FOOD FORWARD NDCs

Reducing emissions from energy use in food storage, cold chains, transport and processing

Overview

In 2018, global greenhouse gas (GHG) emissions from energy use within food supply chains – including from industrial food processing, packaging, refrigeration and retail – were approximately 4.3 billion metric tons of carbon dioxide equivalent ($GtCO_2eq$) per year. An additional 0.5 $GtCO_2eq$ per year stemmed just from food transportation. On top of these already alarming figures, food waste disposal amounted to nearly 1 $GtCO_2eq$ per year in 2018.

Some interventions for reducing emissions from food supply chains have greater potential impacts. Generally, interventions that reduce food loss and food waste in later stages of the supply chain will have a greater impact on reducing GHG emissions. This is because the embedded emissions of products increase over time as they move through the supply chain.

Concrete measures to implement

Several measures, including both technological innovation and behaviour change, can reduce emissions associated with food supply chains. Measures to reduce emissions along supply chains include:

- Improved storage on the farm:
    - Promote use of natural insecticides: Plant species and extracts with natural pesticide abilities have been found, and are already commonly used as part of traditional practices, to protect grains from insects in

several African and Asian countries. Plant-based chemicals and products are biodegradable, environmentally friendly and relatively safer for human health.

  - Invest in **hermetic storage (HS)**, also known as "sealed storage" or "airtight storage" (e.g., metal drums and silos, and hermetic bags). HS is an effective storage method for cereal, pulses, coffee and cocoa beans, as it reduces the use of chemicals and pesticides.

- Cold storage measures:

  - Promote **lower-cost, off-grid cooling technologies** (e.g., biogas- or solar-powered technologies) that offer a low-emission alternative to cold storage facilities. For example, **Coolbots** serve to convert window air conditioners to walk-in refrigerator cooling units and can be powered by an off-grid system using solar power. They are estimated to be about 25% more efficient than conventional cooling systems.
  - Invest in cold storage facilities with greater energy efficiency. About **15%** of electricity consumed worldwide is used for refrigeration and about **1%** of global GHG emissions are produced by **cold chains**. **Energy-efficient** cold storage technologies include phase change material, thermal energy storage and phase change thermal storage units.
  - Encourage **behavioural and design changes** that reduce energy usage in existing cold storage facilities. This includes ensuring rapid transfer of temperature-controlled food from one unit to another; taking advantage of "free" cooling (i.e., naturally lower evening temperatures); designing systems for efficiency at typical temperatures; and improving systems to minimise refrigerant leakage (improved room insulation in cold storage facilities alone could generate **energy savings of 25%**).
  - Phase-out use of hydrofluorocarbons (HFCs), a type of highly potent GHG often used in refrigeration. For instance, the United States is phasing out HFCs under the **AIM Act.** There are several known low-emissions **alternatives** to HFCs in refrigeration, such as natural refrigerants (e.g., ammonia, carbon dioxide, hydrocarbons, water and air).
  - Incentivise households to buy more energy-efficient refrigerators through subsidies and/or labelling schemes such as the labels provided by the European Union's **Ecodesign Directive**.

- Processing measures, such as:
    - Promote and support farmers to **acquire drying equipment** — from simple tarpaulins to shelters that protect harvests from the rain. Most grain losses occur during storage due to improper drying, leading to mold damage.
    - Support smallholder farmers to acquire **appropriate machinery** (e.g., maize shellers and mechanical rice threshers) for the threshing and shelling of grain crops.
    - Promote low emissions drying technologies such as **solar dryers**.
    - Promote use of low-emissions food **processing technologies** (e.g., canning, irradiation and dehydrating) that extend shelf life and eliminate or reduce the need for cold storage. For more information on technologies that can help to reduce emissions associated with food supply chains, see ***Reducing post-harvest food loss at storage, transport, and processing levels***.
- Transportation measures:
    - Increase responsible investment in transport infrastructure (e.g., improved road and rail networks from high-production areas and in more **GHG-efficient modes of transport**) by adopting territorial approaches to improve market connectivity and trade access, particularly in areas with high multidimensional poverty. For example, rail and barges are **more energy efficient** per ton of cargo than air freight. Similarly, larger trucks are more emissions efficient than smaller vehicles.
    - Use information and communications technology to design the **least emissions-intensive transportation routes and storage strategies**. For example, in a **study** of Californian farmers' markets, the introduction of consolidation centers where farmers could transport their goods before they were brought to the market was estimated to decrease total distance travelled by 30% and reduce transportation emissions by 19% or more.
- Cross-cutting measures:
    - Establish energy-use requirements for refrigerators and other food storage, processing and transportation technologies. For example, the

European Union's **Ecodesign Directive** provides design requirements for many types of technologies, including refrigeration technologies.

- Implement technologies and practices to **reduce food loss and waste**. Food loss and waste is a major contributor to emissions stemming from food systems and supply chains. For detailed information on measures that can help to reduce food losses (and associated emissions) along food supply chains, see ***Reducing post-harvest food loss at storage, transport, and processing levels***.
- Invest in **trigeneration** systems, a technology which offers significant reductions in GHG emissions associated with supply chain processes. Trigeneration, sometimes referred to as CCHP, CHRP or polygeneration depending on the system, involves the integration of local combined heat and power generation (CHP) with refrigeration technologies to provide simultaneous electrical power, heating and cooling/refrigeration. This can produce significant energy and GHG reductions compared to separate production systems for electricity, heat and refrigeration. Compared to conventional HFC-based cooling systems, integrated trigeneration and CO_2 systems can be at least 15% more energy-efficient and reduce carbon emissions by 44%.
- Increase responsible investment in infrastructure, technologies, logistics, services and supply chains, by adopting territorial approaches to improve market connectivity and trade access, particularly in areas with high multidimensional poverty.

Enabling governance measures

Many of the measures to reduce emissions associated with food storage, cold chains, transport and processing might only be possible given broader governance and policy reforms. The following governance measures can serve to facilitate the measures listed above:

- Support smallholder farmers and small and medium businesses with upfront investment costs for infrastructure and technologies to reduce post-harvest food loss, with particular emphasis on supporting low-income areas and marginalised groups.
- Reform food and manufacturing policies (e.g., introduce market-based measures and subsidies) to enable the design and implementation of more energy-efficient technologies for food storage, processing and transportation, by providing incentives for investment in crucial technological Research & Development for more energy-efficient and effective cold chains. Manufacturers could be incentivised to invest in these technologies through programmes such as the UK's Enhanced Capital Allowances Schemes or Climate Change Levy.

- Improve public services infrastructure (e.g., reliable internet and electricity supply) to enhance efficiency of supply chain processes and reduce overall emissions.
- Along with making technologies available, the government agencies and organisations must ensure the equitable development of facilities to provide accessible, clear information and training about the use and maintenance of these technologies in the local language, to ensure the successful adaptation and effective use of these technologies.
- Invest in renewable energy production and distribution to facilitate replacement of fossil fuel-powered equipment and machinery along the food supply chain. See ***Shifting to clean energy at the farm level***.
- Conduct research that quantifies emissions embedded in food supply chains to identify where in food supply chains emissions are arising and thereby develop targeted interventions.
- Encourage supermarkets and other food retailers to alter their **choice architecture** to steer consumers away from emissions-intensive products. For more information on measures that can influence consumers to opt for more sustainable options, see ***Regulating advertising of unhealthy and unsustainable food***.

Tools and MRV systems to monitor progress

Life cycle assessment (LCA)

LCAs can assess environmental impacts of agri-food chains, including emissions.

Link: https://link.springer.com/chapter/10.1007/978-94-024-1016-7_19

For more information on LCA and other assessment methodologies, see ***Food system assessment***.

Ex-Ante Carbon-balance Tool for Value Chains (EX-ACT VC)

The Ex-Ante Carbon-balance Tool for Value Chains (EX-ACT VC), derived from the EX-ACT tool, can support policymakers in identifying GHG emissions along agri-food value chains and identifying possible policy interventions for developing lower-carbon value chains.

Link: https://www.fao.org/in-action/epic/ex-act-tool/suite-of-tools/ex-act-vc/en/

Mitigation benefits

Implementation of new storage, cooling and drying technologies that are more energy efficient or operate using renewable energy rather than fossil fuels result in net reduction of GHG emissions in food systems:

- Studies indicate that improved food storage technologies could reduce CO_2 emissions associated with supply chains by two-fold.
- The contributions of each post-production phase to the overall carbon footprint of supply chains is approximately 17% of emissions in post-harvest handling and storage, 14% in processing and 15% in distribution. Consumption contributes approximately 35% of the overall carbon footprint.

Other environmental benefits

- Improved air quality from reduced burning of fossil fuels.

Adaptation benefits

- The energy savings from system improvements to cold storage facilities can increase revenue, reduce expenses and shorten the payback period. These improvements also enable sellers to provide agricultural products to consumers at more competitive and affordable prices.
- The introduction of new, lower-emissions technologies can reduce labour costs and provide jobs for skilled workers.

Other sustainable development benefits

- SDG 1 (Zero hunger)
- SDG 2 (No poverty)
- SDG 7 (Affordable and clean energy)
- SDG 9 (Industry, innovation, and infrastructure)
- SDG 12 (Responsible consumption and production)

- SDG 13 (Climate action)

Main implementation challenges and potential negative externalities and trade-offs

- It can be expensive to design, implement and operate new supply chain technologies and infrastructure. This can be an especially significant obstacle in developing countries.
- Biogas-powered cooling technology relies on digesters to produce the biogas, a process which requires **large amounts of water** (50-100 litres per day to mix the manure, or around 25,000 litres of water per year).
- Energy efficiency gains (and corresponding emission reductions) in refrigeration could be **offset** by increased use of refrigeration technology due to growth of societal dependence on refrigeration. This is an example of the so-called "**rebound effect**."

Measures to minimize challenges and potential negative externalities and trade-offs

- Costs from the development, purchase and/or use of improved technologies could be offset through subsidies or support (e.g., financial and/or technical) from wealthier governments or institutions.
- **Solar-powered coolers** use less water as compared to biogas-powered coolers. They were found to have the capacity to save around 1 million litres of water per year in Tanzania and around 3 million litres per year in Tunisia. However, this impact was not seen in Kenya.
- The potential increase in overall energy usage and emissions, despite efficiency gains in refrigeration and other food supply chain technologies, can be avoided by encouraging consumers and/or supply chain actors to consume less overall. Further, any cost savings from efficiency gains could be taxed in order to keep costs the same.

Implementation costs

- An **analysis** of domestic biogas-powered milk chillers found that in Kenya and Tanzania, adoption of the chillers requires an upfront investment of

USD 1,600 per household.

    - In the same analysis, solar-powered coolers required an upfront investment of USD 40,000.

- Initial investment costs for **trigeneration systems** can be relatively high, but payback periods of three to five years can be achieved given certain conditions.

Intervention in practice

- An FAO and European Bank for Reconstruction and Development **study** in Morocco assessed the potential for more energy- and emissions-efficient climate control techniques in food supply chains. The results show that improving the efficiency of the cold chain in Morocco is “low-hanging fruit” with high impact (i.e., it has considerable emissions mitigation potential without significant trade-offs or barriers to implementation).

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