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Climate Change and Agriculture Production: An Overview of Risks and Opportunities

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Impacts of Climate Change on Agriculture

Although climate change is likely to affect agriculture differently from region to region, the scientific consensus is that it will have major, generally negative impacts on food systems. As highlighted by the Intergovernmental Panel on Climate Change (IPCC) Report on Climate Change and Land[1], climate change has already impacted food production in many areas, and the impacts will become more severe as the world continues to warm. Water scarcity, heat waves, storms, and sea level rise are already compromising agricultural productivity and will continue to destabilize agricultural supply chains unless we take action.

Climate change harms agricultural production in the following ways:

- Warmer mean temperatures and hotter extremes result in reduced crop yields and increased animal loss from heat stress and disease.
- Increased probability of drought and precipitation deficits increases crop stress and reduces livestock yield.
- Increased frequency, intensity and/or amount of heavy precipitation degrades and inundates farms and livestock operations.

In addition to harming agricultural production in the short term, some climate impacts can have long lasting or irreversible effects:

- Salt water intrusion and the rise in sea levels in some coastal regions of the world result in a reduction in usable cropland.
- Disruption of the movement of water in the atmosphere as a result of the dieback of tropical forests could cause major shifts in precipitation in key agricultural areas.
- Climate change reduces biodiversity, such as by reducing the populations of pollinating insects, which can threaten agricultural resilience and crop productivity.

Impacts of Agriculture on Climate Change

While climate change affects agriculture, the conversion of natural habitats and the practices used in agricultural and livestock operations also contribute to climate change. Agriculture, forestry, and other land use changes are the largest greenhouse gas (GHG) emitting sector after energy. Currently, the sector accounts for 23% of net anthropogenic GHG emissions: 11% come directly from agricultural production and an additional 12% from land use change[1].

Direct contributions from agricultural production include:

- Land use change from commodity crop and subsistence agriculture. Agriculture drove up to 88% of forest loss in Latin America and 81% in Southeast Asia between 2001 and 2015[2].
- GHGs generated during livestock production and manure management. Methane from the digestion of carbohydrates by cattle is the largest single source of agricultural GHGs[1], and methane is 25 times more potent in the atmosphere than carbon dioxide over a 100-year period).
- Production of nitrous oxide from synthetic fertilizer used to grow crops for both human consumption and, disproportionately, livestock feed.
- Methane produced during the cultivation of rice in flooded conditions.
- Fossil fuel emissions from powering machinery and irrigation pumps.

The contribution of agriculture as a source of emissions varies widely by country due to the efficiency and type of agricultural systems. For example, the amount of GHGs emitted for the production of each pound of beef in developed countries in 2016 was less than half the amount emitted in developing countries the same year[3].

Projected Growth in GHG Emissions from Agriculture

Emissions from crop and livestock are expected to increase by 30-40% between 2019 and 2050, considering both efficiency improvements and dietary changes[1].

Population Growth: Feeding 2.2 Billion More People in 2050

The world population was 7.6 billion in 2017, representing an increase of one billion people over the last 12 years. Though fertility rates have started to decline and are expected to continue to, the global population is nonetheless expected to grow to 8.6 billion in 2030, 9.8 billion in 2050, and 11.2 billion in 2100. If production continues along the same emissions trajectory, rising food demand and production growth is expected to dramatically increase agricultural GHG emissions.

Income-Driven Dietary Changes

Shifts in diet will also strongly affect future GHG emissions from food production. Compared to the average diet in 2009, the average diet in 2050 will have 15% more total calories[4]. This reflects a shift predicated on global economic growth and associated increase in household income. Dietary changes include shifts towards higher calorie consumption, particularly from animal-based protein, sugar and fat.

In developing countries, the rate of growth in consumption of calories from animal-based protein is projected to increase much more quickly than overall calorie consumption (123% compared to 31%)[4]. While livestock products provide protein and a wide range of essential micronutrients, their production, especially from cattle and other ruminants, is more emission-intensive than other food sources. Increased livestock production due to growing demand for meat products has also been linked to the destruction of forests and grasslands.

In the U.S. alone, the carrying capacity of existing agricultural land can support 402 million people given the current average U.S. diet, but could feed twice as many (807 million) if people adopted a vegetarian diet[5]. Halving meat consumption and avoiding meat from producers with above-median emissions around the world could free up 13 million square miles of agricultural land and reduce emissions by 5 billion tons of carbon dioxide, equivalent to 11.6 billion barrels of oil (or up to 10.4 billion tons of carbon dioxide, equivalent to 24.2 billion barrels of oil, if the vegetation on previously agricultural land is reforested)[1].

Measuring and Disclosing GHG Emissions from Food Supply Chains

Ceres reviewed practices for measuring and disclosing GHG emissions at the top 50 food and beverage companies in the United States, based on their reporting to CDP. In 2018, Scope 1 emissions from companies' facilities and vehicles and scope 2 emissions from purchased electricity, steam, heating, and cooling for facilities accounted for 6% and 5%, respectively, of large food and beverage companies' emissions. Supply chain emissions, called scope 3 emissions, accounted for the remaining 89%, the bulk of which came from purchased goods and services and, significantly, from agricultural production. In 2018, emissions from 24 large U.S. food companies that fully disclosed scope 3 emissions accounted for roughly 692 million tons of carbon dioxide equivalents, comparable in magnitude to GHG emissions from 1609 million barrels of oil.

Nonetheless, despite the fact that scope 3 emissions represent an enormous portion of total company emissions, less than half of the top 50 food and beverage companies in the U.S. and Canada publicly disclosed scope 3 emissions in 2018. By not fully disclosing scope 3 emissions, companies grossly under-represent their emissions footprint and may not adequately account for substantial material risk, particularly in light of the growing necessity to assess and address the impacts of climate change.

While 32 of the top 50 food and beverage companies have emission reduction targets, most targets only cover scope 1 and scope 2 emissions. Only 9 of the top 50 food and beverage companies have set reduction targets on the full range of scope 3 emissions. This failure to set targets for scope 3 emission reductions poses substantial material risks to companies and investors. By not reducing emissions from purchased goods and services, especially from agricultural production, companies are neither addressing nor protecting supply chains from the potential impacts of climate change.

Measuring emissions from agricultural production and land use change involves complex interactions between natural and human processes and requires data on agricultural management, soil, and climatic factors at the site of production. It takes serious commitment for companies producing multiple products and sourcing from thousands of producers, but it is getting easier. The report "Measure the Chain: Tools for Assessing GHG Emissions in Agricultural Supply Chains," provides investors and companies a science-based approach to increasing their disclosure of scope 3 emissions.

Explicit, science-based climate change mitigation targets for scope 3 emissions will likely become a non-negotiable requirement in long-range business planning. However, some companies are already making strides when it comes to measuring scope 3 emissions. Jeff Hanratty, applied sustainability manager at

General Mills, acknowledges that, "Reducing climate impact especially across our agricultural value chain is critical to the long-term viability of our business, and more important the Earth. Working alongside partners like The Nature Conservancy and Ceres is helping advance our climate work to more quickly have meaningful impact from farm to fork."

Companies are not the only ones thinking seriously about measuring and disclosing scope 3 emissions. "It's clear to us that if a food and beverage company is serious about reducing its climate impacts, it absolutely must be working to reduce the emissions associated with agricultural production of its products," says Allan Pearce, Shareholder Advocate at Trillium Asset Management. "Working to measure and manage these supply chain emissions will help build supply chain resiliency and preserve shareholder value, which is why we at Trillium are interested in how food and beverage companies are addressing their scope 3 emissions."

Food Companies and Climate Change Mitigation Opportunities

In order to limit average global temperature increase to 1.5 degrees Celsius, food companies must widen their focus beyond direct operations to work with their suppliers to report and reduce GHG emissions across supply chains.

Conserve Forested Lands

Conserving forested lands is essential in order to mitigate climate change. One third of all anthropogenic GHG emissions to the atmosphere since 1750 have come from land use change (deforestation and agriculture)[6]. Of particular importance is the conservation of tropical forested land. Tropical forests store 55% of global forest carbon stocks, more than that of boreal forests (32%) and temperate forests (14%) combined[7]. If tropical deforestation was a country, yearly emissions would only be behind those of China and the U.S[8].

Expand Agroforestry on Annual Cropland

Investing in sustainable tree crops and adding an agroforestry component to annual cropping systems contributes to carbon sequestration, the process involved in carbon capture and long-term storage of atmospheric carbon dioxide or other forms of carbon. Additionally, adding trees on farms can increase the yields of annual crops, add income and nutrition from yields of tree crops, and sometimes provide fodder for animals. By expanding agroforestry systems, companies can play a critical role in reducing their GHG emissions.

Manage Livestock Feed, Herds, Manure and Grazing Land

Since 2000, livestock production has accounted for 66% of agricultural GHG emissions[1]. Ruminant meat, especially, is emission-intensive, but providing it is even more intensive in developing countries because production and supply chains tend to be inefficient. Climate change mitigation options for livestock production in developing countries include improved feeding practices, dietary additives, animal breeding, improved manure storage and handling, anaerobic digestion of manure, and more efficient use of manure as nutrient for crops. In many areas, livestock producers may also have the opportunity to sequester carbon by restoring degraded grazing lands and incorporating trees into pastures. Globally, animal science is producing innovations in animal breeding, methane inhibitors, and alterations to ruminant microbiome that could reduce emissions further, even where production is already relatively efficient.

Reduce Methane in Irrigated Rice

Rice is the staple food for more than 3.5 billion people worldwide, roughly half of the world's population, and the second most produced cereal crop in the world. Most rice is grown in flooded conditions that cause high methane emissions. Simple changes to production, such as alternate wetting and drying of irrigated rice, switching to short duration varieties of rice, and improving nutrient use efficiency through urea deep placement, can significantly reduce methane emissions, while preserving yields and saving growers money on fertilizer and water inputs.

Improve Soil and Nutrient Management

Many soil management best-practices can reduce GHG emissions and sequester carbon. For example, optimizing nutrient use by applying the right type of fertilizer at the right rate, time and place, contributes to higher yields and reduces fertilizer-induced nitrous oxide emissions. Reducing tillage while increasing organic matter inputs to soils also has the potential to sequester carbon in soils, if such practices are maintained long-term.

Reduce Food Loss and Waste

An estimated 25-30% of all food produced globally is never eaten – it is either discarded or lost at some point along the food value chain[1]. The global economic, environmental, and social cost of food wastage is estimated at $2.6 trillion. The impact of the food system on climate change can also be decreased by reducing the amount of food lost and wasted. Companies can reduce food loss and waste by changing food storage, handling and manufacturing processes, designing packaging to extend shelf life, changing date labeling on packaging to reduce post-consumer waste, and introducing new product lines made from food that would otherwise have been wasted.

Expand Alternative Protein Options

With two-thirds of U.S. consumers reducing meat consumption[9], alternative proteins present an opportunity for food companies to reduce GHG emissions and claim space in a new market. Alternative protein options include plant-based products (i.e. Impossible Foods, Beyond Meat etc.), emerging products (i.e. Protix, AgriProtein etc.) and lab-grown products (i.e. Mosa Meat, Memphis Meats etc.). The global plant-based meat market alone is expected to grow at an annual rate of 15% between 2019 and 2025[10], and companies such as Tyson, Cargill, Kellogg's and Kraft are investing in and acquiring many emerging plant-based businesses. Increasing research and development efforts and adding alternative protein options can help companies do their part to mitigate climate change.

Investor Engagement

A trajectory of increased agricultural emissions will not limit average global temperature rise to less than 2 degrees Celsius above pre-industrial levels, the key goal of the Paris Climate Agreement, and it will certainly not limit it to no more than 1.5 degrees Celsius, as recommended by the IPCC. To limit the rise to 1.5 degrees Celsius, global carbon dioxide emissions will need to reach net zero by 2050[11]. Delays in implementing climate change mitigation efforts will substantially decrease policy and economic options and increase the difficulties of transitioning to a low-emission economy.

Major investments in systemic change to supply chains are necessary to achieve substantial reductions in agricultural emissions. While public financing is often discussed as a solution in the international community, the private sector was responsible for two-thirds of all climate change mitigation finance globally between 2015 and 2016[12]. Undoubtedly, both public and private financing will be necessary. Investors recognize the need to engage when it comes to agricultural emissions, and many are stepping up to the plate to address these issues.

Priority for Investor Engagement

Ceres' Work to Drive Implementation of No-Deforestation Commitments

Corporate no-deforestation commitments are a critical step to ending deforestation in supply chains. Hundreds of companies have set 2020 as a deadline to meet their pledges, but have yet to disclose their progress in meeting these critical targets. As the deadline approaches, Ceres is supporting investors looking to drive corporate action at scale by providing information on progress, helping investors define outcome-based metrics and other key performance indicators to follow up on corporate commitments, and supporting a collective action ask from investors to companies. Read Ceres' Investor Brief on Disclosure of No-Deforestation Progress.

Ceres Investor Network on Climate Risk and Sustainability

This network is comprised of more than 130 institutional investors who collectively manage more than $17 trillion in assets. It works to advance leading investment practices, corporate engagement strategies and policy solutions to build an equitable, sustainable global economy and planet. The network engages directly with portfolio companies on environmental, social and governance (ESG) risks and opportunities through investor engagement tactics via multiple working groups, including the Shareholder Initiative for Climate and Sustainability (SICS). Explore Ceres' Climate and Sustainability Shareholder Resolution Database.

Ceres-PRI Investor Initiative for Sustainable Forests (IISF)

A joint initiative led by Ceres and PRI to transform industry practices to eliminate deforestation from cattle and soy supply chains. The IISF is led by an advisory committee of institutional investors across different geographies. Working groups within the broader initiative focus on individual commodities and enable investors to engage with companies in a collaborative manner alongside other investors. Read more about the Investor Initiative for Sustainable Forests.

Climate Action 100+

An investor-led initiative which engages the world's largest corporate GHG emitters on taking necessary action on climate change. To date, more than 360 investors with more than $34 trillion in assets under management have joined the initiative. More than a dozen companies on the Climate Action 100+ list are in the food and beverage sector, and investors are focused on ensuring these companies set robust scope 3 GHG reduction targets that include commitments to end deforestation in their supply chains. Read more about Climate Action 100+.

Priority Commodities

Among the most commonly-sourced commodities profiled in Engage the Chain, climate change impacts are most significant in the production of beef, dairy, soy and palm oil. Of particular note are the deforestation and land use changes related to the production of beef, palm oil, and soybeans, which all also contribute to global climate change.

The following section summarizes how the production of beef, dairy, soy and palm oil contribute worldwide to climate change. It is important to consider that the scale of the impacts depends on the practices used by individual livestock operations and feed growers, as well as on regional and local conditions.

Beef

Global beef production has a significant impact on climate change:

- Cows contribute directly to GHG emissions when they digest their feed and produce large amounts of methane and manure. Fertilizers and energy used for growing the animals' feed, as well as deforestation associated with the production of soy meal, also contribute to total GHG emissions.
- Between 43-51% of the global emissions from the livestock sector are related to beef cattle[1].
- Globally, beef production is expected to increase by 9 million metric tons by 2028[13].

Dairy

Global dairy production has a significant impact on climate change:

- Dairy cows release methane, a GHG 25 times more potent than carbon dioxide, when they digest their feed (enteric fermentation).
- Dairy operations contribute GHG during manure management (anaerobic decomposition of organic matter in manure).
- Globally, yearly consumption of milk is expected to increase by 304 million metric tons by 2030[14].

Soy

Global soy production has a significant impact on climate change:

- At least 8.4 thousand square miles in the Amazon and Cerrado biomes in Brazil were deforested between 2006 and 2017 to grow soy[15]. The carbon emissions associated to the Cerrado deforestation for soy in that period, 210 million tons of carbon dioxide equivalent, are comparable to 488 million barrels of oil.
- Despite efforts made to reduce deforestation in the Amazon (such as more intense monitoring and the Soy Moratorium in Brazil), the risk of land conversion for soy production continues to be significant. In fact, after a noticeable deceleration in deforestation rates between 2004 and 2012, there has now been a serious uptick[16]. Land conversion and deforestation in Brazil to grow soybeans in other biomes, such as the Cerrado (where 60% of Brazilian soy is grown[17]), is also expected to remain a material business risk.

Palm oil

Global palm oil production has a significant impact on climate change:

- The rapid and poorly managed expansion of palm oil production is causing massive large-scale deforestation and significant associated GHG emissions from clearcutting and burning tropical forests.
- Palm oil production has been a major driver of deforestation in Indonesia and Malaysia. In Indonesia, from 2000 to 2010, the total harvested palm area grew dramatically, tripling to 6 million hectares.

Of this, 500,000 hectares was observed to be from peat swamp deforestation[18]. The draining and burning of these carbon-rich peat soils can emit up to 30 times more GHGs than simply clearing the forest. Due to its high deforestation rate, Indonesia is now one of the world's biggest emitters of GHGs, contributing 5% of global emissions.

Resources

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