

REVIEW ARTICLE

Strategies for Climate-Smart Farming in Agribusiness: Soil to Carbon Markets

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ABSTRACT

People are starting to see climate-smart farming as an important way to make farming more resilient, productive, and environmentally friendly in the face of climate change. This analysis looks at methods that agribusinesses might adopt climate-smart practices, with a focus on soil health and carbon sequestration. The paper highlighted the scientific and financial reasons for using soil-centered methods like conservation tillage, cover cropping, bio-char, and regenerative agriculture as the main tools for making the climate more resilient. It also looks at how these approaches could be used in new carbon markets, where farmers and agribusinesses can make money by selling carbon credits. The main problems are looked at, such as how to test and verify soil carbon, how to get money, how complicated the rules are, and how ready the market is. Lastly, the review finds policy frameworks, digital technologies, and collaboration models that can help speed up large-scale adoption. The research says that connecting soil health measures with participation in the carbon market is a alternative for agribusiness to make money while also helping the environment.

KEYWORDS

• Soil health • Carbon sequestration • Conservation tillage • Carbon credits
• Agribusiness

INTRODUCTION

Climate change damages and helps farming at the same time. Extreme weather, changing rainfall patterns, and rising temperatures

are having a highest effect on food systems.¹ This makes it even more important to switch to farming methods that are more robust and sustainable. As a result, the idea

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of climate-smart agriculture has come up as a guiding framework. Its goals are to boost agricultural output, make farms more resilient (adaptation), and cut greenhouse gas (GHG) emissions (mitigation), all while making sure that food is safe and the economy is strong. Soil management is a very important part of this larger picture.² Healthy soils not only help crops grow and hold water, but they are also one of the best natural carbon sinks. Cover cropping, decreased tillage, organic additions, agroforestry, and regenerative farming are all ways to considerably raise soil organic carbon (SOC) levels.³ This has two benefits: it makes farms more productive and helps the climate. These soil-focused treatments have recently become important in terms of money since they are linked to carbon markets. Farmers and agribusinesses can earn carbon credits by using methods that store carbon. These credits can be traded in voluntary and compliance carbon markets. This change from “soil to carbon markets” is adding a new level of value to farming, making carbon sequestration an asset for both the environment and the economy.⁴ But this chance comes with a lot of hard problems. To use climate-smart agriculture in agribusiness, farmers need to modify how they do things and get new ways to measure, record, and verify. They also need access to money, market infrastructure, and policies that help them. To get the most out of climate-smart farming, smallholder farmers, large-scale producers, agri-investors, and governments need to figure out how to deal with these new changes. This review study gives a full overview of ways to use climate-smart farming in agribusiness, with a focus on soil-based interventions and how they relate to carbon markets. It looks at current business models, practices, policies, technology tools, and major obstacles to adoption. In the end, the paper’s goal is to teach scholars, practitioners, and decision-makers how agribusinesses may balance environmental sustainability with economic potential in the age of climate change.

Principles and Methods of Climate-Smart Farming

Climate-smart agriculture is a approach developed to address the interlinked challenges of climate change and food security.⁵

- Sustainably increase agricultural productivity and incomes

- Adapt and build resilience to climate change, and
- Reduce and/or remove greenhouse gas (GHG) emissions, where possible.

Key Principles of Climate-Smart Farming

Focus on productivity: **Climate-smart agriculture** wants to use resource-efficient technologies like precision agriculture, drought-resistant crop varieties, and better irrigation systems to sustainably boost crop yields and livestock output.⁶

Adaptation and Resilience: A key goal is to make farming systems more able to deal with climatic stresses such drought, heat, pests, and floods. Some of these practices are planting different kinds of crops, agroforestry, collecting rainwater, and conservation agriculture.

Mitigation of Emissions: CSA has ways to lower emissions from farming (such methane from rice paddies and animals and nitrous oxide from using fertilizer) and to improve carbon absorption in soil and plants.

Managing landscapes in an integrated way: Climate-smart farming encourages a systems approach that looks at how crops, livestock, water, forests, and biodiversity all work together.

Intervention: There is no one-size-fits-all answer for context-specific interventions. Practices need to be adapted to the soil, climate, market access, and institutional strengths of the area.

Smart farming practices for the climate Climate Smart Agriculture comprises a wide range of practices, many of which give co-benefits across the three objectives:⁷

Practice	Climate Benefit	Business Benefit
Conservation tillage/no-till	Enhances soil carbon, reduces erosion	Cuts fuel/labor costs, improves soil structure
Cover cropping	Reduces erosion, increases soil organic matter	Improves soil fertility and yields
Crop rotation and diversification	Reduces pest/disease risk, improves resilience	Spreads income risk, optimizes resource use
Integrated soil fertility management	Reduces chemical inputs, boosts soil health	Increases long-term productivity
Agroforestry	Sequesters carbon, buffers climate extremes	Provides diversified products and revenue

Practice	Climate Benefit	Business Benefit
Precision nutrient management	Reduces N ₂ O emissions, improves efficiency	Cuts fertilizer costs, raises productivity
Improved livestock feeding systems	Reduces methane emissions, improves efficiency	Increases weight gain, milk/meat output
Water-efficient irrigation	Enhances drought resilience	Saves water, stabilizes yields

Soil Management Practices for Climate Mitigation

These methods not only make the soil healthier and produce more food, but they also cut down on emissions and store carbon:

No-Till Farming or Conservation Tillage

- Lessens carbon loss by disturbing the soil less.
- Allows carbon to build up in the soil over time.
- Cover cropping takes in CO₂ from the air through biomass.
- Increases the amount of organic carbon in the soil and stops erosion.
- Organic Additives (manure, compost, biochar) Keeps carbon in the soil stable, especially biochar.
- Replaces man-made inputs, which lowers emissions.

Better Use of Fertilizer

- Reduces nitrous oxide (N₂O) emissions by applying it in a precise way.
- Helps the health of microbes in the soil.

Systems for Agroforestry

- Combines trees and crops or animals to store carbon in the ground and in the air.
- Improves ecosystem services and biodiversity.

Changing crops and adding new ones

- Makes you more resilient to climate shocks.
- Increases the amount of carbon and fertility in the soil over time.

Managing water and grazing

- Lowers the amount of methane that rice and livestock systems give off.
- Better land management helps store carbon.

Connecting carbon markets to soil management

Soils, especially those used for farming, have a lot of potential to store carbon. Farmers can raise the amount of organic carbon in the soil (SOC) and lower the amount of greenhouse gases (GHGs), mainly CO₂ and N₂O, by using strategies that are focused on regeneration and conservation. In voluntary or compliant carbon markets, these improvements can be measured and sold as carbon credits.⁸

The Soil-to-Carbon Market⁹

Step	Action	Outcome
Adopt Practices	Implement practices like no-till, cover cropping, composting, agroforestry.	Soil carbon increases, emissions decrease.
Monitor & Measure	Use soil sampling, remote sensing, or digital platforms.	Carbon change is quantified.
Verification	Independent verification of carbon gains (via third parties).	Ensures credibility and transparency.
Credit Generation	Verified carbon is converted into carbon credits (usually 1 ton CO ₂ e per credit).	Tradable carbon assets.
Sell/Trade Credits	Farmers/agribusinesses sell credits to corporations or governments needing offsets.	New income stream.

Soil Management Practices suitable for Carbon Credits

Practice	Carbon Benefit
No-Till / Reduced Tillage	Increases SOC, reduces fuel emissions
Cover Cropping	Enhances biomass and SOC
Organic Amendments (e.g., compost, biochar)	Adds stable carbon
Agroforestry	Sequesters above- and below-ground carbon
Improved Grazing	Increases SOC, reduces CH ₄
Precision Nitrogen Management	Cuts N ₂ O emissions

Benefits to farming and agribusiness¹⁰

Carbon credits are a new way to make money. Improved Soil Health, productivity, and drought resilience.

CONCLUSIONS

Climate-smart farming is a alternate way for agribusiness to deal with both climate change and the need for sustainable agriculture. Soil management is at the heart of these plans. It is the basis for productive farming and a potent way to reduce climate change by storing carbon. This review shows that conservation tillage, cover cropping, organic amendments, agroforestry, and better nutrient management not only make soil healthier and more productive, but they also cut down on greenhouse gas emissions. By connecting these soil-based activities to new carbon markets, agribusinesses may make money from their climate-friendly actions through verified carbon credits. This helps them reach their environmental goals while also bringing in new sources of income. But for integration to work, there needs to be strong systems in place for measuring and verifying carbon, as well as fair access to the market, especially for smallholders. To make these practices bigger and make sure that climate-smart farming helps both the planet and the people who work the land, we will need policies, incentives, and new technologies. In the end, making soil management work with carbon markets makes agriculture a crucial player in the worldwide shift toward a resilient, low-carbon, and sustainable agricultural future.

REFERENCES

1. Lipper, L., Thornton, P., Campbell, B. M., Baedeker, T., Braimoh, A., Bwalya, M., & Torquebiau, E. F. (2014). Climate-smart agriculture for food security. *Nature Climate Change*, 4(12), 1068–1072. <https://doi.org/10.1038/nclimate2437>
2. Paustian, K., Lehmann, J., Ogle, S., Reay, D., Robertson, G. P., & Smith, P. (2016). Climate-smart soils. *Nature*, 532(7597), 49–57. <https://doi.org/10.1038/nature17174>
3. Lal, R. (2016). Soil health and carbon management. *Food and Energy Security*, 5(4), 212–222. <https://doi.org/10.1002/fes3.96>
4. Bossio, D. A., Cook-Patton, S. C., Ellis, P. W., Fargione, J., Sanderman, J., Smith, P., & Griscom, B. W. (2020). The role of soil carbon in natural climate solutions. *Nature Sustainability*, 3(5), 391–398. <https://doi.org/10.1038/s41893-020-0491-z>
5. Balo, S., & Mahata, S. (2022). A review of climate-smart agriculture as a new approach to farming system. *International Journal of Environment and Climate Change*, 12(11), 2682–2692. <https://doi.org/10.9734/ijec/2022/v12i1131186>
6. Zhang, J., Wang, Y., & Liu, H. (2023). A review of climate-smart agriculture: Recent advancements, challenges, and future directions. *Sustainability*, 15(4), 3404. <https://doi.org/10.3390/su15043404>
7. Bhattacharyya, P., Pathak, H., & Pal, D. (2020). *Climate-smart agriculture: Concepts, challenges, and opportunities*. Springer. <https://doi.org/10.1007/978-981-15-9132-7>
8. Bossio, D. A., Cook-Patton, S. C., Ellis, P. W., Fargione, J., Sanderman, J., Smith, P., ... Griscom, B. W. (2020). The role of soil carbon in natural climate solutions. *Nature Sustainability*, 3(5), 391–398. <https://doi.org/10.1038/s41893-020-0491-z>
9. Lal, R. (2020). Soil organic matter content and crop yield. *Soil Science and Plant Nutrition*, 66(1), 1–13. <https://doi.org/10.1080/00380768.2020.1719538>
10. World Bank. (2016). *Carbon sequestration in agricultural soils: Potential and challenges*. Agriculture Global Practice Discussion Paper. <https://openknowledge.worldbank.org/handle/10986/24463>