The Importance of Reducing Animal Product Consumption and Wasted Food in Mitigating Catastrophic Climate Change

JOHNS HOPKINS
CENTER for A LIVABLE FUTURE

Brent Kim, MHS; Roni Neff, PhD, SM; Raychel Santo; and Juliana Vigorito

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Overview

This report, prepared in advance of the United Nations Conference of the Parties 21 (COP21) in Paris, reviews the scientific literature on the roles of reducing animal product consumption and wasted food in meeting climate change mitigation targets.

Key findings

- If global trends in meat and dairy intake continue, global mean temperature rise will more than likely exceed 2° C, even with dramatic emissions reductions across non-agricultural sectors.
- Immediate and substantial reductions in wasted food and meat and dairy intake, particularly ruminant meat (e.g., beef and lamb), are imperative to mitigating catastrophic climate change.
- The urgency of these interventions is not represented in negotiations for climate change mitigation.

Background

Mitigating catastrophic climate change

World leaders have agreed on the goal of limiting global mean temperature rise to no more than 2° Celsius above pre-industrial levels. While even 2° C is projected to have major global impacts, as warming rises above that level, the likelihood of severe and irreversible consequences significantly increases. This means greater threats to people and public health, including:[1]

- Decreased food and water security
- More frequent and intense extreme weather events
- Increased heat-related mortality
- Population displacement from rising sea levels and natural disasters
- Spread of vector- and water-borne disease
- Increased damages from flooding and wildfires

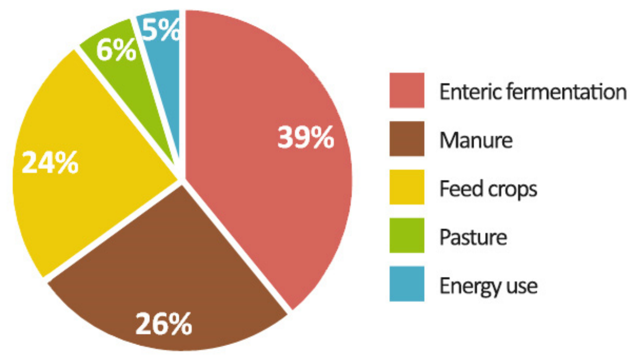
For at least a 66 percent chance of keeping global mean temperature rise below 2° C, estimates suggest global greenhouse gas (GHG) emissions from human activities must be kept at or below 21 ± 3 gigatons (Gt) of carbon dioxide equivalents (CO_2e) per year by 2050.[2] Even if this goal is met, many climate impacts – such as sea level rise – will likely still continue for centuries, albeit with less severity.[1] Global emissions in 2010 reached 49 Gt[1] – more than double the target threshold – so meeting the 2050 mitigation target will require rapid and dramatic reductions across all sectors.

Livestock's contributions to climate change

Livestock production contributes an estimated 14.5 percent of global anthropogenic GHG emissions – more than the entire transportation sector.[3] As shown in Figure 1**,** the single largest share of livestock-related emissions (39%) is from enteric fermentation, a digestive process unique to ruminant animals (e.g., cattle and goats) that releases methane as a byproduct. Other major sources include manure (26%), feed crop production (24%), and deforestation for feed crops and pasture (9%). Per serving, ruminant meat and dairy are far more emissions-intensive per serving than pork and poultry.[4]

There is considerable debate over differences in GHG emissions-intensity between conventional and grass fed beef. Studies have demonstrated that methane and GHG emissions per unit of beef are lower among cattle fed a higher proportion of concentrate (feed) compared to forage (pasture).[5–8] This is partly due to differences in how starches (grain) vs. fiber (grass) are digested in the rumen. Accounting for carbon sequestration in well-managed pastureland, however, may shift the balance in favor of grass fed beef. Some research suggests this may the case[5] while other studies suggest conventional production is still favorable from a climate perspective even after accounting for sequestration.[7,8] Regardless, pasture-based production offers other public health, ecosystem, and animal welfare benefits compared to conventional production.

Figure 1: Livestock's contributions to climate change



Source: Gerber et al., 2013

Wasted food: sources and contributions to climate change

Globally about 30 percent of the food supply is never eaten.[9] If all the world's food losses and waste (henceforth: wasted food) were represented as a country, it would be the third highest GHG emitter, after China and the U.S.[10] Discarding food is akin to discarding all the embodied GHG emissions involved in its production. Additionally, food decomposing in landfills generates significant quantities of methane. Animal products are wasted at relatively low rates (13 percent of global food waste by volume) compared to other foods, but due to their high emissions intensity, account for roughly one-third of GHG emissions associated with food waste.[10]

Waste occurs for different reasons in different places. In higher income countries, the majority of waste occurs among consumers, retail, and restaurants, with purposeful and inadvertent decisions a primary cause. By contrast, in lower and middle income countries, losses in food production, processing, and distribution dominate, primarily caused by inadequacies in infrastructure, storage capacity, and mechanization.

Diet, agriculture, and wasted food in national mitigation plans

Prior to the COP21 climate change negotiations taking place in December 2015, countries prepared plans signifying their initial commitments, subject to change under negotiations, to reduce domestic GHG emissions. These plans – called Intended Nationally

Determined Contributions, or INDCs – vary greatly; however, most share one common feature: the absence of wasted food, and the near absence of diet and agriculture, as areas to address in reducing emissions. When agriculture or land use change are mentioned, livestock production is not referenced directly.

While agriculture's contributions to climate change are underrepresented, multiple INDCs address climate change impacts on agriculture and food security – both severely threatened by climate change, and essential to include in national adaptation planning. Some developing nations with heavy reliance on agriculture, including Indonesia and Bangladesh, mention plans to mitigate deforestation, a major source of agriculture-related emissions. Brazil, a major beef exporter, plans to restore large tracts of pastureland, but does not otherwise mention food production in its INDC. Land use policies such as these represent an important step toward mitigating livestock's contributions to climate change, but they only address one aspect of production. India, a major emitter where more than half of the population is employed in agriculture, briefly discusses sustainable agriculture initiatives but does not specifically target food animal production. As described in this report, reducing livestock production and wasted food are essential for meeting emissions targets, and must become part of the conversation.

2050 Emissions Scenarios: Business as Usual

Figure 2 shows five studies providing a range of projections for agriculture-related GHG emissions in 2050 under different scenarios.

For each study, the **red bars** show agriculture-related emissions for 2050 under a "business-as-usual" scenario. Trends in global dietary patterns, based on projections from the UN Food and Agriculture Organization (FAO), are characterized in large part by increased meat and dairy intake with rising GDP and population growth.[11]

Bajželj et al.[12] model the most comprehensive scope of agriculture-related emissions, and may therefore be considered the most robust of the five studies; the others exclude emissions sources such as land-use change due to deforestation. This is why the emissions reported by Bajželj et al. are greater than those for the other studies (see Appendix for further description of each study).

The **dashed line** marks the emissions threshold (21 ± 3 Gt CO_2e) for at least a 66 percent chance of keeping global warming below 2° C.[2] For context, the **blue bar** shows 2010 emissions from *all* sectors (49 Gt).

Under the business-as-usual scenario modeled by Bajželj et al., emissions from agriculture alone (20.2 Gt CO_2e) would nearly reach the emissions threshold in 2050. Combined with non-agricultural sectors, global emissions would greatly exceed 21 Gt, with severe consequences for people, public health, economies, and ecosystems.

2050 Mitigation Scenarios

The **orange bars** in Figure 2 show scenarios in which agriculture-related emissions are reduced through dietary changes, reduced food waste, and/or increased agricultural yields. The **green bars** show the potential emissions reductions associated with each scenario. Note that results across different studies are not directly comparable due to variations in scope and methods (see Appendix).

Changing diets

Studies suggest that substantial global reductions in meat intake by 2050 could reduce agriculture-related emissions on the order of 55 to 72 percent,[4,13,14] with greater reductions from also reducing dairy and eggs.[13] A global reduction in meat and dairy intake by 75 percent by 2050 could reduce emissions by 7.4 Gt,[15] an amount greater than the emissions from the entire transportation sector in 2010 (7.0 Gt).[16] These are conservative estimates since they do not account for the full spectrum of agriculture-related emissions (see Appendix).

The shift to the healthy, low-meat diet modeled by Bajželj et al. (see Figure 2 footnote) would require, in part, a 31 percent reduction in global animal product intake relative to projected 2050 levels, with greater reductions in regions with higher intake. Western Europe, for example, would require a 64 percent reduction in red meat and poultry intake. This shift would reduce emissions by 5.8 Gt.[12]

Smaller reductions in meat intake will likely not be enough to avoid 2° C warming, but they can be an important first step toward greater dietary shifts. Eliminating meat for one day per week, for example, could reduce emissions by an estimated 1.0 Gt[13] to 1.3 Gt[4,15] per year relative to 2050 business-as-usual scenarios. Reducing emissions by 1.3 Gt would be equivalent to taking 273 million cars off the road, based on typical U.S. passenger vehicles.[17]

Reducing food waste

Halving global wasted food by 2050 could reduce emissions by an estimated 4.5 Gt.[12] This is greater than reductions associated with technological interventions, such as increasing agricultural yields and technical mitigation (e.g., using feed additives to reduce methane emissions from enteric fermentation), which could offer modest reductions on the order of 1.5 – 4.0 Gt.[12,14,15] The food waste recovery hierarchy advocates that in addressing wasted food, the priority should be on preventing waste in the first place, followed by providing surplus to those in need. Transforming the food into animal feed and using it for industrial purposes are lower uses, followed by composting and energy generation. Landfilling is a last resort.[18]

Figure 2: 2050 agriculture-related emissions scenarios

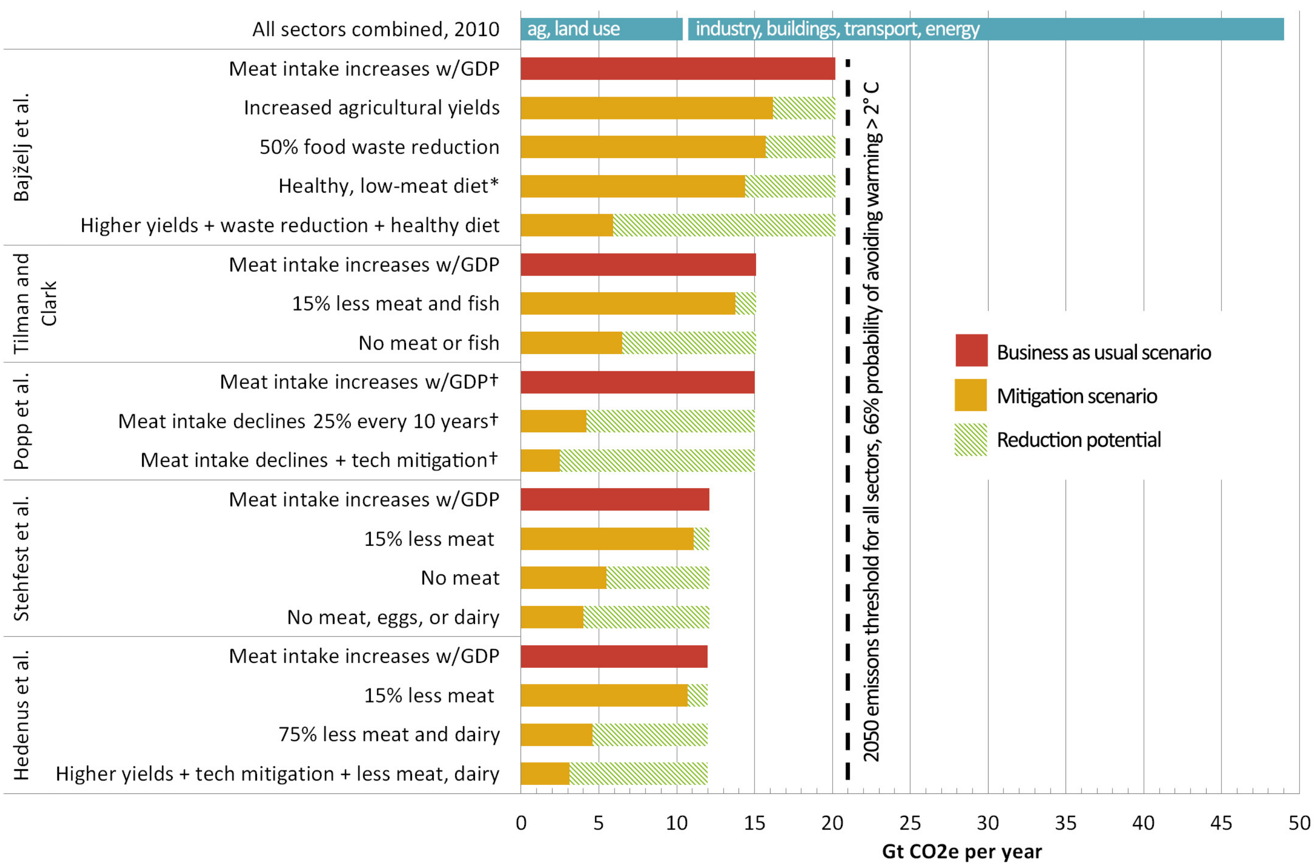


Figure 2 depicts results from five studies examining the effects of dietary changes and reducing wasted food in meeting climate change mitigation targets. In the above scenarios, meat includes ruminant meat (e.g., beef and lamb), pork, and poultry. Fish consumption was modeled in only Tilman & Clark.[4] See main text and Appendix for details.

*The "healthy diet" limits intake of red meat (max of two 85 g / 3 oz. portions per week), poultry (max of one 85 g / 3 oz. portion per day), dairy, eggs, sugars, and oils to levels recommended by health organizations (e.g., WHO, FAO, American Heart Association, Harvard Medical School), and sets a minimum for fruit and vegetable intake.

†2055 scenario.

Combined interventions

Keeping global warming below 2° C will more than likely require reductions in both meat and dairy intake *and* wasted food, combined with rapid and dramatic reductions across non-agricultural sectors. The combined effect of adopting a healthy, low-meat diet, reducing wasted food by 50 percent, and increasing agricultural yields could reduce agriculture-related emissions by 14.3 Gt by 2050.[12] To remain below the threshold of 21 Gt, this scenario would leave roughly 15 Gt for non-agricultural sectors. This is still a very narrow margin, considering direct CO_2 emissions from the energy sector alone reached 14.4 Gt per year in 2010 and are projected to almost double or even triple by 2050.[16] The urgency of extensive and rapid reductions means every available approach must be maximized. Ample opportunities exist to cut animal product consumption and wasted food.

Recommendations

Reducing food animal production and consumption

- **Create policy incentives to support shifts toward reduced meat and dairy production and consumption**, for example, by shifting or removing subsidies, tax breaks, and other economic supports for feed and livestock production that artificially lower the price of animal products; increasing support for research and development of plant-based meat alternatives; aligning dietary guidelines with sustainability goals; expanding plant-based options in federal meal programs (e.g., school lunches); and implementing carbon tax policies that account for livestock emissions. Reductions in animal product intake should be paired with efforts to reduce emissions associated with livestock production.
- **Leverage behavior change campaigns aimed at reducing demand for livestock production**. The *Meatless Monday* campaign, for example, represents an important first step toward the necessary dietary changes, particularly if adopting modest reductions in meat intake subsequently leads to greater dietary shifts.
- **Focus efforts to reduce animal product consumption among populations with the highest per capita intake**. By contrast, populations suffering from nutrient deficiencies may benefit from increasing animal product consumption, particularly in the absence of accessible plant-based alternatives.

Reducing wasted food

- **Create ambitious waste reduction goals with detailed implementation plans, strong policies, and effective monitoring mechanisms.** The United Nations and multiple countries, for example, have pledged to halve wasted food by 2030. Policies effective for reducing wasted food include governmental investment and support for: infrastructure and food storage solutions in lower- and middle-income countries, research and development to prolong food shelf life, food recovery programs, and improved date labeling.[19]
- **Develop multi-intervention strategies within a country or area.** In the United Kingdom, for example, an extensive and multi-pronged set of interventions involving research, policy change, and interventions with consumers, businesses, and others led to a 21 percent reduction in avoidable consumer food waste in only 5 years.[20]
- **Target waste reduction interventions.** In higher-income countries, interventions should focus near the consumer end of the food chain, while in lower and middle income countries the greatest need is at the production end. For maximal GHG emissions reduction, strategies should also focus on the most emissions-intensive foods, such as ruminant meats and dairy; and those most wasted, such as fruits and vegetables.

About the Center

The Johns Hopkins Center for a Livable Future is an interdisciplinary academic center focused on the relationships among environment, diet, food production, and public health. Recognizing how climate change, resource depletion, population growth and lack of equity serve as core drivers affecting those relationships is central to our work. Founded in 1996, the Center's programs, projects, and activities concentrate on multiple aspects of the food system, including food animal production, meat consumption, wasted food, community-based approaches to food system change, and food and agricultural policy. Learn more at www.jhsph.edu/clf.

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Appendix

2050 agriculture-related emissions scenarios

Source	Study scope	2050 Scenario	Gt CO_2e / year	Reduction (%), relative to business as usual in 2050
Bajželj et al., 2014	Includes agriculture and land use change	Meat intake increases with GDP	20.2	
		Increased agricultural yields	16.2	4.0 (20%)
		50% reduction in food waste	15.7	4.5 (22%)
		Healthy diet*†	14.4	5.8 (29%)
		Increased ag yields + 50% food waste reduction + healthy diet	5.9	14.3 (71%)
Tilman and Clark, 2014††	Excludes agricultural land-use change	Meat intake increases with GDP	15.08	
		15% less meat and fish†††	13.78	1.30 (9%)
		No meat or fish	6.50	8.58 (57%)
Popp et al., 2010	Scenario for 2055; non-CO_2 emissions only	Meat intake increases w/GDP	15	
		Meat intake declines 25% every 10 years	4.2	10.8 (72%)
		Meat intake declines + tech mitigation	2.5	12.5 (83%)
Stehfest et al., 2009††	Land-use emissions only	Meat intake increases w/GDP	12.1	
		15% less meat†††	11.1	1.0 (8%)
		No meat	5.5	6.6 (55%)
		No meat, eggs, or dairy	4.0	8.1 (67%)
Hedenus et al., 2014	Excludes agricultural land-use change	Meat intake increases w/GDP	12	
		15% less meat†	10.7	1.3 (11%)
		75% less meat and dairy†	4.6	7.4 (62%)
		Increased ag yields + tech mitigation + 75% less meat and dairy	3.1	8.9 (74%)

Results from five studies examining the effects of dietary changes and reducing wasted food in meeting climate change mitigation targets. In the above scenarios, meat includes ruminant meat (e.g., beef and lamb), pork, and poultry. Fish consumption was modeled in only Tilman and Clark.[4]

*The "healthy diet" limits intake of red meat (max of two 85 g / 3 oz. portions per week), poultry (max of one 85 g / 3 oz. portion per day), dairy, eggs, sugars, and oils to levels recommended by health organizations (e.g., WHO, FAO, American Heart Association, Harvard Medical School), and sets a minimum for fruit and vegetable intake.

††Values converted from carbon equivalents.

†Personal communication with the authors.

†††Calculated as follows: reference diet – (0.15 x (business as usual – no meat diet)).