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Net-zero in Agriculture:

Role of Technologies

Contents

Impact of Climate change on Agriculture and Food Systems

- Impact of increasing GHG emissions on Agriculture and Food Systems
- Risks posed for business sustainability
- Net-zero commitments in response to these risks
- Challenges in achieving net-zero commitments

The emerging role of Technologies

- Introduction to Net-Zero Technologies for Agriculture
- 7 priority digital and non-digital technology clusters
- Scaling these technology clusters

Climate change is affecting the accessibility of arable land and the productivity of both crops and livestock, threatening both food security and incomes of smallholder producers

Challenge

Agriculture and food systems contributes to almost 1/3rd of global GHG emissions (around 16-18 GtCO2eq)

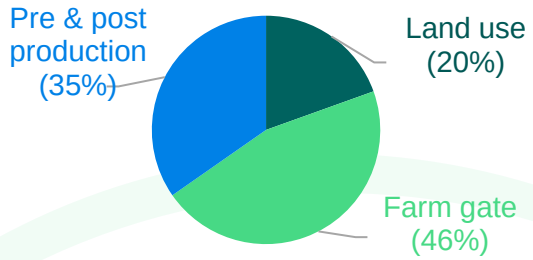
In the absence of mitigation measures, this is projected to increase to 30 GtCO2eq by 2050

Key sources of GHG emissions in agriculture and food systems-

Agricultural activities at the farm-gate have the highest share of emissions across all value chains.

- **18%** Deforestation due to changes in land use
- **18%** Enteric fermentation from livestock
- **10%** Soil degradation due to the uneven use of chemical inputs and water
- **10%** Poor farm waste management

GHG emissions from agriculture and food system (2020 data)



Impact of increased temperature due to excess GHG emissions

- Risk for global food security
- Strong impact on the livelihood of smallholder farmers of LMIC

Reduction in current cultivable area

COCOA
A rise of just **2.1ºC could leave ~90% of land used to cultivate coca, unsuitable** by 2050

COFFEE
50% of the coffee cultivation area may no longer be suitable for its cultivation by 2050

Decrease in productivity

WHEAT
Every 1º C increase above mean temperature of 23º C **decreases wheat yield by 10%**

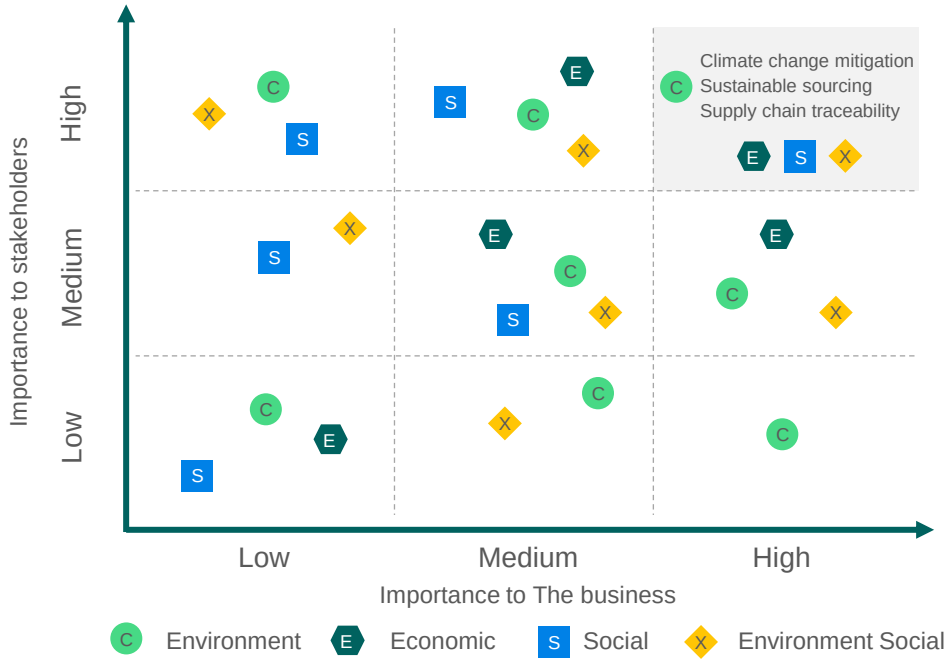
Increased heat stress for livestock

LIVESTOCK
Rising temperatures can cause **increased instability in feed supply**, increased heat stress changes to fertility and disease susceptibility

The detrimental consequences of climate change also pose multifaceted risks to the sustainability of agri-food businesses

Climate change identified as key risk by major Agri and food corporates

Currently the materiality matrix of most of global corporates identifies climate change and sustainable sourcing as issues that are important to stakeholders and that have a significant impact on business operations.



*TCFD- [Task Force on Climate-Related Financial Disclosures]

Risks associated with the increased GHG emissions

Reputational Risks

- Increased consumer awareness and demand for responsible sourcing and fair-trade practices for the products they purchase

Climate related financial Risks

- Increased need for sustainability reporting.
- Better TCFD* and ESG scores attract investors and make finance available at competitive rates.

Supply chain and procurement Risks

- Increased procurement price due to reduced availability of raw materials.
- This, in turn, can lead to uncompetitive product prices.

As a response to the risks, several corporates have set voluntary net-zero commitments

Increasing commitments towards net-zero Transitions

- **More than 70 countries**, accounting for 76% of global emissions, have committed to net-zero targets in their NDC*s
- These countries have introduced, or plan to introduce, regulations promoting the decarbonization of supply chains

- **550 agri-food sector companies are committed** to setting science-based targets for decarbonization
- Of these, **176 have committed to net-zero emissions**

Example of decarbonization commitments of agriculture and food system corporates

Nestlé

Net-zero by 2050

Committed to reducing emissions by 20% by 2025 from its baseline year of 2018, 50% by 2030, and to reaching net-zero emissions by 2050

PepsiCo

Net-zero by 2040

Committed to reducing absolute GHG emissions across its direct operations by 75% by 2030, compared to a 2015 baseline. The company also plans to cut Scope 3 emissions by 40% by 2030

Mondelēz International

Net-zero by 2050

Committed to 100% responsible cocoa sourcing and 100% recyclable packaging by 2025

Olam

Net-zero by 2050

Target to reduce GHG emissions by 50% both in its own operations and across Olam-managed farmer programs

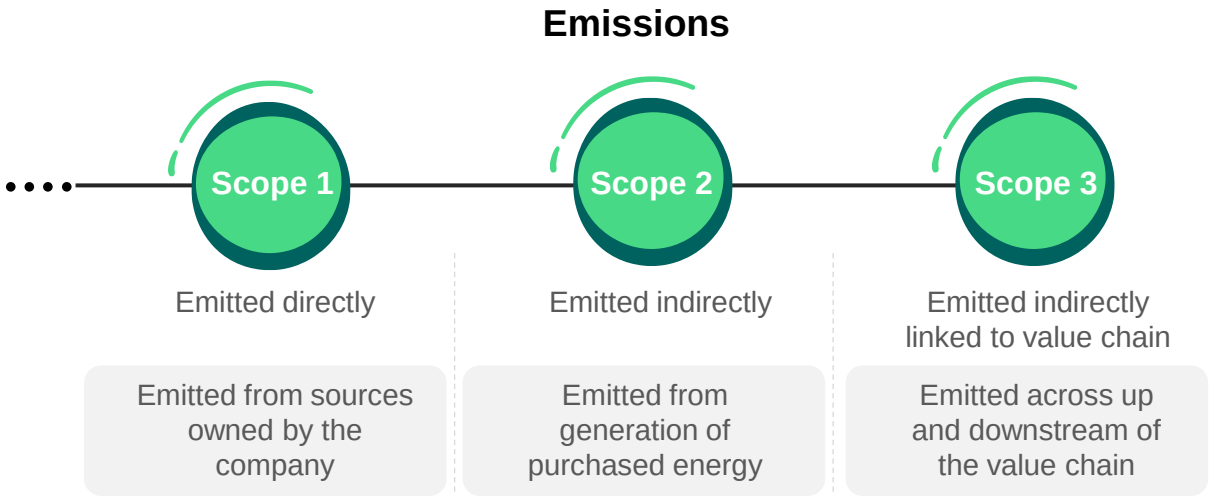
Labeyrie Fine Foods

Not defined

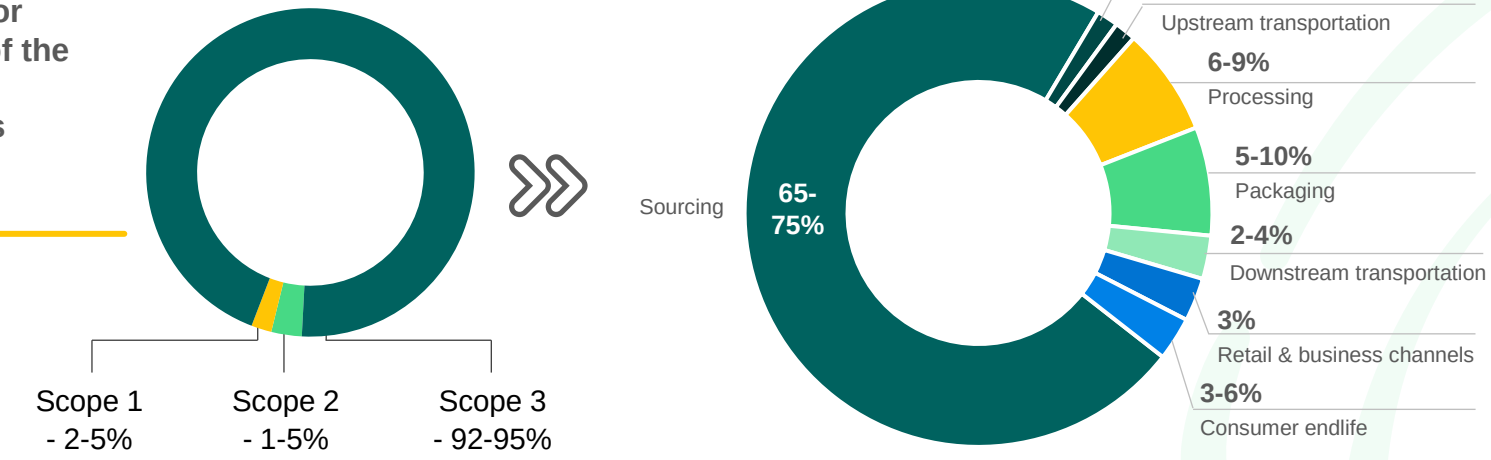
Has set a target to reduce its scope 3 GHG emissions by 22% by 2030 compared to 2019 baseline

One of the major hurdles in fulfilling net-zero commitments lies in reducing scope 3 emissions

Share of Scope 1,2 and 3 in the total GHG emissions of a typical agri and food corporate



Scope 3 emissions account for majority of the total GHG emissions



Key Challenges faced in mapping and reduction of GHG emissions

- Lack of availability of reliable and specific data
- High marginal abatement cost of net-zero technologies
- Poor last mile connectivity and implementation challenges
- Convince and align large supplier base towards net-zero
- Concern over passing increased cost to the customers

Technological innovations can plan a keystone role in helping mitigate scope 3 emissions;

IDH and Intellecap studied several of these innovations

Approach followed to derive high impact technology clusters

Accessed

- Agri-corporate supply chain & mapped GHG emissions
- Potential technologies

Grouped

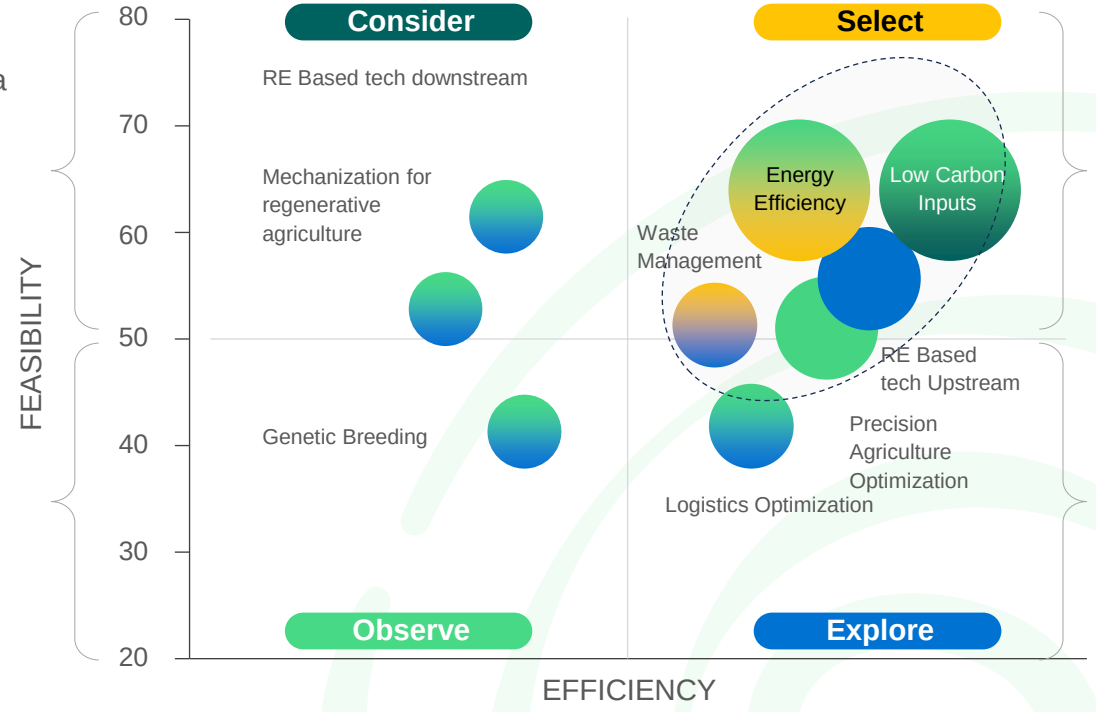
- Grouped technologies into 13 potential clusters

Mapped

- Scored potential tech clusters based on their efficiency and feasibility

Consider for further evaluation on how a combination of these technologies with the selected technologies bring in higher efficiency

Observe these clusters till they realize higher efficiency and/or feasibility



Selected 5 high impact clusters

Explore these clusters as they require and require certain enabling environment for implementation in LMICs

The study prioritized 5 high-impact technology clusters and 2 enabling clusters that have the potential to significant mitigate scope 3 emissions

Technology clusters refer to groups of digital and non-digital technologies that share similarities and have the potential to reduce GHG emissions across an agri-corporation's supply chain

High Impact tech cluster

01 Low Carbon Inputs

02 Upstream Renewable Energy

03 Waste Management

04 Energy Efficiency

05 Precision Agriculture Optimization

Enabling cluster

06 GHG Accounting Solutions

07 Carbon Financing Platforms

Shortlisted clusters based on an assessment of their potential to reduce GHG emissions and their feasibility of implementation in low and middle-income countries.

Enable transitions to net-zero emissions by facilitating mapping, measurement, or buying carbon credits

Technologies that replace conventional inputs which have high GHG emissions with alternative inputs that have a lower environmental footprint.

Case study

PepsiCo's tropicana Premium orange fruit juice

Synthetic fertilizers used in orange production contribute 35% of GHG emissions in the juice supply chain.

To address this PepsiCo had collaborated with Florida suppliers to test Yara and ERTH fertilizers, aiming to cut nitrous oxide emissions by 90%. Success could lead to a 15% reduction in GHG emissions for Tropicana Pure premium orange juice.

	Alternative Fertilizers	Controlled Fertilizers	Biochar	Alternative Feeds	Feed Additives
ABOUT	• Fertilizers that use microbes to fix Nitrogen • Low carbon ammonia fertilizers.	Fertilizers that contain nutrients which are gradually released for plant uptake and use.	Fertilizers generated from farm waste and other biomass using pyrolysis.	Low carbon feeds made up of raw materials produced without deforestation and carbon intensive farming.	Feed additives that aids faster digestion and reduces enteric fermentation in livestock.
PATHWAYS	Reduces the use of synthetic fertilizer	Prevents soil carbon loss	Prevents deforestation by reducing soy, rice, wheat based feeds	Reduces enteric fermentation	

Emission Hotspot Impacted

30-40% impact in GHG emission mitigation at Farm gate

Benefits

- Potential to address the significant share of GHG emissions at farm gate
- Prevents soil degradation and reduces input costs in long term

Challenges

Cost

Comparatively higher initial cost than their existing counterparts (for some of the technologies)

Complexity

Lack of understanding and protocols regarding usage and application

Capability

Suppliers need to engage in intensive efforts to build capacities of farmers

Technologies that reduce GHG emissions by replacing non-renewable energy for on-farm operations with renewable energy.

Case study

Bboxx, EDF, and Sunculture partnered with Togo Government to support sustainable solar-powered farming

As part of partnership, the government is providing a 50% subsidy to farmers The solar water pumps provided by Sunculture are integrated with Bboxx's comprehensive management platform using IoT technology, allowing for remote management and monitoring.

This will improve farmers' economic opportunity along with along with decreasing the carbon footprint.

ABOUT

Irrigation

Irrigation technologies like solar-powered pumps or drip irrigation systems powered by renewable energy.

Mechanization

Mechanization technologies, such as solar-powered or electric-powered machinery for agricultural operations.

Transportation

Transportation technologies like electric/ biogas-powered vehicles for transportation

Ventilation & energy use in Livestock & Aquaculture

Technologies like Solar-powered fans, biogas generators, to provide ventilation and heating for livestock, aquaculture.

PATHWAYS

Reduces fossil fuel usage

Emission Hotspot Impacted

6-8% impact in GHG emission mitigation at Farm gate

Benefits

- High decarbonization potential: ~80% reduction in GHG emission per unit of energy used for pumping water (CO_2eq/kWh) compared to traditional pumps
- Economic benefits: 34-40% savings in fuel consumption per ton of crop produced and harvested

Challenges

Cost

Significant initial costs compared to the potential for emissions reduction

Capability

Expertise needed to operate and maintain renewable energy systems

Technologies that reduce GHG emissions through efficient farm and livestock waste management.

Case study

Nestle's focus on farm waste management and circularity

Nestle introduced NESCAFÉ NATIV Cascara, a carbonated soft drink made from the coffee berry, which is typically discarded as waste. It presents a unique beverage with floral and fruity notes, introduced in Australia.

Additionally, under its Les Recettes de L'Atelier brand, Nestle launched Incoa, a 70% dark chocolate bar that incorporates cocoa pulp, applying innovative methods to utilize the cocoa fruit in products like these.

	Farm Waste Management	Livestock Waste Management
ABOUT	Technologies like microbe-based decomposition; gasification, pyrolysis using thermos-chemical pathways and fermentative and oil plant based biorefineries that convert agricultural farm waste and crop residue into useful products like packaging materials, fuel, fertilizer, specialty chemicals etc.	Technologies like anaerobic digestors, urease inhibitors, composters and bio-digestors. that mitigate methane and ammonia emissions from manure storage and deposition.
PATHWAYS	Reduce GHG emissions due to farm waste disposal and crop burning	Reduce methane & ammonia emission from livestock manure

Emission Hotspot Impacted

10-12% impact in GHG emission mitigation at Farm gate

Benefits

- Innovative technologies for managing farm waste have the potential to reduce GHG emissions by 5-15% across the supply chain
- Reduces other type of pollutions related to water and air

Challenges

Cost

Income from managing waste might not offset the expenses for waste collection and processing.

Complexity

Farmers might need extensive training for effective waste management.

Capability

Waste aggregation to usable volumes is highly complex in rural settings with limited infrastructure

Technologies that reduce GHG emissions by optimizing the use of fossil-fuel-based energy during upstream and/or downstream activities in the Agri and food system supply chain.

Case study

Del Monte's energy efficient solutions

Del Monte Philippines, Inc. achieved a significant milestone by earning carbon-negative certification for scopes 1, 2, and 3 within its pineapple operations.

The efforts involved exploring more efficient energy sources and enhancing energy conservation at their sites, contributing to a commendable reduction in GHG emissions.

ABOUT

Energy efficiency solution for upstream

Technologies like smart water controllers, energy saving pumps, farm equipment route management, small farm level cool boxes for storing perishables, which help optimize fuel and energy at the farm level.

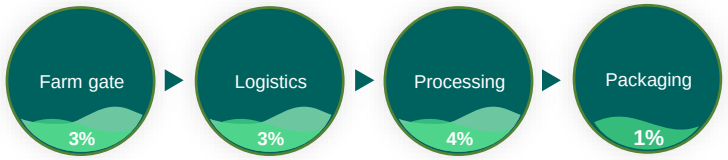
Energy efficiency solution for downstream

Technologies like logistic route optimization, hybrid engines, and smart energy meters for warehouses and cold storage units, that reduce energy consumption and improve energy efficiency in various activities such as transportation, storage, and processing of agricultural products.

PATHWAYS

Optimize usage of fossil fuel and other farm inputs

Emission Hotspot Impacted



6-4% impact in GHG emission mitigation across multiple hotspots

Benefits

- Have added benefits like saving of water and overall energy usage
- Prevents soil degradation and reduces input costs in long term

Challenges

Cost

Initial investment needed for acquiring or enhancing equipment

Capability

Limited motivation to choose energy-efficient solutions without evident economic benefits

Agri 4.0 technologies which help to reduce GHG emissions by providing precise advisory to optimize the use of inputs and enable more informed decision at the farm level

Case study

Cargill's Digital Tools Revolutionize Farming for Sustainable Cocoa Production

Cargill- a multinational corporation uses digital tools to help farmers improve their productivity while reducing their environmental impact.

Under Cargill Cocoa Promise program, Cargill has developed a platform which uses satellite imagery and machine learning to provide cocoa farmers with personalized recommendations on crop management practices. This is helping the farmers optimize their yields while minimizing the use of water and chemicals.

ABOUT

Precise input use at farm level

Technologies like AI, ML, Big data analytics, Block chain, IoT, Smart sensors, Robotics, Drones etc. to advise or facilitate optimum input usage

Efficient Livestock management

Technologies like sensors, IoT and predictive analytics used to provide data-driven guidance for effective herd management and tracking livestock health and feeding patterns.

Precise aquaculture management

Technologies like AI, ML and computer vision to monitor growth of fish and shrimps and accordingly advise on optimum input usage.

PATHWAYS

- Reduce usage of synthetic fertilizers and agro-chemicals
- Increase soil organic carbon, prevent the degradation and leaching of soil
- Reduce methane emissions from enteric fermentation in livestock
- Reduce GHG emissions from aquaculture by optimizing the use of feed

Emission Hotspot Impacted

30-40% impact in GHG emission mitigation at Farm gate

Benefits

- Significant cost optimization through input use optimization and use of better alternatives
- Increases productivity and reduce waste of input and outputs

Challenges

Cost

Higher marginal cost of reducing emissions, involving asset investments

Complexity

Significant expertise needed to operate advanced technology effectively

Capability

Significant capacity building is required at farmer level

Technologies enabling a reduction in GHG emissions by assisting corporates to map, monitor and account for GHG emissions across their supply chain.

Case study

Mondelez's Climate-Friendly Efforts in Cocoa-Growing Regions

Mondelez International collaborated with Global Forest Watch **to monitor deforestation in six cocoa-growing areas in LMICs** under its Cocoa Life initiative.

The program supports farmers in adopting climate-friendly practices such as agroforestry and optimal input usage to reduce deforestation rates.

It is backed by the Payment of Ecosystem Services to Farmers Act, incentivizing tree planting and the preservation of forest areas.

ABOUT

Geospatial monitoring of biomass and soil carbon

Satellite or aerial imagery, machine learning, and Geographic Information Systems (GIS) used to monitor used to monitor and analyze changes in climate and land cover.

Emission accounting software- Supply chain mapping for accessing suppliers' GHG emission

Digital tools used to track and quantify GHG emissions from suppliers, with the aim of identifying opportunities to reduce emissions and improve sustainability.

Benefits

- Leveraging satellite-based monitoring could potentially slash tropical deforestation emissions by 18% by 2030, equal to removing about 1 billion cars from the roads annually

For ex: Utilizing supply chain mapping tools and taking actions may lead to a 41% reduction in emissions in the soybean supply chain by 2025 compared to business-as-usual scenarios

Challenges

Cost

Significant time and cost involved in customizing technology for better imagery,

Complexity

Needs region-specific algorithms, making the process complex
.

Capability

Field staff might require extra training for credible GHG accounting

Technologies that enable the reduction of GHG emissions by measuring, reporting and verifying (MRV) carbon credits generated in carbon offset/ inset projects and facilitate the trade of carbon credits by connecting buyers and sellers.

Case study

Indigo's 'Terraton Initiative': Aiming for Carbon Removal in Agriculture

Indigo Ag introduces the "Terraton Initiative" striving to eliminate one trillion tons of carbon dioxide from the atmosphere across 12 billion acres. The initiative promotes regenerative farming practices, including cover crop planting, minimizing chemical usage, crop rotation, and integrating livestock to enhance soil health.

The initiative has already sequestered approximately 40-60 MMT CO2eq and offers farmers who embrace these methods an estimated increase of $30-$45/acre/year in potential gross income through soil enrichment.

ABOUT

Designing and implementing carbon removal projects within own supply chain

Advanced digital technologies like satellite imaging, GIS and AI models for MRV of carbon removal programs like regenerative practices and agroforestry within a company's supply chain.

Carbon trading platforms for carbon offsetting outside own supply chain

Online platforms providing real-time monitoring capabilities used to track carbon credits generated from offsetting projects like agroforestry, avoiding crop waste burning, and regenerative agriculture that take place outside a company's value chain.

Benefits

- Carbon trading platforms offer a market-driven incentives to farmers to cut emissions. They could reduce up to 1.5 billion tons of CO2eq per year in agricultural emissions by 2030, aiding global climate change efforts
- Carbon finance acts as secondary source of income for farmers to adopt new practices

Challenges

Cost

The expenses, including emission measuring, reporting, and verifying, are high, along with carbon offset project development

Complexity

Evolving regulations and technical complexities make it challenging to monitor and verify credits

.

Capability

Insufficient evidence in low-and-middle-income regions and long-term returns create initial funding challenges

The seven identified technology clusters suggested in this study not only reduce GHG emissions across various activities but also enhance climate resilience

High Impact tech cluster

Enabling cluster

01	02	03	04	05	06	07
 Low Carbon Inputs	 Upstream Renewable Energy	 Waste Management	 Energy Efficiency	 Precision Agriculture Optimization	 GHG Accounting Solutions	 Carbon Financing Platforms
• Increases **soil water holding capacity** to withstand adverse environment conditions • **Reduces cost of cultivation** in the long-run due to reduction in usage of synthetic inputs	• **Reduces irrigation expenses** and results in higher savings in the **long run** • Build absorptive capacity of farmers	• Generates additional revenues from sustainable waste management	• Increases in economic savings due to reduced use of electricity for farm operations	• Increased financial capacity due to input and output maximization • Increased knowledge of farmers to adapt to climate change	• Increased income realization due to climate ready farm management and certification of the produce. • Increased readiness to tackle climate disasters	• Increased financial capacity due to enablement of carbon finance, Payment of Ecosystem Services (PES). • Increased biodiversity due to diversification of farm activities

A multistakeholder approach is required for scaling the adoption of these technologies for net-zero agriculture

Stakeholder category	Actions
Corporates	• Train their suppliers about publicly available tools for emission monitoring • Collaborate and pre-competitive levels to test high impact technologies • Incentivize farmers to adopt technologies by offering sustainability differential, Payment for Economic Services (PES) / Differentials
Technology providers	• Bundle GHG-reducing technologies with other services, such as financing and building market linkages, to improve adoption. • Design custom made solutions as per the needs of the supply chain
Government	• Create an enabling environment for data sharing on the efficacy of technologies • Mobilize funds to facilitate designing of blended finance vehicles • Provide incubation support
Financial institutions	• Link lending terms and finance to ESG scores • Design and offer innovative financing mechanisms to suppliers and technology providers Ex. (Result based financing, Risk mitigation instruments, bundled financial instruments)
Industry Associations and Coalitions	• Create awareness on the advantages of adopting available technologies • Setting up a platform to facilitate collaboration among stakeholders • Co-finance and implement pilot programs

Thank You

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