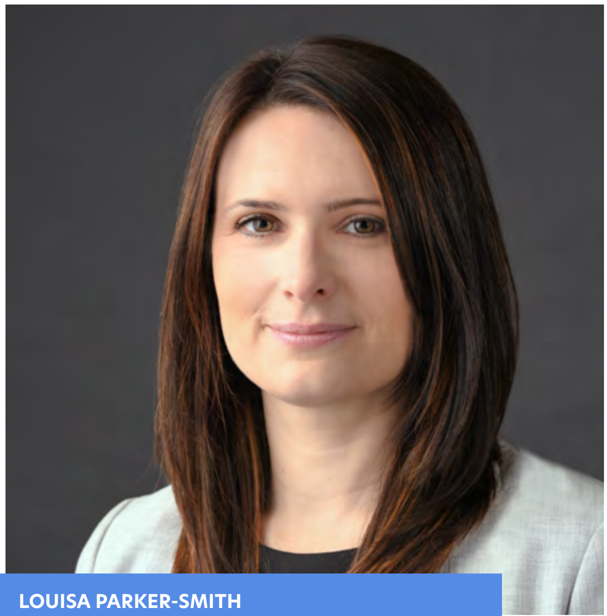
Farming for a better future

AGCO FINANCE climate journey

Welcome to our exciting journey



ROB VAN DEN HEUVEL
PRESIDENT AND GLOBAL CEO
AGCO FINANCE



LOUISA PARKER-SMITH
DIRECTOR, CORPORATE SUSTAINABILITY
AGCO CORPORATION

"AGCO Finance is delighted to embark on a sustainability journey together with our farmers and to embrace it across everything we do under our new strategy AgFinance 2025. We believe that finance has a crucial role to play in enabling change towards more sustainable farming practices, leading to resilient ecosystems, food security, and societal wellbeing. This is why we plan to jointly undertake this journey with our partners and stakeholders, learn from each other, and collectively achieve our shared goals."

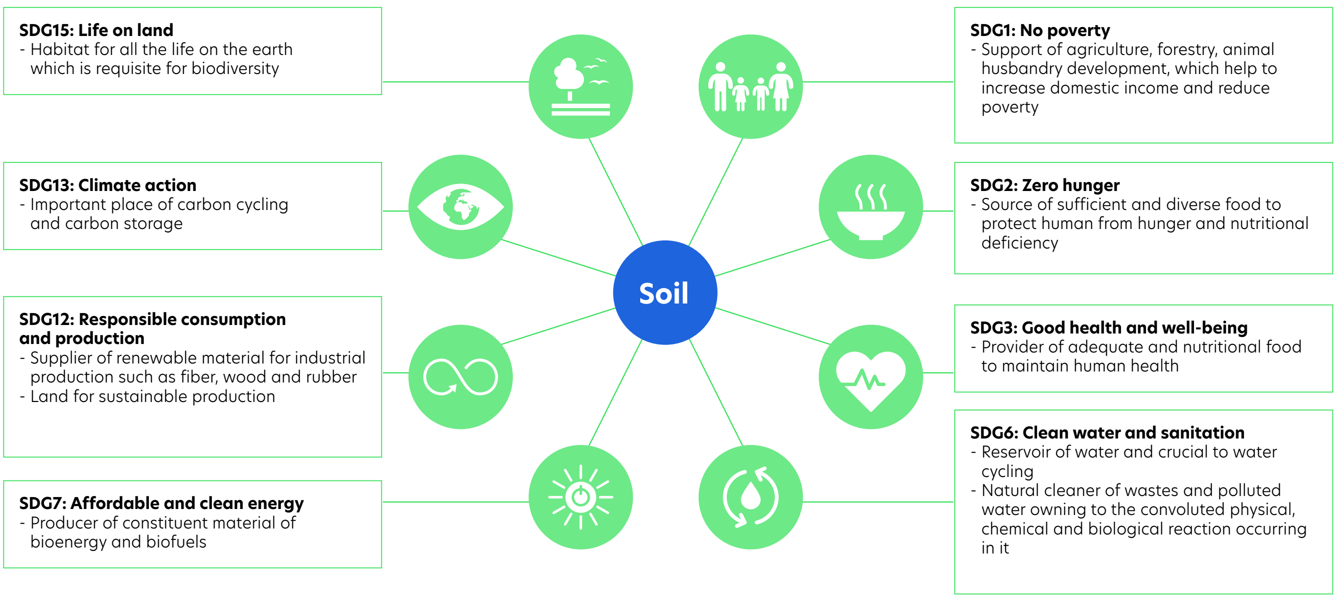
"At AGCO, we believe that agriculture has a crucial role to play in addressing climate change. Agricultural soils are farmers' most important asset, essential to feeding the growing world population and mitigating climatic changes. Our purpose is to deliver "farmer-focused solutions to sustainably feed our world", and we truly develop our products and technology solutions to fit that purpose. Advancing Soil Health and enabling Soil Carbon Sequestration through our equipment, technology and solutions constitute one of the four pillars of our sustainability strategy, and we are delighted to have AGCO Finance discovering ways to support farmers as they transition to low carbon farming. With farmers as our guides, we seek to advance and share knowledge about the benefits of sustainable farming practices. We are confident that together we can tackle this challenge head-on."

Executive summary

- Climate change is progressing and current commitments are insufficient to reach the goal of the Paris Agreement, unstable climate may exacerbate risks for agricultural productivity, but agriculture is also key to reversing climate change.
- Agricultural machinery like tractors contribute to direct carbon emissions in farm operations and are a vital part of Scope 3 carbon footprinting that businesses are increasingly turning to.
- Although not free of limitations, carbon sequestration is a recognized method in research and practice for removing CO_2 from the atmosphere. A set of established regenerative practices with varying potentials can be distinguished based on their focus like tillage, crop management, nutrient management, or agroforestry.
- Precision farming tools like Variable Rate Technologies are important means of increasing resource efficiency, helping farmers decrease environmental impacts and costs of farming operations.
- With the shifting policy landscape as well as growing number of corporate commitments to reach net-zero, carbon farming has the potential to become a new source of revenue for the farmers.

Introduction

The accelerating threat of climate change is a daunting challenge, creating various economic risks as well as opportunities for enacting a transition to more sustainable business practices. Farmers investing in carbon farming stand to benefit from the maturing market-based instruments in this space and important co-benefits that carbon farming rooted in principles of regenerative ag can offer to their businesses, such as improved freshwater availability, crop productivity, farmer livelihoods and preservation of biodiversity[1]. Soil carbon sequestration holds considerable potential to help combat climate change while increasing farm resilience, ensuring future profitability and growth, and providing a source of new business models and potential revenue streams. With the growing commitment of governments and businesses to achieve net-zero, nature-based solutions like soil carbon sequestration are increasingly sought. The UN predicts a need for a 15-fold scale-up of carbon sequestration projects in the voluntary carbon market by 2030, the overall size of which could reach even $50 billion. The evolving policy landscape indicates that agriculture is set to play an increasingly important role in mitigating climate change by incentivizing the adoption of approved nature-based solutions. Agriculture is a contributor to climate change but also an integral solution to it. This paper aims to raise awareness about the challenge of climate change and highlights why farmers should care given the inherent opportunities that transition to more sustainable business practices offers.



Source: Hou, Deyi, et al. "Sustainable soil use and management: An interdisciplinary and systematic approach." Science of the Total Environment 729 (2020): 138961.

Climate change and agriculture

The world we live in runs in cycles, and as the old saying goes, 'What goes around comes around'. Nowhere this is truer than in the Earth system, which runs the climate we live under. Right now, this system is under considerable pressure, in particular, due to an increase in atmospheric concentrations of anthropogenic greenhouse gases (GHG). The Earth can be imagined as a spaceship[2] or a closed system with a fixed amount of matter within it. This system is comprised of limited reservoirs intertwined with one another through complex interactions. Between them, the matter is continuously recycled via ecological processes known as biogeochemical cycles. The heat-trapping GHG like Carbon Dioxide (CO_2), Nitrous Oxide (N_2O) and Methane (CH_4) constitute a crucial part of that system. Thanks to their presence in the atmosphere, the Earth's average temperature has remained sufficiently warm to support life through the so-called natural greenhouse effect. However, with the advent of the Industrial Revolution, humans began to emit into the atmosphere exorbitant amounts of GHG, primarily through fossil fuels' burning[3], while putting under pressure vital reservoirs like land and ocean. Thereby upsetting the capacity of the Earth system to recycle GHG accumulated in the atmosphere seamlessly. This, in turn, has disturbed the balance between the amount of solar energy that reaches and leaves the Earth, in consequence, fuelling climate change.

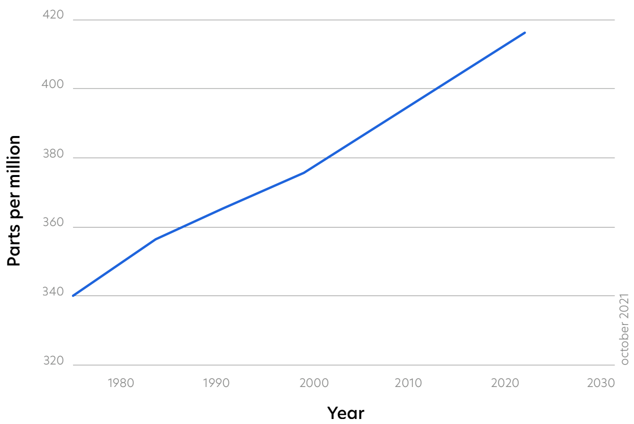


Fig. 1 Source: National Oceanic and Atmospheric Administration

At the time of the writing, the global monthly mean of CO_2 in the atmosphere was 414.46 ppm[4] (Parts Per Million) (see Figure 1). This is about 50% higher than at the onset of the 18th century's industrial era. With current rates, CO_2 concentrations could easily pass 500 ppm around 2050[5]. According to the Intergovernmental Panel on Climate Change, such build-up would be consistent with a likely path to above 3°C by the end of the century[6]. According to the Climate Action Tracker, an independent scientific body that monitors governmental climate change mitigation commitments, the current national net-zero pledges, if fully implemented, would result in a warming of 2.4°C by the end of the century[7] (see Figure 2). The need for widescale decarbonization is thus palpable. The global food production system is responsible for estimated GHG emissions of 18 Billion tons CO_2-equivalent per year (35% of total annual emissions), 71% of which comes from land-based emissions which includes agricultural production[8]. Growing temperatures are bound to increase the risk to food security. The majority of the projections indicate decreasing crop yields from the 2030s onwards[9], necessitating implementation of extra measures to adapt to the reality of a warmer planet. A global survey conducted by Syngenta showed that 87% of farmers surveyed already experienced some effects of climate change and extreme weather, with majority being the arable farmers[10] (see Figure 3).

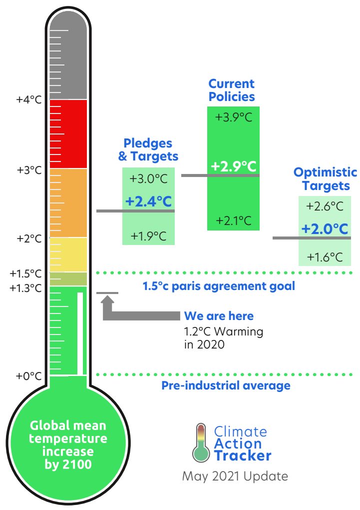


Fig. 2 Source: Climate Action Tracker

A carbon dioxide equivalent or CO_2 equivalent, abbreviated as CO_2-eq is a metric measure used to compare the emissions from various greenhouse gases on the basis of their global-warming potential (GWP), by converting amounts of other gases to the equivalent amount of carbon dioxide with the same global warming potential.

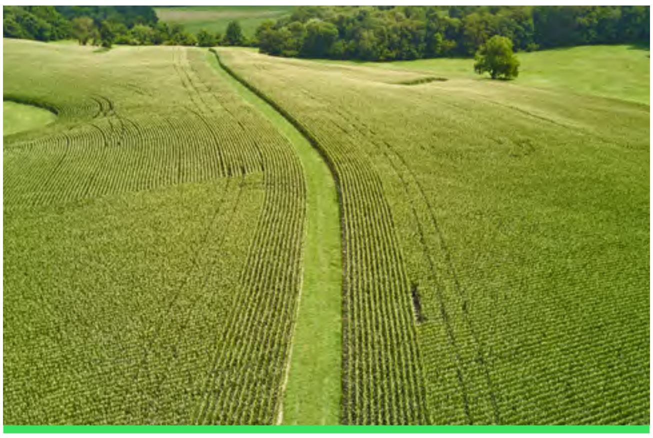
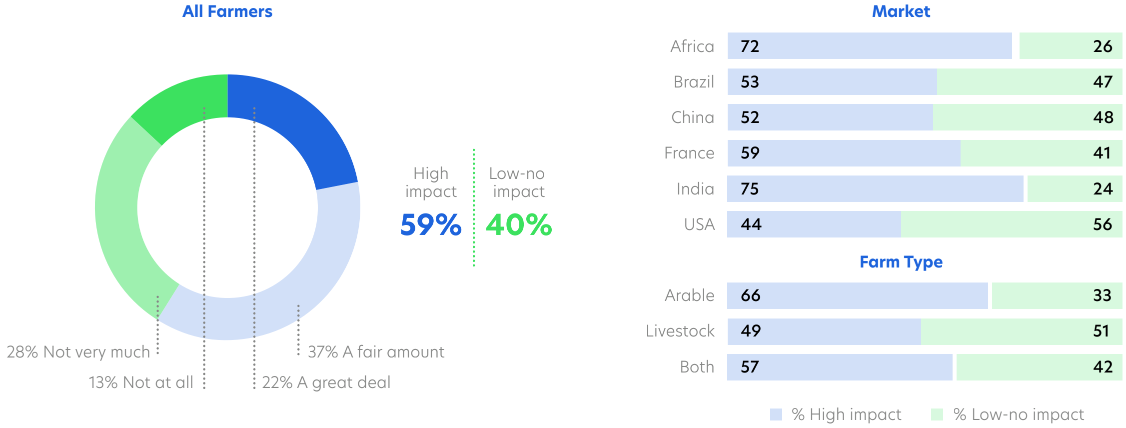


Fig. 3 Source: Syngenta



To reach the Paris Agreement target in keeping the temperature within 2°C, and ideally 1.5°C, we have to reduce our emissions and remove some of the pending in the atmosphere GHG, especially CO_2. The '4 per 1000' initiative launched during COP21 aims to demonstrate that agriculture and sustainable soil management have a vital role to play in our fight against climate change[11]. This is because soils constitute our second-biggest carbon sink after the ocean, with an estimated capacity to store soil organic carbon at 1500 Billion tons (to a depth of 1 m)[12]. The '4 per 1000' initiative argues that an annual growth rate of 0.4% in the soil carbon stocks, or 4‰ per year, in the first 30-40 cm of soil, would significantly reduce the CO_2 concentration in the atmosphere. Agricultural soils hold around 600 Billion tons of carbon (to a depth of 1 m), and increasing this stock yearly by 0.4% (2.4 Billion tons of carbon per year) could offset about 5% of global GHG emissions[13]. This can be done by deploying recommended management practices to stimulate the rate of soil carbon sequestration[14]. Farmers are therefore at the forefront of the fight against climate change – both feeding the world and preserving our climate.

Carbon footprint and agricultural machinery

With the modernization of agriculture, machinery has increased the productivity and profitability of farm operations, as well as their energy demand. Growing consumption of energy inputs has ramped up emissions of anthropogenic CO_2, 96% of which comes from the burning of fossil fuels[15]. With it, the concept of carbon footprint has gained increasing attention. In loose terms, it can be understood as total weight, usually in metric tonnes, of direct and indirect GHG emissions of an individual, organization or product over a specific period expressed in CO_2-equivalents[16]. For non-road mobile machinery like tractors, direct emissions are typically associated with work done on arable lands. Tilling is amongst the most important primary sources of CO_2 emissions in farm operations[17]. This is due to the increased fuel consumption during tillage, which depends on soil properties, tractor size, equipment used, and tillage depth. As fuel consumption increases, so do emissions of CO_2 and the derived from thereof carbon footprint. Part of that footprint can be avoided by adopting alternatives to the conventional tillage such as strip-tillage which requires much less energy inputs per hectare while increasing crop yields.

The carbon footprint assessment can be considered as a subset of the Life Cycle Assessment (LCA). LCA, however, takes a much more comprehensive view on the environmental impacts of a given product or service. Carbon footprint, on the other hand, focuses on the impact on global warming from energy-related emissions. The completeness of which depends on the scope of emissions under assessment.

One of the most notable carbon footprint accounting methodologies is the GHG Protocol, where three scopes are distinguished. Scope 1 and Scope 2 refer to direct and indirect emissions from an organization's operations, and Scope 3 to the upstream and downstream value chain emissions. Scope 3 is crucial to measure because this is typically where the bulk of emissions happens (see Figure 4). Knowing precisely where most of the emission impacts occur within the value chain allows for pinpointing hotspots with the highest exposure to climate-related risks. To realize the goal of the Paris Agreement, addressing Scope 3 emissions is essential. Especially, in the context of self-propelled machinery where, as in the broader automotive sector, everyday usage (downstream emissions) constitutes up to 80% of emissions[18].

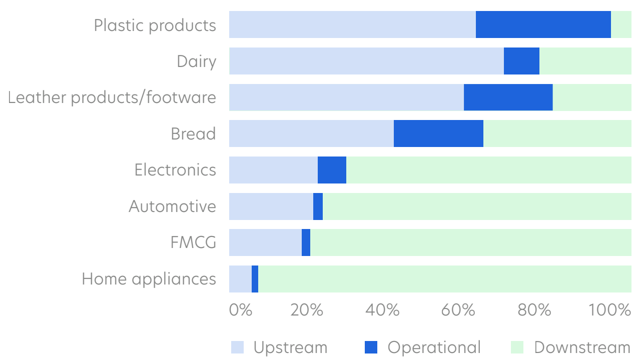


Fig. 4 Value chain emissions

Sustainable farming and the power of soil carbon sequestration

Mitigation of climate change takes different forms and can be viewed as either reducing emissions, avoiding emissions, or removing the heat-trapping GHG such as CO_2 via, for example, nature-based solutions such as soil carbon sequestration. Carbon sequestration refers to the process of capturing CO_2 from the atmosphere and moving it to another reservoir, such as terrestrial biosphere, where it ought to be stored over a long period. This can be done by increasing carbon stocks in the soil via enhanced biomass production and decreasing organic matter decomposition rates. Soil carbon sequestration, however, comes with a few limitations. The two most important ones are the issue of permanence and saturation[19]. Sequestered carbon in the soil is easily reversible for example through tillage; therefore, the accumulated carbon stocks must be maintained indefinitely through sustainable soil management to guarantee true mitigation through permanence. The potential to store carbon in the soil is finite, and soils cease to build up carbon stocks as they saturate and reach a new steady state. Also, for genuine climate change mitigation, comprehensive GHG accounting is needed as some practices may stimulate fluxes of other powerful GHG such as N_2O (265 times more potent global warming potential than CO_2) and CH_4 (28 times more potent global warming potential than CO_2)[20].

The North Sea Region's top five carbon farming practices.

Practices that enhance the capability of soils to absorb GHG like CO_2 from the atmosphere and store in the soil and vegetation have been recognized in research as beneficial to climate change mitigation21. Sequestration is, however, site-specific, and results achieved in one specific location might differ in others. It is also a process highly dependent on the climatic conditions, particularly temperatures and moisture, as well as soil texture. Typically increasing temperatures have a more negative effect on soil carbon sequestration due to higher decomposition rates of organic matter. Increasing moisture, on the other hand, has more positive effect resulting from elevated rates of biomass production. Soils with higher content of clay minerals provide more favorable conditions for soil carbon sequestration. Whereas soils with disproportionately high (acid) or low (alkaline) pH negatively impact soil organic matter accrual.

Generally, arable lands offer a lower potential for carbon sequestration than land conversion to forest or grassland. Potential in the global context varies between 0.37 to 4,22 tons of CO_2 sequestered per hectare annually[22 23]. At the same time, croplands with high yield gaps and soil degradation status are especially receptive to regeneration through soil carbon

Decision supporting tools:
- **EU's Soil Navigator**
- **US COMET-Planner**

sequestration based on practices adapted to local conditions and management opportunities[24]. Different sustainable soil management practices offer different potentials to sequester carbon. These can be combined to achieve optimal results. The most commonly discussed sustainable soil management practices in the context of climate change mitigation on arable lands are described below, together with their potential to sequester carbon in croplands of continental Europe.
The indicated values stipulate potential sequestration rates, i.e. mass of CO_2 [25] taken out of the atmosphere per unit of area and time. The presented values are based mainly on carbon stocks accumulated at a depth of 30 cm.

Tilling

The practice of ploughing the soils is a typical feature of conventional agriculture. Tilling, however, disturbs the soil and makes it vulnerable to erosion by wind and water run-off, thereby degrading soil quality. If frequently done, it can lead to a breakdown of soil structure due to a decline in soil biodiversity. Turning the soil decreases its quality by enhancing the decomposition of soil organic matter, which contributes to emissions of CO_2 into the atmosphere. Conservation tillage has been proposed as an alternative to conventional ploughing. It is a management approach that stresses moderation in tilling in terms of its intensity and frequency. A transition to no-till or reduced-till has been shown to positively affect soil chemical and biological properties while also promoting crop resilience[26].

Reducing soil disturbance helps preserve the carbon content gained via photosynthesis during the growing season. Also, systems in which the fallow period is minimized and where crop residue is retained help soil increase its carbon content when vibrant soil microbial communities absorb left residues. It has been estimated that the adoption of conservation tilling could help sequester carbon at the rate of 0.7 tons of CO_2 per hectare annually[27 28 29]. However, some authors take issue with the contribution of especially no-till practices to climate change mitigation, arguing that it contributes more to accumulation than sequestration of carbon, especially in the topsoil rather than in the deeper layers where residence time is longer[30]. Therefore, for genuine mitigation, conservation tillage should be combined with companion practices such as planting cover crops and implementing crop rotations. Also, conservation tillage may generate fluxes of other powerful GHG like N_2O due to increased moisture, although these effects are site-specific, highly variable and wrought with quantification challenges. Taken together, however, the mitigation potential of conservation tillage has been estimated to vary between -0.44 to 1.89 tons of CO_2-equivalent per hectare annually[31].

Crop management

Improved crop management practices that increase crop yields and carbon inputs benefit the process of soil carbon sequestration by enhancing stocks of soil organic content. Such practices include cultivation of crop species with higher root biomass that help store carbon in the deeper layers of the soil, implementing crop rotational cycles with different characteristics such as nitrogen fixing in one season and non-fixing in another, retaining crop residue and planting cover crops that minimize the time soil is left bare while providing continuous input of carbon. It is estimated that deploying these types of practices can sequester carbon at the rate of 0.88 tons of CO_2 per hectare annually[32 33 34]. A possible side effect from increased organic material providing a source of mineralizable nitrogen is the increased flux of N_2O from the soil into the atmosphere. Taken together, therefore, improved crop management has the potential to mitigate between 0.51 to 1.45 tons of CO_2-equivalent per hectare annually[35].

The genetically diverse plots with rich biodiversity that resemble more natural ecosystems enjoy greater resiliency thanks to positive interactions transpiring above and below the ground between plant, animals, and microbial communities. Changing environmental conditions resulting from global warming will increase risks to agricultural productivity from pests and pathogens. Cropping systems, convivially dubbed as 'smart agriculture', which prioritize diversity over monoculture also offer greater adaptive capacity to shifting environmental conditions like changing temperature and precipitation patterns[36] while reducing reliance on external inputs such as pesticides and herbicides.

Nutrient management

Nutrients are crucial for plant growth and the building of soil organic carbon stocks. Improved nutrient management with judicious application of organic fertilizers such as manure or compost can help sequester carbon while reducing and avoiding direct and indirect emissions from nitrogen leaching or the manufacture of synthetic fertilizers. The effect of organic fertilization on soil organic content refers to the amount of biomass produced or returned to the soil and its humification rates, which can be enhanced under elevated CO_2 concentrations in the atmosphere. This is particularly true in the agroecosystems characterized by low yield and nutrient deficiency. In systems with a history of excessive fertilization, a reduction to more economically optimal rates is recommended. This can be done with precision fertilization techniques such as application of fertilizers based on precise crop needs with spatial variabilities based on patterns of soil fertility, improving the timing of fertilization to match it with plant nitrogen uptake, placing fertilizer more closely to plant roots or avoiding fertilization where possible. It is estimated that improved nutrient management practices can help sequester 0.55 tons of CO_2 per hectare annually[37 38 39]. This effect can be greatly enhanced if combined with conservation tilling and mulch farming. Fertilization is closely interlinked with fluxes of N_2O, and arable soils are the single biggest source of anthropogenic N_2O in the atmosphere[40 41]. Unlike CO_2, N_2O does not have any significant terrestrial sink, therefore decreasing its emissions from known sources is the best abatement strategy. A shift to improved nutrient management practices that help reduce N_2O emissions from soil through efficient use of fertilizers can mitigate between 0.02 to 1.42 tons of CO_2-equivalent per hectare annually[42].

Biochar as a soil amendment is being recognized in research for its positive effects on nutrient retention, soil health, and biomass productivity[43]. As such, biochar has a significant potential to enhance soil carbon sequestration thanks to its rich carbon content and slow decomposition process[44] , which helps reduce mineralization of the accumulated organic matter in the soils. Although the application of this method in agricultural soils is strictly context-dependent and data on long term effects is still lacking. The technical mitigation potential, meaning what can be achieved without taking barriers for adoption into account such as high production cost and widespread low availability, in world soils has been estimated at between 8.96 to more than 10 tons of CO_2-equivalent per hectare annually[45 46].

Agroforestry

Agroforestry is a land-use system characterized by the integration of trees with crop and animal farming systems. It has been acclaimed for its regenerative potential stemming from positive contributions to soil health, water retention, biodiversity preservation, and carbon sequestration. Agroforestry systems help reduce soil erosion and nutrient leaching, improve microclimate of the plot, increase pest control and attractiveness of agricultural landscapes. Most commonly used agroforestry practices include alley cropping or silvoarable agroforestry, contour hedgerow, windbreak and riparian buffers. Typically, trees planted on arable lands sequester faster carbon than trees in forests because there is less competition over water and nutrients. Intercropping systems combining plant species with multilayered above and below-ground biomass production are capable of sequestering carbon much more efficiently than monocultures. Trees sequester carbon by storing it in their woody elements and soil.

The amount of carbon sequestered in the agroforestry systems is the function of trees total biomass and their contribution to soil organic content changes. The rates at which trees are capable of sequestering carbon in agroecosystems vary considerably depending on the soil and climatic conditions and type of trees planted, a practice employed, and the trees' density. The number of studies examining the potential of agroforestry systems in Europe to sequester carbon is limited. Some studies estimate that in the European arable lands a potential 10.06 tons of CO_2 per hectare annually can be sequestered in the tree's biomass[47]. Others point to the high variability in estimates ranging from 5.5 to 14.67 tons of CO_2 per hectare sequestered annually[48]. Additionally, through soil organic carbon increases, another 1.1 to 3.81 tons of CO_2 per hectare annually could be sequestered[49 50]. These valuations can be greatly improved if combined with practices such as planting cover crops and conservation tilling.

Climate change mitigation and precision farming solutions

There is no doubt that the agricultural sector is likely to experience considerable pressure in the coming decades, particularly from climate change and resource scarcity. All while needing to feed a growing world population without compromising more land for food production[51]. Achieving more with less is a challenge that requires a shift to new tools able to leverage innovative information technologies. Precision farming technologies help optimize the use of agricultural inputs, like fertilizer or fuel, by layering real time spatial and temporal data from multiple sources to improve resource management by accounting for the field's variability[52]. In the context of climate change mitigation, precision farming serves mainly to reduce environmental impacts based on greater efficiency gains. Precision farming technologies can be broadly classified into three main groups[53]:

- Guidance technologies involving all forms of automatic steering and guidance for tractors and implements in the field. These include Controlled Traffic Farming, Driver Assistance and Machine Guidance.
- Recording technologies mounted on a tractor or other platform like drones to collect spatial data. These include soil mapping, soil moisture sensing, canopy sensing and yield mapping.
- Reacting technologies used for the management of placement of agricultural inputs such as Variable Rate Technologies for irrigation, nutrient application, crop protection agents, seeding and precision weeding. These include the Precision Planting SmartFirmer used for determining the state of the seedbed based on the variability in the field, including its content of soil organic matter[54].

There are considerable environmental and economic benefits to be derived from the application of these technologies. For climate change mitigation, especially the Variable-Rate Nutrient Application offers significant benefits as improved nitrogen application can considerably decrease emissions of

N_2O from cropland soil. Application of this technology at one of the field trials in the Swiss Future Farm resulted in improved yields while markedly enhancing nitrogen efficiency[55 56]. Generally, the addition of nitrogen is beneficial for plant growth up to a certain point, after which the costs of added nitrogen outweigh its benefits. With Variable Rate Technologies, farmers can precisely pinpoint when their crop is about to reach this economic optimum, allowing them to save on nitrogen costs while safeguarding their yields and avoiding harm to the environment[57]. Fuel consumption can be decreased through Controlled Traffic Farming and Machine Guidance technologies, such as Fendt's VarioGuide[58 59], which help limit the use of tractor with precise machinery movements. More efficient operations through, for instance, reduced overlaps help decrease soil compaction, making it easier to cultivate thanks to improved soil structure. A study done in Denmark identified an estimated 25-27% fuel savings from the implementation of Controlled Traffic Farming systems[60]. Greater efficiency means lower operational costs for the farmers and lower carbon footprint.

FUSE Smart Farming Return on Investment calculator.

Precision agriculture is not a new concept. Various tools falling into the above categories have been present on the market already for some time. Adoption of these tools, however, has been slow. This is mainly due to the perceived costs and risks associated with an investment in these technologies. Therefore, institutional support is needed to alleviate farmers' concerns about the impact of innovative tools on the profitability of their operations. Other obstacles involve the complexity associated with using various precision farming tools in tandem to allow for maximum efficiency gains. Farmers need to know how to leverage advanced data analytics to their benefit, for which advisory services and knowledge exchange are crucial. Also, practical problems such as connectivity may constitute a challenge, particularly in rural areas where broadband infrastructure is lacking. The digitalization of production processes, of which precision agriculture is just one of the manifestations, is inherently a process of social transformation requiring a favorable enabling environment to ensure effective uptake.

Carbon farming, net-zero and the new business models

With the proliferation of carbon markets, carbon farming is becoming a popular notion signifying the commodification of carbon. Carbon farming refers to farming practices that contribute to climate change mitigation, such as the process of soil carbon sequestration, implemented to generate carbon credits and, consequently, obtain a financial benefit[61]. Through carbon farming, farmers may be incentivized to adopt more sustainable forms of soil cultivation. The generated carbon credits are tradable units, usually representing 1 ton of CO_2-equivalent reduced, avoided or removed, provided to actors pursuing recognized climate change mitigation activities[62], and sold to market actors seeking to offset their unavoidable emissions. Farmers implementing such mitigation activities should achieve emission reductions compared to the business-as-usual scenario that does not include the sustainable innovations being financed. The achieved reductions have to be attributable to the newly implemented interventions verified by the crediting institution. In doing so, the mechanism of carbon credits issuance strives to safeguard one of its fundamental criteria - additionality, meaning avoiding claiming credits for activities implemented for reasons other than generating certified carbon credits.

ICROA principles for carbon credits

- **Real:** All emission reductions and removals—and the project activities that generate them—shall be proven to have genuinely taken place.
- **Measurable:** All emission reductions and removals shall be quantifiable, using recognised measurement tools (including adjustments for uncertainty and leakage), against a credible emissions baseline.
- **Permanent:** Carbon credits shall represent permanent emission reductions and removals. Where projects carry a risk of reversibility, at minimum, adequate safeguards shall be in place to ensure that the risk is minimized and that, should any reversal occur, a mechanism is in place that guarantees the reductions or removals shall be replaced or compensated. The internationally accepted norm for permanence is 100 years.
- **Additional:** Additionality is a fundamental criterion for any offset project. Project-based emission reductions and removals shall be additional to what would have occurred if the project had not been carried out.
- **Independently verified:** All emission reductions and removals shall be verified to a reasonable level of assurance by an independent and qualified third-party.
- **Unique:** No more than one carbon credit can be associated with a single emission reduction or removal as one (1) metric ton of carbon dioxide equivalent (CO2e). Carbon credits shall be stored and retired in an independent registry.

In the voluntary carbon markets, where credits generated from agricultural projects are currently traded, the demand for carbon credits is poised to grow as countries and companies ramp up their commitments to meet the Paris Agreement target and satisfy growing regulatory and shareholder needs. Current voluntary carbon markets are highly fragmented and relatively complex, with significant price disparities averaging €13 per ton of CO_2 sequestered in the EU (range from €6 - €110)[63]. To meet the 1.5°C target, it is estimated that 2 Billion tons will have to come from carbon sequestration projects, requiring a 15-fold scale-up of voluntary offsetting projects in 2030 compared to 2019, according to the UN Taskforce on Scaling Voluntary Carbon Markets[64]. As such, there could be considerable scope for farmers willing to capitalize on the potential future growth in demand. According to the Ecosystem Marketplace, the number of companies making climate-neutral or net-zero pledges has doubled during the COVID-19 pandemic[65]. Companies are also increasingly looking beyond their direct operations when designing net-zero roadmaps to include their value chain emissions, the so-called Scope 3 emissions[66]. Farmers are a crucial part of many value chains, and their engagement will be sought to create meaningful corporate climate targets and avoid the risk of "greenwashing". In the realm of policy, particularly in Europe, the recently approved Climate Law sets a binding legal obligation to reach net-zero by 2050, with an interim target of 55% emissions reduction by 2030. The Commission also communicated a legislative package, the so-called "Fit-for-55", which provides a pathway towards realizing the Climate Law targets. For the agricultural sector, the most important legislative framework remains the Common Agricultural Policy (CAP). For the years

Design project	Fund project	Develop project	Operate/ Certify carbon offsets	Purchase/sell carbon offsets
Select the project parameters - including project type, region, size, desired co-benefits, etcetera	Secure funding for the initial CAPEX the project requires - funding can be secured from the typical sources (e.g. debt, equity)	Build (physically) the project - can be contracted to an EPC firm or specialized offset developer	Work with a established certification standard (e.a. Gold Standard, VCS) to validate carbon offsets	Redeem offset credits towards carbon footprint, and/or resell credits back to market (can fund future projects)

Carbon credits project development cycle.

2023-2027, the revised version will strive to regenerate the natural carbon sinks, such as the soil. The "Fit-for-55" in its current proposal entails the target of increasing carbon removals in the Land Use Land Use Change and Forestry sector to 310 million tons of CO_2-equivalent by 2030. Enhancing carbon sinks also contributes to objectives of the Farm to Fork Strategy and Biodiversity Strategy 2030 through synergetic linkages with aims that seek to protect the fertility of the soil, reduce its erosion and increase its content of organic matter. To achieve these goals, farmers enrolment will be crucial. The embedded within the CAP Greening Architecture has been designed to provide farmers with the incentives to implement more sustainable practices. Beyond enhanced conditionality which stresses new Good Agricultural and Environmental Conditions, such as the implementation of crop rotations, reducing tillage and minimizing fallow period, the newly proposed Eco-schemes will include many practices for which farmers will receive additional rewards in the form of direct payments, these can include implementation of agroforestry systems, deployment of precision agriculture tools, or adoption of carbon farming, amongst other practices. Carbon farming has been recognized as an important tool in the EU's climate agenda[67] and a new green business model to foster the creation of alternative income streams for the farmers seeking to participate in voluntary carbon markets. The future work will focus on developing a robust regulatory framework for certifying carbon removals[68], for which the action plan is set to be communicated by the end of 2021.

Throughout the years, the voluntary carbon market has been characterized by the oversupply of credits whose additionality was contested, thereby keeping the prices relatively low. In recent years, however, the demand has been growing and shifting from old credits focused mainly on renewables to new credits from nature-based solutions, the volume and price of which has increased disproportionality higher by 264% and 30%, respectively[69, 70]. According to some estimates, the overall carbon credits market size could reach even up to $50 billion in 2030[71]. The North Sea Region Carbon Farming project has researched carbon sequestration-based business models for farmers[72]. In the carbon credits business model, a trend from buying credits produced in developing countries to credits produced locally has been identified. This is driven by the willingness of consumers to support local farmers and companies using their locally purchased credits in marketing campaigns. As such, credits generated locally enjoy an added value for the prospective buyers. However, reluctance of farmers to invest in carbon farming practices which may in the near term negatively impact their bottom lines is a potential hinderance to these developments.

Journey ahead

Agriculture is both vulnerable to climate change and extreme weather events and in many ways vital to reversing it given, for example, the significant potential of soils to store carbon. However, increasing soil carbon stocks in agricultural soils requires a transition to practices able to facilitate soil carbon sequestration. Here several established regenerative soil management techniques were discussed with varying potentials to sequester carbon. The relatively small potentials suggest that for these practices to be effective, both in terms of climate change mitigation and economic attractiveness for the farmers seeking to enter carbon markets, an effective scale-up and clear incentives proposed are needed.

The political environment in light of the plainly changing climate and shifting societal expectations unarguably indicates the beginning of a long transition towards climate-friendly business practices. In the EU, the Green Deal's objectives are increasingly mainstreamed into various legislative packages. At the same time, in the US, the Biden Administration continuous to signal support for climate action and the Senate, through bipartisan support, has recently approved the Growing Climate Solutions Act designed to help link farmers to voluntary carbon markets. Effective initiatives are urgently needed to avoid the worst effects of climate change. Carbon farming is promoted as a vehicle to enrol farmer's support in that effort. Their buy-in is essential to ensure that agricultural production is sustainable. Carbon markets driven by the strengthening climate policy are set to grow. Market actors are aware of this trend and, as a result, are driving demand for credible carbon credits. However, the success of carbon markets depends on the mobilization of innovative farmers willing to join as suppliers. For that to happen, there are nonetheless various obstacles that farmers will need to overcome. This includes access to credit for farmers for whom transition invites a new risk to the profitability of their businesses, given the often low-profit margins under which farmers operate.

Business-as-usual is increasingly questioned because of its environmental footprint. But with the growing world population set to reach more than 9 billion by 2050, the agricultural output needs to increase by roughly 70%. More stringent climate legislation is set to impact the prices of carbon-intensive farm inputs such as synthetic fertilizers. Farmers will need to seek ecological alternatives to increase their output without driving up the costs of food. The grand challenge involves meeting the growing food demand while ensuring that agriculture does not deteriorate the natural environment on which it depends. The food production, therefore, needs to be not only sustainable but also regenerative. Carbon farming can do more than mitigate climate change thanks to additional benefits such as building up organic matter that helps increase crop productivity. Regenerated soils also hold more water, therefore strengthening the resilience of crops against droughts that are increasingly a new normal during the growing season. Technology has a significant role to play in both reducing negative impacts through innovation like precision farming and ensuring that the actions farmers take are real and that their environmental integrity is safeguarded through robust Measurement, Reporting and Verification mechanisms.

AGCO Finance, together with AGCO Corp. and Rabobank, is continuously exploring how to support farmers in their sustainability journey. Together with the farmers feeding the world, we seek to tackle the threat of climate change head-on. Soil health is one of our strategic priorities[73]. We are committed to applying our expertise in financial services to engage farmers and join them on this journey to prepare together for the challenges of tomorrow, and be part of the solution.

Advancing Soil Health & Soil Carbon Sequestration

Reducing atmospheric greenhouse gas by capturing carbon in agricultural soils

Decarbonizing our Operations & Products

Reducing CO_2 emissions to limit the extent of climate change

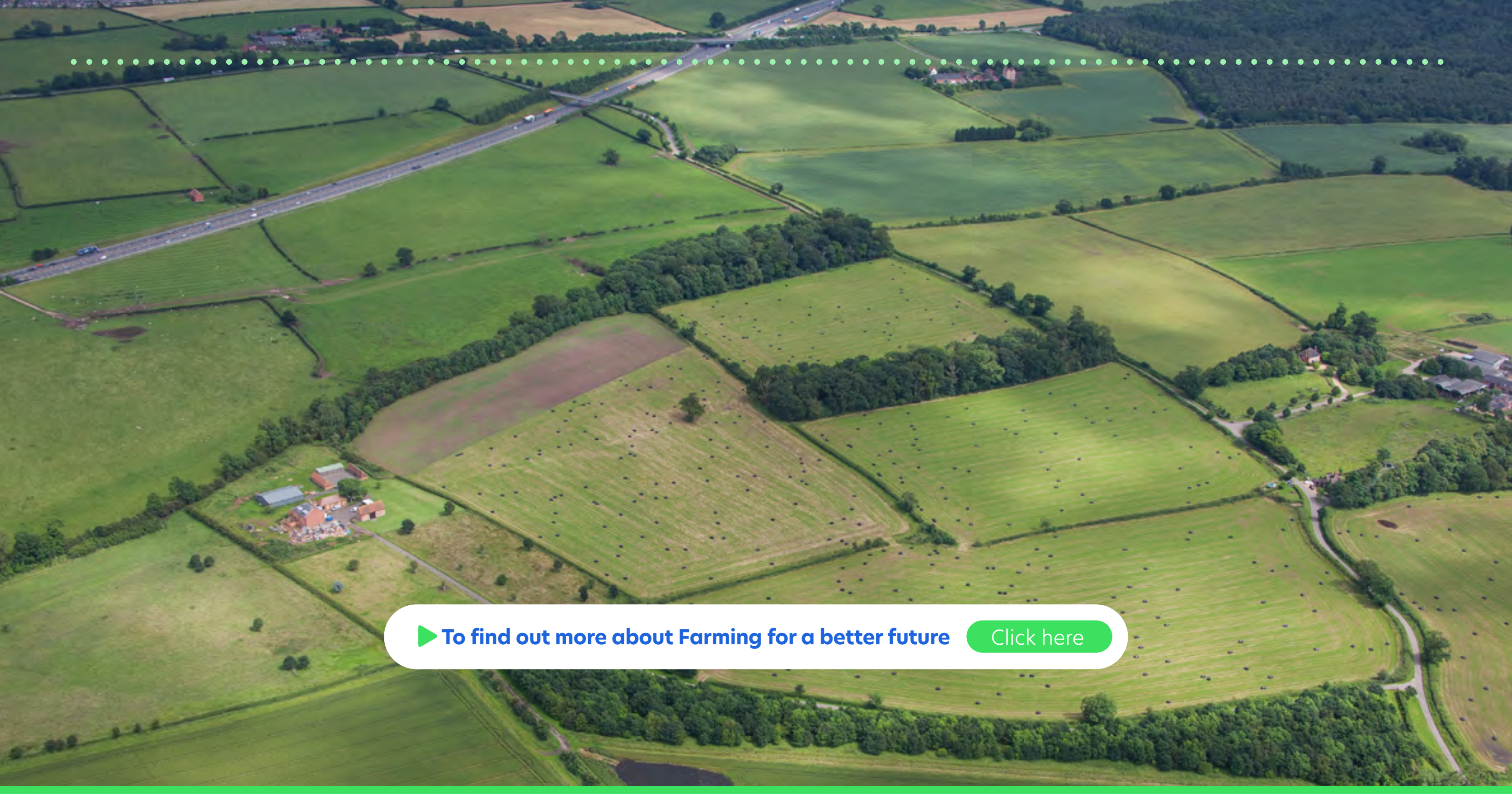
Elevating Employee Health & Safety

Ensuring that all AGCO workplaces protect the health and safety of employees

Prioritizing Animal Welfare in Food Production

Leveraging technology to drive innovation for animal-based food production

Source: AGCO Corp. 2020 Sustainability Report



To find out more about Farming for a better future Click here

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