



# Eating our way through the Anthropocene

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## ABSTRACT

This paper examines the complex interactions between food systems, diets, and the environment. We discuss the challenges facing the food system as a result of environmental degradation and climate change. We review the state of current diets and their effects on human health outcomes. As we consider paths forward, we examine holistic solutions that align nutrition, health, and environmental goals. Finally, we identify ethical questions relevant to the changing global food system. We consider our moral obligations to other people – both now and in the future – and the planet, and we posit that eating is an ethical act requiring reflection at all scales.

## 1. Introduction

Food systems represent the nexus between human health and environmental well-being. Food systems help to determine diets, thus shaping nutrition and health outcomes. Environmental factors affect what foods people are able to eat, but the food system also carries negative consequences for planetary well-being. The challenges posed by climate change will constrain the food system as we move forward, adding more demands to the already complex, interconnected relationship between the food system and the environment.

The Green Revolution of the mid-20th century transformed the structure of agriculture, and, in turn, food systems and human health. The food system's supply chain – from processing and transport to distribution and consumption – changed as agriculture became more intensive. These developments in food and agriculture brought about major benefits for food security, as rates of undernutrition and deaths from famine declined around the world.

However, the transformations to agriculture and the food system caused negative repercussions for the environment [23]. As nearly all of Earth's systems show signs of serious impact from humans, many scientists suggest that we have entered a new geological era, The Anthropocene, which is characterized by the influence of humans on the planet [18]. A preponderance of global evidence shows that atmospheric, geologic, hydrologic, biospheric and other planetary system processes are now altered by humans [29,34]. Of the human behaviors driving the changes of the Anthropocene, agriculture and food production contribute significantly to climate change and other environmental stressors.

Despite numerous calls for action to mitigate these anthropogenic effects (e.g., (Hoegh-Goldberg et al., n.d.; [14,24])), the pressure on Earth's systems shows little sign of lessening. Climate modeling shows that an increase of more than 0.5C from the current global mean surface temperature of 0.87C will have devastating, irreparable effects on the planet's habitability for humans and many other species [13]. If we continue on our current path, the global surface temperature will increase by 3C to 4C above the pre-industrial period [14]. The projected warming of the planet will result in more hot days and hotter hot days across the globe, with regions around the equator becoming unsafe for human health [14].

Over the next 50 years, agriculture and food systems will be significantly affected by changes in the planet's systems. Hotter temperatures, a more limited water supply, and the acidification of the soil and oceans will make it more difficult to produce food for a growing population [13]. Given that food systems contribute to environmental stress and experience the repercussions of it, they are both instigators and casualties of climate change.

Moving forward in a world affected by climate change will require us to transform our food system and diets. To ensure that everyone has equitable access to sufficient, nutritious food, food systems will need to support both human health and environmental sustainability. Achieving these goals requires engaging with ethical questions about what we eat and how we produce our food.

## 2. Food systems: instigators and casualties of climate change

Food systems directly affect the climate and environment, largely

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through agriculture, but they are also influenced by planetary well-being. Agriculture is a major contributor to the environmental changes of the Anthropocene. The industry now uses 37% of the earth's land and 70% of its fresh water supply [26]. Agriculture is the biggest source of nutrient runoff, causing hypoxia and acidification of the planet's freshwater and ocean ecosystems [14]. This, along with the accelerated clearing of forests for agricultural use, has contributed to a mass extinction event, in which the diversity of vertebrate species on earth has declined 58% since 1970 [24].

Agriculture and associated land-use change account for nearly one-quarter of greenhouse gas emissions, making the sector the second biggest industrial emitter of greenhouse gases after the energy sector [26]. Ruminant livestock raised for food account for nearly half of these production-related emissions in the form of methane and nitrous oxide [26]. It is worth noting that many climate reports measure the environmental impacts of agricultural production alone, and do not incorporate storage, transportation, consumption, and other aspects of the food supply chain in their calculations of emissions and other impacts [25].

The current structure of the global food system cannot be supported by the planet's natural systems. If we continue with business as usual, the environmental impacts will be devastating and irreparable. Continued deforestation to clear land for agriculture will cause ecological collapse of certain systems. This has the potential to affect the entire planet's oxygen levels on land and in the ocean [19]. Biodiversity will be severely diminished, partly due to deforestation, increasing the vulnerability of ecosystems important to agricultural products and humans [10,14,31]. Extreme weather, food and water shortages, increased prevalence of disease, and other climate-related maladies are projected to cause an additional 529,000 deaths per year [28].

The bi-directional relationship between agriculture and climate change carries repercussions for healthy diets and adequate food supplies. Agriculture acts as a driver of climate change, but it is also significantly affected by the changing climate. Although the precise impacts of climate change on agriculture are uncertain, projections suggest that the current methods and intensity of food production will be unsustainable under climate change. Higher temperatures and lower availability of water are likely to reduce the amount of arable land [26]. Pest populations are expected to flourish and migrate amidst in warmer temperature, while crop diseases may also become more prevalent [21].

Additionally, the environmental challenges posed by climate change may require the production of even more food. Climate-induced stressors on the agricultural system will likely contribute to a reduction in crop yields, especially in equatorial regions [26]. These projections vary substantially, however, between regions and crops [35]. Food safety, distribution, and affordability challenges will also affect people's ability to access food [7]. In addition to reduced yields, the quality of food may also diminish due to climate change. While increased concentrations of carbon dioxide may benefit some crops in the short term, elevated carbon dioxide levels have been shown to reduce the mineral and protein content of several staple crops [20,26]. There will not only be more people to feed, but more food per person will be required to maintain a healthy diet.

The entire food system will experience the effects of climate change. In addition to a higher prevalence of crop diseases, there is likely to be an increase of pathogens in the food supply post-harvest, during storage and transport [17,33]. To combat these outbreaks, we will need more cold storage of food, requiring more energy [22]. When food reaches markets, prices will likely be higher as a result of decreased availability [28]. Food will be less affordable, especially for those who are poor [5,7].

### 3. The effects of diets on nutrition and health

Food systems shape diets, which have direct effects on people's nutrition and health. The Green Revolution contributed to reductions in

global malnutrition, helping to lower rates of undernourishment from 18% to about 10% globally. Stunting in children has also lessened. Deaths from famine declined below one million for the first time in the 2010s [2,4].

Although rates of undernutrition have decreased, malnutrition still remains a major concern. Nearly every country now faces the complex, interwoven burdens of undernourishment, overweight, and micronutrient deficiencies within their borders. Globally, one in three people is malnourished in one or multiple ways. Hunger remains a critical issue, while overweight and obesity are rapidly increasing all over the world, including in low- and middle-income countries [8,32]. An estimated 2.1 billion adults are obese, and there are nearly as many overweight children globally as there are wasted children (40 million and 49.5 million, respectively) [8].

The overall quality of diets is diminishing, which carries direct repercussions for health outcomes. In all regions, people are consuming too much salt and sugar, and insufficient vegetables, fruits, and whole grains [1]. Diets contribute to the incidence of Type II diabetes, hypertension, and heart disease. As these health issues become increasingly prevalent, poor diets have surpassed tobacco and alcohol to become one of the top risk factors for death globally, contributing to nearly 10 million deaths in 2017 [1].

Moving forward, the effects of climate change will further constrain food systems and diets, which in turn will pose additional threats to human nutrition and health. If we continue with business as usual, one in two people will experience malnourishment in 2030 [8,30]. Changes in both quality and quantity of available food will result in worsened human health outcomes. The projected decline in vegetable and fruit yields alone will result in an estimated 543,000 diet-related deaths by 2050 [28]. Under projected warming, the risks for contamination of maize by aflatoxin will double in certain regions [3]. The overuse of antibiotics in the livestock sector has already resulted in several outbreaks of novel infectious diseases [9]. Environmental degradation will reverberate through the entire food system and will negatively affect our health by means of the food available to us. Left unchecked, our dietary choices will accelerate and intensify these problems.

### 4. The ethics of eating: trade-offs and obligations

Eating is an inherently ethical act: in choosing what to eat, we engage in moral decision-making and our decisions contribute to societal and environmental outcomes. As individuals and societies, our decisions about food reflect our aesthetic, moral, cultural, and religious values. Our food choices carry ramifications that reverberate throughout the food system to affect human health and the environment.

The complex connections between food, health, and the environment give rise to ethical questions about how we protect the well-being of people and the planet. In order to ensure that all people, now and in the future, are able to achieve optimal health, they must have access to safe, sufficient, and nutritious food. To fulfill this moral imperative, we must also consider the effects of diets on the environment. How can we achieve diets that are both high-quality and sustainable? Are there ethically permissible options to ensure that our global population consumes foods that meet nutrition requirements and adhere to planetary boundaries?

Achieving the dual goals of human health and planetary well-being will require a major transformation of agriculture and dietary patterns. In 2018, the EAT-Lancet Commission developed the Healthy Reference Diet, a plant-based diet that includes a low to moderate amount of seafood and poultry, and little to no red meat. This diet aims to meet the nutritional needs of the planet's future population, while also keeping food system activities within environmental limits in order to restrain global warming to +1.5C [35].

Although implementing the Healthy Reference Diet could lead to benefits for both human health and environmental sustainability, doing

so would require overcoming practical challenges and addressing ethical concerns. Meeting nutritional needs would require doubling yields of fruits, vegetables, and nuts globally by 2050, but the effects of climate change on agriculture will make it difficult to achieve this goal. The diet is unaffordable for nearly 1.6 million people [12], which is especially concerning given that malnutrition is concentrated among economically poorer populations [8,32]. Moreover, while populations in high- and middle-income countries would benefit from reducing meat consumption [11,27], animal source foods can be a valuable source of nutrients for people experiencing undernutrition [6,15,16].

We must also consider our obligation to meet present-day nutritional needs. The dietary choices of the wealthy have consequences for climate change that disproportionately affect the lives of people who are poor, both globally and within countries [30]. Deep-set inequities limit the ability of less wealthy populations to access and afford nutritious food [11]. Despite the environmental impacts of animal source food production and the critical issue of human undernutrition, 27% of the world's calories are currently given as feed to animals in order to satisfy wealthy countries' demands for meat [26].

## 5. Conclusion

The multivariate and interrelated goals of optimal human health, sustainable food systems, and planetary well-being are difficult to achieve. As individuals and societies moving forward amidst the challenges posed by climate change, we must maintain and negotiate these imperatives. Human behavior has led to climate change, and our behavior, now and in the future, matters if we are to mitigate its effects on human and planetary well-being. The effects of climate change are already being felt on the planet's systems, and these effects will grow exponentially unless significant, immediate action is taken.

Food systems represent an opportunity to achieve these intertwined goals of health and sustainability. Our current diets and systems of food production have serious implications for environmental resources and climate change. By changing and improving behavior and practices in this area, we can improve dietary quality and nutrition, which has direct effects on both health and social issues. Diets that are nutritious, equitable, and sustainable can also help mitigate the environmental harms of our current food system.

But changing behaviors and transforming the food system to achieve these multivariate goals will be challenging, if not impossible. Choosing what to eat is an ethical act with global implications. Changes to the food system will inevitably result in ethical issues that require addressing trade-offs and setting priorities. Is it ethical to produce livestock that require extensive environmental resources and a significant proportion of available calories, when so many people still experience hunger and undernutrition – and are unable to access these animal source foods? How do we ensure that nutritious, environmentally sustainable diets are affordable and accessible to all, not just the wealthy? How do we balance the need for people in high-income countries to reduce their consumption of animal source foods, while others need to eat more of these foods to ensure optimal nutrition and health? These are just a few of the many complex ethical questions that policymakers must consider in order to mitigate environmental harms and social injustices through the food system.

Addressing these complex issues will require a holistic approach in order to usher the entire food system through the changes of the Anthropocene. Our challenge lies in engendering food systems that support human health *and* planetary well-being, despite the limitations posed by these environmental changes. Policy, cultural, and economic changes must account for both sustainable food systems and human nutritional needs. Individual choices, local and national policies, and global unity and coordination are all necessary to achieve these goals.

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