Oxford Open Climate Change, 2025, **5(1)**, kgae024
https://doi.org/10.1093/oxfclm/kgae024
Advance Access Publication Date: 2 January 2025
Short Communication

Solving climate change requires changing our food systems

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Abstract

Humanity is facing an important existential threat—irreversible climate change caused by human activity. Until recently, most of the proposals to address climate change have downplayed or ignored the adverse impact of food systems, especially intensive animal agriculture. This is in spite of the fact that up to a third of global greenhouse gas production to date can be attributed to animal agriculture. Recent developments at COP28 have signaled that the tide is turning, however, and that food systems are becoming part of global discussions on climate change solutions. The pressing nature of irreversible climate change requires rethinking our food systems. To solve the climate change crisis, we propose transitioning to a predominantly plant-based diet, and phasing out intensive animal agriculture as diets shift, without increasing pastoral farming. We suggest that such transformations in global food systems can be accomplished largely through education and large-scale public information campaigns, removal of subsidies, taxation to account for externalized costs of animal agriculture, improved labelling of products, and various investment/divestment drivers. Better metrics and industry benchmarks involving food and agriculture-specific performance indicators that reflect food system sustainability will be important. Increased global awareness of these issues and a change in mindset (which will drive political will) also are needed. Our current trajectory is untenable, and we must begin to turn the ship now towards sustainable food systems and diets.

Keywords: climate change; food systems; climate change mitigation; plant-based diet; factory farming

One of the most important existential threats to humanity today is irreversible climate change caused by human activity [1–5]. Exploitation of natural resources, environmental pollution, and reliance on animal agriculture have given rise to biodiversity loss, negatively affected ecosystem functioning, spread and increased risk of global pandemics, and caused unprecedented

Received: April 3, 2024. **Revised:** November 29, 2024. **Accepted:** December 4, 2024

changes to Earth's climate [2, 4, 6–9]. Anthropogenic release of greenhouse gases (GHG), has already caused global average temperature to increase by more than 1°C [9]. The effects of this temperature increase are observable in severe climate events and unwanted consequences resulting in human displacement, starvation, and failing crops [10–12]. To avoid additional irreversible effects of climate change, scientists have estimated that we have a very brief window of time (7–8 years) to enact meaningful changes [4, 8, 13]. Specifically, we must reduce GHG emissions by 45% (along our present trajectory, emissions are predicted to rise by 10–15%) by 2030 to limit global warming to 1.5°C above pre-industrial levels [3, 4, 13].

Many of the proposals for combatting climate change have neglected the significant adverse impacts of food systems, especially intensive animal agriculture, yet these impacts are greater than those of transportation, which deservedly receives focused attention [2, 14–16]. In particular, few scientific solutions to mediating climate change proposed over the last 20 years have taken into account that up to a third of all global anthropogenic GHG emissions are attributable to animal agriculture [2, 7, 17–20]. For example, when industrial and farm processes, packaging, waste, fuel/transport, retail/consumption, and land use change are taken into account, agriculture and food systems are responsible for approximately 34% of all global GHG emissions annually [18, 19]. As much as a third of global GHG emissions to date are accounted for by the livestock sector [7, 17]. Previous more conservative estimates of GHG emissions from animal agriculture did not take into account land use/land use change, fuel use, deforestation and desertification, eutrophication, biodiversity loss, emissions from buildings/industry, and water use [7, 18, 19].

Recent developments at the COP28 United Nations (UN) Climate Change Conference, however, signal an important shift in the global recognition of food systems as a determinant of climate change. Among the new developments were: the inclusion of food systems in climate change adaptation and mitigation responses for the first time at one of these meetings; a first-ever Global Stocktake which assessed the world's climate change responses and emphasized sustainable food production and consumption; a road map developed by the UN Food and Agriculture Organization (FAO) that proposed a 25% reduction in agri-food related emissions by 2030; and the United Arab Emirates (UAE) Declaration on Sustainable Agriculture, Resilient Food Systems and Climate Action, signed by 160 countries and territories, which committed signatories to include agriculture and food systems in national climate plans by 2025, and to reorient national policies and agricultural subsidies towards practices that reduce greenhouse gas emissions, increase ecosystem resilience, realize ecosystem services, and improve human and animal health.

For humanity to mitigate climate change successfully, it is important that the direction and momentum achieved at COP28 are sustained and accelerated, and that countries and corporate entities continue to address the environmental and nutritional burdens, including food insecurities, current food systems place on human society and its host planet. To avert a climate crisis, we cannot continue on a 'business as usual' basis [2]. Enacting meaningful change involves recognizing and addressing the role of intensive animal agriculture and animal-source food consumption in climate change mitigation (animal-source food refers to any food product derived from animals such as meat, dairy, eggs, and seafood). We are proposing a unique and novel approach to the issue of climate change mitigation; namely, that intensive animal agriculture and food systems must be part of the climate change solution.

In keeping with COP28 developments, we must undertake a global shift to a fundamentally plant-based diet and a gradual global reduction and eventual phaseout of intensive factory farming, the most prolific and damaging form of agriculture. These changes have the potential to stabilize atmospheric GHG levels for 30 years and offset our total current GHG emissions by as much as 68% by the end of the century; specifically, the global phaseout of industrialized animal agriculture and a global shift to a predominantly plant-based diet [2, 7]. Estimates of the magnitude of the effect of a gradual animal agriculture phaseout and global shift to a plant-based diet are based on research quantifying the full climate opportunity cost of current global animal agriculture production including progressive reduction in livestock production, emissions, and full biomass recovery, with full benefits realized gradually over the century [7]. Factory farms, also known as concentrated animal feeding operations (CAFOs), are a major and rapidly increasing contributor to climate change, and a mounting threat to human, nonhuman, and environmental health [7, 8, 21]. Our increasing human population and consumption of factory-farmed animal products (over 98% of farm animals in the US and 70% globally are now factory farmed) magnifies the unsustainability of our current practices [22].

The FAO has estimated that "World meat production is expected to double by 2050" [23]. Given our current trajectory, this would require that we convert approximately 80% of existing forests and shrubland into land devoted to raising animals to produce meat, dairy, and eggs—a conversion that would be unsustainable and would have a devastating impact on the Earth's climate [24, 25]. An additional 35 million km^2 of land would be required to meet the growing demand for animal products, equating to roughly the combined area of Australia and Africa [7]. Proponents of pastoral farming argue that pastoral farming has existed for thousands of years without the devastating impacts on our planet and major contribution to climate change that have accompanied the emergence and subsequent explosion of factory farming over the last 40–50 years [18, 21, 26, 27]. However, increasing pastoral farming to replace all factory-farmed animals would require prohibitive amounts of land. These factors make reducing demand for animal products unavoidable. As the world population increases, food insecurity and starvation will intensify if we continue to rely on a model of food production (i.e. animal factory farming) which is extraordinarily inefficient and resource intensive.

Although 83% of the world's farmland is occupied by animal agriculture, this provides just 18% of the calories and 37% of the protein humans consume, and the majority of cereals and soy produced today are fed to farm animals [28, 29]. More people could be fed with fewer resources, if the use of animals for food is reduced or eliminated [2]. Furthermore, meat consumption contributes four times as much to global GHG emissions as a plant-based diet [29]. A comprehensive meta-analysis assessing environmental impacts of food production at each stage of the supply chain found that shifting away from current diets to a diet without animal products has transformative potential [29]. The immediate adoption of a plant-based diet on a global scale would have the potential to reduce demand for land by up to 76%, GHG emissions from food by 49% (in the United States, this reduction is between 61% and 73% due to meat consumption being three times the global average), acidification and eutrophication by up to 50%, and a reduction in freshwater withdrawals by 19% for a 2010 reference year [29]. Plant food production (e.g. legumes and cereals) can be redirected to provide food for humans instead of for livestock. Overall, replacing animal-source foods with plant-based and novel alternatives (e.g. lab-grown meat) would reduce animal agriculture's environmental impact by over 80% (in terms of land/water use and global warming potential) [30]. This study used a linear programming model to reduce the environmental impacts of the current European diet, taking into account water and land use, and global warming potential while adhering to nutritional needs and consumption constraints [30]. Having more plant food available for humans can reduce world hunger and food insecurities, while preserving biodiversity and vital ecosystems [8, 21]. Further, a global shift to a fundamentally plant-based diet will reduce the rapidly rising economic burden of medicine and healthcare [8, 31–35].

Non-communicable diseases linked to the consumption of animal-source foods, are resulting in disabilities and chronic conditions that, in turn, are major drivers of current and future healthcare costs [35, 36]. Consumption of meat, dairy, and eggs contributes to the development of chronic cardiometabolic and cardiovascular diseases, including obesity, diabetes, hypertension, coronary artery and heart disease, autoimmune disorders, and many forms of cancer (e.g. pancreatic and colorectal) [32–35, 37–42]. Antibiotic-resistant infections in humans are associated with proximity to animal farms and with manure applications to crop fields, and are a global health threat, killing approximately 700 000 people worldwide annually [43, 44]. Approximately 80% of antibiotics sold in the United States are used in livestock feeds [43, 45]. The manure produced by farm animals contains resistance genes, antibiotics, and antibiotic resistant bacteria [43]. Thus, proximity and exposure to animal farms and manure crop applications poses a risk to members of the community for anti-biotic resistant infections [43]. Additionally, lethal human zoonoses such as avian influenza (bird flu) and H1N1 (swine flu) resulting from factory farming operations are far more common today than historically, and threaten to cause pandemics as bad or even worse than COVID-19 [25, 26, 46, 47]. Shifting to a more plant-based diet could prevent 5.1 million human deaths annually; a completely plant-based diet could prevent 8.1 million deaths annually by 2050 [31]. Researchers achieved these estimates by comparing the average current European diet to three diet scenarios: healthy global diet, vegetarian diet, and vegan diet in terms of mortality association with weight and dietary risk factors [31]. The health benefits of a predominantly plant-based diet were attributed to lower prevalence of obesity, increased fruit and vegetable consumption, and lower red meat consumption [31]. The economic benefits of a predominantly plant-based diet could yield up to 31 trillion US dollars annually in healthcare cost savings and productivity gains due to decreases in diet-related diseases [31].

Using plants to feed companion animals also should be included in the global shift away from animal agriculture. Pet dogs and cats consume at least 9% of all livestock annually and 20% in the US (which has higher pet ownership than the global average) [48, 49]. Large amounts of land could be freed up globally by adopting nutritionally sound plant-based diets for humans, as well as for pet dogs and cats [48, 49]. Land saved would exceed the areas of nations such as India and Russia for humans, Mexico or Saudi Arabia for dogs, and Germany or Japan for cats [48]. Such land could be used for climate mitigation through afforestation, biodiversity preservation, and production of healthy plant-based foods for humans. For example, restoring agricultural land (within forest ecosystems) back to forest will double GHG emission reductions, allowing us to reach 92% of land sector mitigation potential and halve ecosystem decline by 2050 [50]. Nutritionally sound plant-based diets for humans, dogs, and cats would reduce GHGs by quantities greater than all the GHG emissions produced by: the entire EU (for humans), the UK (for dogs), and New Zealand (for cats) [48]. Enormous volumes of freshwater would also be saved, and food energy savings associated with a plant-based diet for humans could feed another 5.3 billion people or 2/3 of Earth's current population, as significant additional numbers could be fed using plant-based diets for dogs and cats [48, 51]. When commercially available plant-based pet diets are formulated to be nutritionally-sound, health outcomes are normally good [52, 53].

Plant derived food sources such as beans, nuts, seeds, grains, peas, lentils, and tofu can replace meat, alongside recently developed plant-based alternatives to meat/dairy/eggs (i.e. novel foods developed to mimic the taste/consistency of animal products), and lab-cultured meat products (also referred to as "clean meat" or "future foods") [8, 50, 54, 55]. Replacing animal products with plant, novel, and future foods will reduce the environmental impact of animal agriculture in terms of global warming potential, and use of land and water by up to 80% [30]. Even animal products with the lowest impact (e.g. eggs, poultry) have a greater impact on climate change than do plant foods, and this alone points to a need for fundamental dietary change [29].

Challenges such as nutritional, socio-economic, trade and supply chain factors, need to be addressed in the global transition to a predominantly plant-based diet and phaseout of industrialized animal agriculture. We acknowledge that many rural and low-middle income countries (LMICs) rely on animal farming for their livelihoods. The onus is on wealthier nations to drive change in our food systems and support communities and LMICs through local and global investment initiatives [2]. High-emitting and high-income countries could financially support agricultural productivity, restoration of land and high-carbon forests, and support food security in LMICs [17]. Also, with small nutritional adjustments, animal-source foods could be replaced by existing crops in terms of calories, protein, and fat while significantly reducing food's carbon footprint [7, 56].

Additional investment and development in technologies are required to achieve more affordable and readily available alternatives to eggs, dairy, and meat [57]. Further, government and business initiatives to increase the availability and supply of nutritious plant-based foods are needed. For example, plant-based meals can be used as the default option for catering and institutional dining such as university cafeterias and restaurants [58–61]. Land previously used for animal agriculture could be restored or used to grow new crops or used for power generation [2]. Tax cuts and funded health campaigns to reduce animal-source food consumption can help make plant-based alternatives less expensive [2]. Government subsidies previously provided to the animal agriculture industry and taxes can be used to aid farmers in their transition from animal to non-animal agriculture and for the development of technological innovations for plant-based foods. The global costs to humanity (in economic, health, social, and climate terms) of unabated agricultural emissions far outweigh these challenges. Failure to act may result in irreversible climate changes characterized by environmental, agricultural, and human degradation [8, 17].

Several strategies may help achieve a gradual global phaseout of factory farming and adoption of a fundamentally plant-based diet. For example, removal of subsidies from animal-source foods and taxation of such foods to reflect externalized costs of animal agriculture will help reshape markets to make it less profitable to engage in current practices (factory farming) and more profitable to shift to other products (e.g. plant-based foods). Also, public education and information campaigns highlighting the health and environment benefits of plant-based diets and the detrimental effects of factory farming, combined with product labelling that reflects climate change impact and human/animal/environmental health consequences, can inform consumers and reduce demand for animal-source foods [2, 7, 21, 29].

Developing scientifically valid and uniform industry benchmarks, inclusive of food and agriculture-specific performance indicators, will provide a sustainability ranking rubric for the food system, helping to inform investment and divestment decisions [2]. Such an environmental sustainability ranking rubric can be applied to corporations and countries [2]. Further, taxes on animal products can be used for: plant food production and investment in plant-based crops to feed humans; land carbon sequestration through afforestation of previously farmed land, and trophic rewilding [21, 62–65].

The adoption of a more plant-based diet and the gradual phaseout of factory farming should be incorporated into country-specific and global GHG targets, policy changes, and education initiatives at the forefront of climate mitigation strategies [7, 29]. Achieving these ends would allow us to feed all or most of the world's one billion people who suffer from food insecurity in addition to reducing the risks of zoonotic pandemics, deforestation, and biodiversity loss [8, 21, 26, 66]. It would end the killing of billions of farmed land animals, trillions of wild-caught and farmed fish, and marine animals annually [48]. On a personal level, adoption of a plant-based diet is the single most effective way to reduce one's impact on the planet [2, 7, 67].

The unsustainability of our current course and the urgency for actions to change our food systems are undeniable [2, 8]. The critical changes will require a shift in our global mindset from a human-centric paradigm to a more All Life or One Health paradigm in government policy and corporate behavior. We must rethink our relationship with all life on Earth, and our many impacts on Earth itself [26, 68]. Our survival, that of nonhuman animals, ecosystems, and the planet depend on recognizing the interconnectedness of all life and our mindfulness in the choices we make. What is good for the planet and its nonhuman inhabitants is virtually always in the best interests of humans [8]. Restraint, compassion, and empathy for how our everyday activities affect nonhuman animals and planet Earth is needed, now. The future of humanity and all life on our planet depends on sustainability, and the data indicate that we will not succeed on the issue of climate change unless we change the way that we produce and consume food [2, 7, 8].

Acknowledgements

The authors have no acknowledgements to report.

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Conflict of interest: The authors have no conflict of interest to declare.

Funding

None declared.

Data availability

Available from the corresponding author upon reasonable request.

Statement of ethics

Not applicable, no participants were involved.

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Oxford Open Climate Change, 2024, 5, 1–6
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Short Communication