

THE FOODS WE CHOOSE CAN CONTRIBUTE TO CLIMATE CHANGE

Adrian Leip^{1*}, Göran Berndes² and Diana Ürge-Vorsatz³

¹DG Research & Innovation, European Commission, Brussels, Belgium

²Department of Space, Earth and Environment, Chalmers University of Technology, Gothenburg, Sweden

³Department of Environmental Sciences and Policy, Central European University, Vienna, Austria

YOUNG REVIEWERS:



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What should I eat? Many people ask this question several times a day. What we eat determines whether we get all the nutrients and energy that we need. But our choice of foods is also important for the environment and Earth's climate. Which diets are nutritious, healthy, *and* climate friendly? There is no easy answer. All the activities involved in putting food on our tables—farming, food processing, transport, storage, and cooking—can cause greenhouse gas emissions. In this article we will explain what food systems are, how some food systems can be harmful to the environment, how we can eat diets that are both healthy *and* climate friendly.

FOOD PRODUCTION CAN DAMAGE THE ENVIRONMENT

Everybody needs to eat! Food keeps us healthy and gives us the energy to go about our daily lives. However, producing the foods we eat requires a lot of natural resources. For example, farmers must use a lot of land to grow crops or animals, they use fuels to power their farming equipment, and they often apply fertilizers to enhance crop growth. If there is too little rain, farmers may need to use water from the ground or from lakes and rivers to irrigate their crops.

This resource use can be bad for the planet, but there are even more ways that the foods we eat can cause environmental problems. For example, excessive use of fertilizers or pesticides can cause pollution of nearby land and water and can even affect human health [1]. Consequently, or when land is cleared for food production, the number of different plants, animals, and other living things on those lands can be reduced, decreasing Earth's natural **biodiversity**. Pesticides can also harm pollinator populations (such as bees) that are very important for plant growth. Another environmental problem caused by farming is the overuse of medicines called antibiotics that protect farm animals against harmful bacteria, which then makes those medicines less effective for humans. Finally, food production can be a major source of **greenhouse gas** (GHG) emissions—this is what we will focus on in the rest of this article.

WHAT ARE FOOD SYSTEMS?

Food systems include the entire life cycle of a food. This includes its production on farms, processing it to get it ready for sale, transportation to places where it will be sold, cooking or other preparation to get it ready to eat, consumption of food, and management of food loss and waste. Food systems also include everything that is needed so that these activities are possible, such as building roads, developing new technologies, or providing clean water [2].

Current food systems not only harm the environment and release greenhouse gases; often the food that is consumed leads to health problems. Many of us eat or drink more than what we need. This can lead to overweight, which today affects more than 2 Billion people [3, 4]. At the same time, more than 700 million people were affected by hunger in 2021 [5]. Some foods, we should be careful not to eat too much of, for example those high in sugar, salt or saturated fats. For other foods, many people should eat more than what they currently do. For example, fruits and vegetables, nuts, and seeds.

BIODIVERSITY

The variety of all life on Earth, including plants, animals, and the ecosystems that they live in.

GREENHOUSE GASES

Gases in the atmosphere which can absorb heat and cause the planet to warm up. These occur naturally, such as carbon dioxide and water vapor, but human activity is putting more greenhouse gases into the air leading to the planet getting warmer.

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GHG FOOTPRINT

All emissions of greenhouse gases which occur during the life of a product, from input required for its production over processing, transport, consumption, and waste management.

METHANE (CH₄)

A greenhouse gas that is mainly emitted from some animals that eat grass, from land under water tables as rice or wetlands, and from waste management.

NITROUS OXIDE (N₂O)

A very powerful greenhouse gas that is mainly emitted from nitrogen sources, such as fertilizers used to enhance crop growth, from animal excretions, or in sewage systems.

Figure 1

Food system GHG emissions from agriculture, Land Use, Land Use Change and Forestry, waste, and energy & industry sectors. Data source: IPCC 2022 [7].

RUMINANT

Ruminant animals are animals that are able to eat a diet of grass and leaves. Examples of ruminant animals are cattle, sheep, and goats.

HOW DO FOOD SYSTEMS RELEASE GREENHOUSE GASES?

The **GHG footprint** of a food includes all GHG emissions that occur during the life cycle of that food product, from the farm all the way through food preparation and the management of food waste. For example, a fruit will have a larger GHG footprint if it has been stored in a refrigerator for several months vs. if it is fresh from the tree. A fruit will also have a larger GHG footprint if it was harvested from farmland created by cutting down a lush forest. The amount of a food that is lost or wasted during its life cycle also affects its GHG footprint.

Researchers have calculated that roughly one third of the warming caused by human GHG emissions is associated with the global food system [6]. Food system-related GHGs include CO₂ from energy use (46%); **methane** from ruminants, rice fields, and waste management (38%); and **nitrous oxide** from fertilizers, grazing animals, and soil breakdown (13%). **Figure 1** shows increases in food system GHG emissions since 1990, which are mainly due to energy and industrial processes. In 2015, 17 gigatons of CO₂ equivalent emissions were produced by the global food system, which means the combined effect of those GHGs on the climate is the same as if 17,000,000,000 tons of CO₂ were emitted!

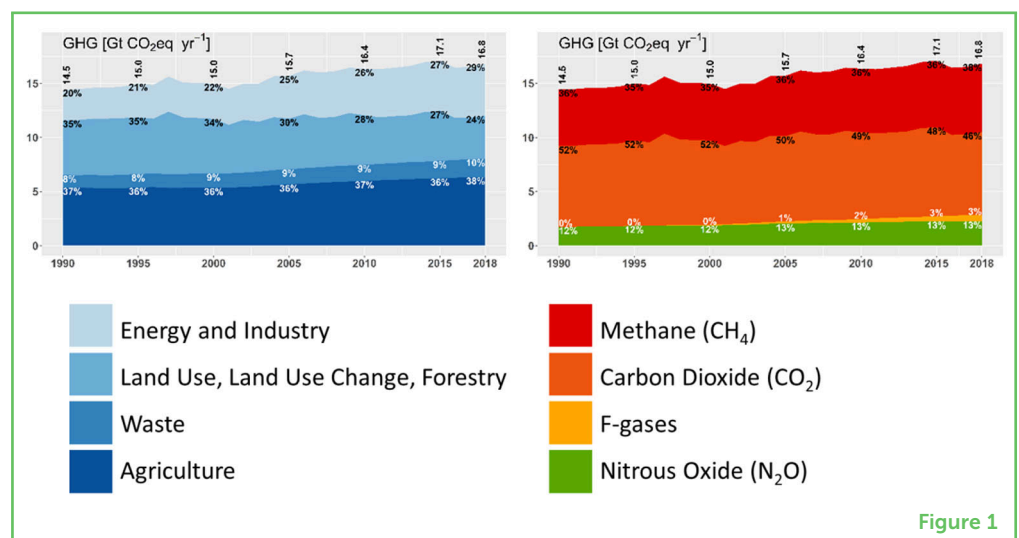


Figure 1

Meat products are among the foods with the highest GHG footprint, especially when the meat comes from **ruminant** animals, such as cattle, sheep, and goats. These animals eat a diet of grass and leaves, which causes them to release methane—a powerful greenhouse gas. Ruminant meats are produced in many different ways, with varying levels of GHG emissions (**Figure 2**). Based on greenhouse gas emissions data, the International Panel on Climate Change (IPCC) concluded in 2022 that “diets high in plant protein and low in meat and dairy are associated with lower GHG emissions” [7]. The high GHG emissions of meats, especially from ruminants, are due to several

factors. First, lots of land and energy are required to produce the animals' food. Also, as we mentioned, these animals release the GHG methane. Finally, if forests are cleared to make way for animal pastures and farmland to grow the animals' food, this causes CO₂ emissions *and* negatively impacts biodiversity.

Figure 2

GHG emissions produced by various types of foods. Units are kgCO₂-eq per 100 g of protein. The black bars indicate the mean (average) emission while the blue bars indicate the emissions at which only 10% of emissions are lower and 10% of emissions are higher. Source: IPCC 2022 [7].

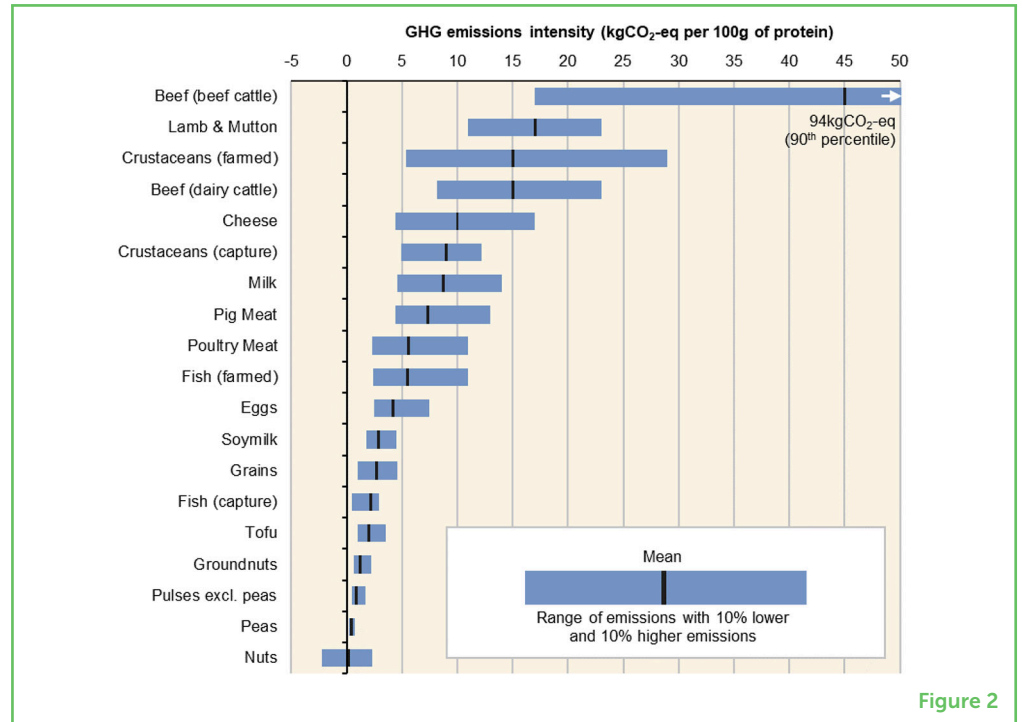


Figure 2

REDUCING GREENHOUSE GAS EMISSIONS FROM FOOD SYSTEMS

There are many options for reducing the climate impacts of the food system (Table 1). For example, improving the efficiency of food production or reducing food waste would require less resources for food production. Some types of farming practices, such as growing certain crops, can increase the amount of carbon stored in the soil and thus reduce GHG emissions. Eating plant-based alternatives to animal products, like peas, beans, or tofu, can also substantially reduce GHG emissions.

Changing eating habits is not easy. Foods for a healthy, sustainable diet are often more expensive and can be difficult to find in supermarkets. Good-quality information about the environmental effects of foods is also difficult to find. Changing farming practices is not easy, either. Environmentally friendly farming practices are often more expensive and require more land to produce the same amount of food. Often, farmers sell their products to large companies that transport and sell their products all over the world, giving these companies considerable power over what people buy.

Table 1

Ways to reduce greenhouse gas emissions from food systems. Green color means a positive effect; red color means a negative effect. The yellow color indicates that the effect can be both positive or negative, or that is uncertain. Based on IPCC 2022 [7].

Food system emission reduction options		Effect on GHG emissions, energy use or food loss and waste, and possible co-benefit			
Agricultural food production and fisheries	Dietary shift, in particular increased share of plant-based protein sources	Direct emissions decrease			Good for land use and animal welfare
	Digital agriculture	Direct emissions decrease			Good for land use and animal welfare
	Gene technology	Direct emissions decrease			
	Sustainable intensification	Direct emissions decrease			Good for land use
	Agroecology	Direct emissions decrease	Energy use decreases	Food losses are reduced	Good for biodiversity
Controlled environment agriculture	Soilless agriculture	Direct emissions decrease	Energy use increases	Food losses are reduced	Good for land use
Emerging Food Production technologies	Insects			Food waste is reduced	
	Algae and bivalves	Direct emissions decrease			Good for land use and animal welfare
	Plant-based alternatives to animal-based food products	Direct emissions decrease			Good for land use and animal welfare
	Cellular agriculture	Direct emissions decrease	Energy use increases	Food losses are reduced	Good for animal welfare
Food processing and packaging	Valorization of by-products, FLW logistics and management			Food waste is reduced	
	Food conservation		Effect on energy use uncertain	Food waste is reduced	
	Smart packaging		Effect on energy use uncertain	Food waste is reduced	
	Improved energy efficiency in Food processing		Energy use decreases		
Storage and distribution	Improved logistics (location, timing, efficiency etc.) in food distribution	Direct emissions decrease			
	Measures to reduce food waste in retail and catering		Energy use decreases	Food waste is reduced	
	Use of alternative fuels or transport modes	Direct emissions decrease			
	Improved efficiency in refrigeration, lighting, climatization etc.		Energy use decreases		
	Replacing refrigerants	Direct emissions decrease			

Table 1

SUSTAINABLE

Sustainability means using resources in a way that protects the planet, so future generations can enjoy it too.

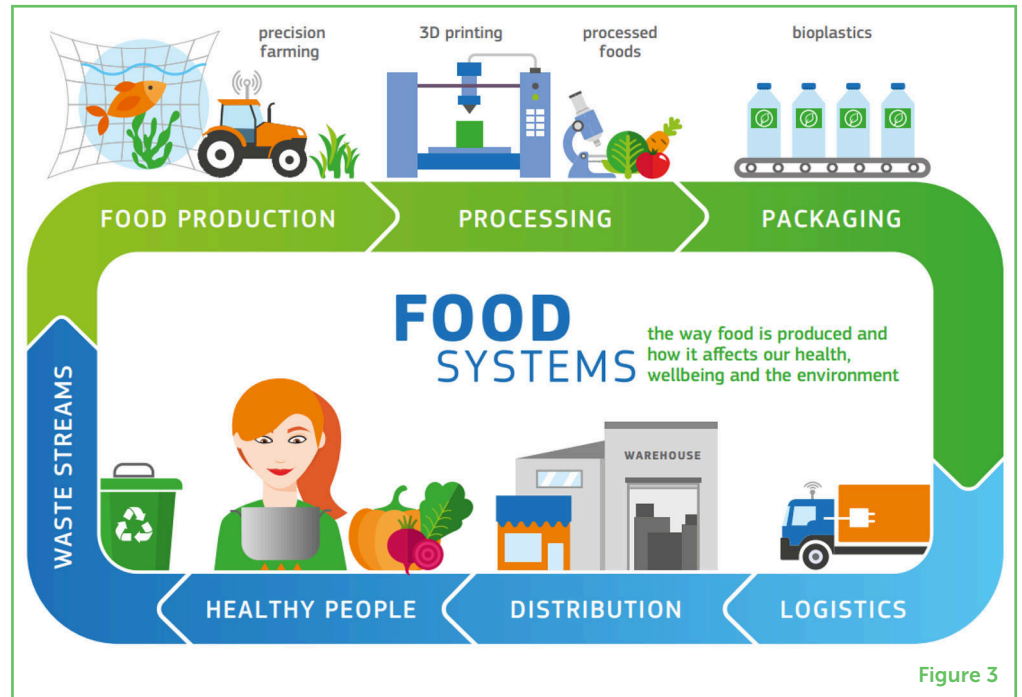
To effectively reduce food system GHGs, new technologies need to be developed, tested, and scaled up. [Figure 3](#) gives some examples of how food systems could be made more **sustainable** through research and innovation [8]. Policies also need to be developed to help sustainable food products reach stores faster— those foods need to be easily available and affordable. Dietary guidelines, information campaigns, and proper food labeling can help consumers to make good choices. In summary, reducing food-related GHG emissions requires changes at all levels, from the producers to the consumers. This works best if there are laws or policies in place that are fair and acceptable to all.

HOW CAN WE HELP—SHOULD WE ALL GO VEGAN?

Everyone who wants to reduce their own food-related GHG footprint can do so, but the options that are available to each person may vary

Figure 3

A food system includes all aspects of a food's life cycle, from production all the way to the generation of food waste. Ideas on how research and innovation can help to make the food system more sustainable are shown. Source: European Commission [8].

**Figure 3**

depending on income, culture, and where they live. Some options are free or even save money. Examples include reducing food waste, eating less, or eating more plant-based proteins instead of meat. Our own actions can also make it more likely that others will follow.

According to the IPCC, eating diets with more plant protein while eating less animal products, added sugars, salt, and saturated fats could reduce food-related GHG emissions. These changes are healthy for both the environment and humans [7]. However, this does not mean that everyone must go **vegan** to make an impact. Some livestock-production systems can keep ecosystems biodiverse while providing nutritious food. There are also places where the land is not good for any type of food production except livestock grazing, like pastures in mountainous areas.

A report to the United Nations recommended that Europeans should decrease the amount of meat and dairy they eat by 50%, along with making technical changes in farming and food-production practices that can help to reduce environmental impact [9]. In some places, like the Global South, there are not enough plant-based foods available to keep people healthy, so people are more dependent on animals for their nutrition. It is important that everyone can obtain the necessary amount of protein in their diets to stay healthy.

In conclusion, if we want to reduce the impact of our food systems on the environment, the world does not need to go completely vegan. However, we *do* need to decrease the amounts of animal-based foods that we produce and consume. Most people can do this

VEGAN

A vegan diet is a way of eating that includes only plant-based foods, like fruits, vegetables, grains, nuts, and beans, without any animal products such as meat, dairy, or eggs.

by eating less meat—namely by replacing animal-based foods with plant-based foods.

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YOUNG REVIEWERS



AYAT, AGE: 12

I love sketching, painting, playing chess, and reading books. My favorite books include "Amari" and "The Magicians of Paris", and anything and everything about fantasy books. I like nature and frequently go out hiking to observe the beauty of nature and take notes and make sketches in my notebook.



YOUNG SCIENTIST ACADEMY, AGES: 11–13

The young reviewers are students at Williston Middle School and participants at Young Scientist Academy (YSA) all aged 11–13 years old: Hala, Ruby, Jeremy, Amaya, Maite, Charles, Jonah, Julia, Millie, Robert, Justin, Evan, Chris, Corbin, Kate, Miabella, Claire, Wisdym, Quinlan, Justin, Parker, Theodore, Paige, Zy, Nayden, Ra'Jaun, Lillian, Evelyn, Naurice, Danny, Caleb, and Steve. YSA is a youth science NGO headquartered in North Carolina that empowers all youth to become community ambassadors in science and technology.

AUTHORS

ADRIAN LEIP

Adrian Leip has worked at the European Commission on the Bioeconomy Strategy since 2021. Before that, he worked at the European Commissions' Joint Research Centre as a scientist studying various topics related to agriculture and food systems. For example, he helped compile the EUs' annual greenhouse gas emissions for agriculture that are submitted to the United Nations Framework Convention on Climate Change, and he did computer simulations on the EUs' agri-food system to see how nitrogen and greenhouse gas emissions can be reduced. Adrian contributed to the 6th Assessment Reports of the International Panel on Climate Change (IPCC), mainly to a section on how greenhouse gas emissions from food systems can be reduced. *adrian.leip@ec.europa.eu





GÖRAN BERNDES

Göran Berndes is a scientist at Chalmers University of Technology in Sweden. He is very interested in ways to reduce human impact on nature, for example how we can reduce greenhouse gas emissions when we produce food, build houses, or travel to different places. Besides working on research projects, he teaches university students and helps politicians and people in government and business find ways to make the world more sustainable. Göran contributed to the 6th Assessment Reports of the International Panel on Climate Change (IPCC), mainly on agriculture and forestry issues and ways to use biomass instead of fossil fuels.



DIANA ÜRGE-VORSATZ

Diana Ürge-Vorsatz has been IPCC vice-chair since July 2023. She served as vice-chair of IPCC's Working Group III in AR6 and was coordinating lead author in two IPCC Assessment Reports. She is a professor at the Department of Environmental Sciences and Policy at the Central European University (CEU). She holds a Ph.D. from the University of California (Los Angeles and Berkeley). Diana is regularly invited to high-level review panels, such as that evaluating the work at Lawrence Berkeley National Laboratory and the EU's Joint Research Centre. She received the Hungarian Republic's Presidential Award "Medium Cross" in 2008, as well as the "Role Model" award in 2009 and was invited as a member of Academia Europaea in 2017.