Can Waste Reduction Move the Needle on **Food Sustainability?**

A look at food waste through the lens of climate change and the role of waste reduction in sustainable food systems.

Global agricultural production in 2050 will need to be 60 percent higher than in 2007 in order to meet increased demand due to population growth and rising incomes.[1] Since food systems already contribute about a quarter of all greenhouse gas (GHG) emissions,[2] rising demand will only make emission reductions in the food sector far more challenging by mid-century than it is today. To make matters worse, one third of the food produced for human consumption today is lost or wasted globally.[3]

To feed the world's population in 2050 and beyond—while ramping down the food sector's GHG emissions—we will need highly efficient production that extracts the most out of every acre of land and every joule of energy, smart consumption that caters to both nutrition and enjoyment of food at a minimal footprint, and significant waste reduction through both behavior changes and technology. Although food sustainability metrics are multidimensional and include resource consumption measures such as land use and fresh water use, it is common to use GHG emissions as a key food sustainability indicator due to the sector's large climate impact. In this article, we take a close look at the food waste component through the lens of climate change and evaluate the role of waste reduction in sustainable food systems.

In casual discussions of food waste, the climate impacts that come to mind first are the GHG emissions from landfills and the need for alternative dispositions such as composting or digestion to reduce these emissions. But life-cycle assessments (LCAs) of food commodities readily show that the production phase of the food life cycle almost always dominates the total cradle-to-grave life cycle emissions. Therefore, recent studies of the climate impacts of U.S. and international food waste have relied on LCAs to estimate the total climate impact of wasted food. Presented here are results from a comprehensive study conducted by this author that analyzed 134 food commodities accounting for most of the food consumed in the United States.[4]

Any rigorous study of food waste starts with a model of the material flow through the system, as shown in Figure 1, and then fits the available data to this model. The raw food waste data in this case comes from the U.S. Department of Agriculture (USDA), known as the loss-adjusted food availability data.

The model tracks the wasted food throughout the post-production supply chain, including the distribution and retail stages. The consumer stage typically generates the largest amount of waste in this chain. Some of the consumer waste is simply unavoidable—this includes the non-edible portions of foods, such as skins, seeds and bones, as well as fat and moisture losses during cooking. This leaves a portion of consumer waste from uneaten food that is avoidable, and this is the focus of many consumer-level waste reduction efforts.

The 134 food commodities in this study include common meats, fish, shellfish, dairy products, oils and fats, eggs, sweeteners, nuts, legumes, grains, vegetables, fruits, and fruit juices. Figure 2 summarizes the annual avoidable food waste data by grouping the food commodities into 16 major categories. Waste at the consumer level has been adjusted to remove the unavoidable waste in consumed foods. Using these data, our total estimate of avoidable food waste in the United States is 55.41 MMT/yr for 2009, which amounts to 28.7 percent of total annual production by weight. This translates to 180 kg/yr of total avoidable waste on a per-capita basis, of which 110 kg represents consumer waste. Consumer waste dominates the total waste, accounting for just over 60 percent of the total avoidable waste. Figure 3 depicts the same data as percentage of food wasted on a weight basis in each category.

Figure 4 summarizes the results by categories based on life-cycle assessments of GHG emissions for all the food commodities, using the material flow model in Figure 1 and a detailed version of the data in Figure 2.

Beef, which accounts for 16 percent of the total emissions, is the single largest contributor to the emissions from wasted food, even though the quantity of beef wasted amounts to less than 2 percent of the total waste by weight. This is because of the high emissions intensity of beef production. Animal products have a disproportionate climate change impact because of their relatively high emission footprints. They

Figure 1. Life-cycle model of material flow from production to disposal.

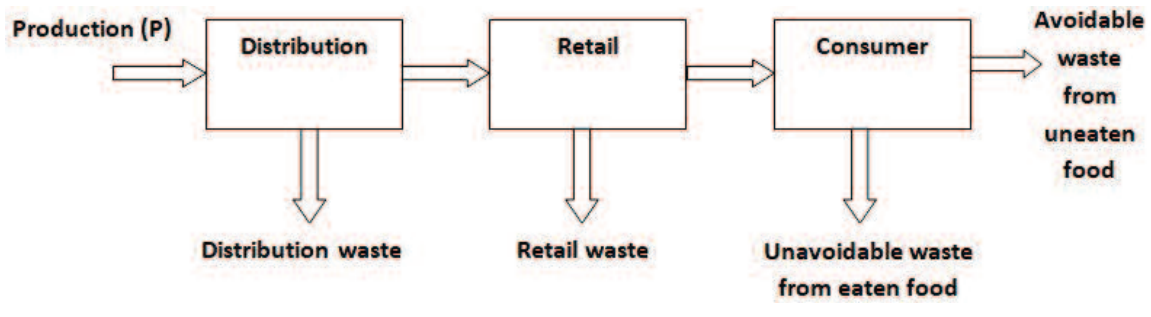
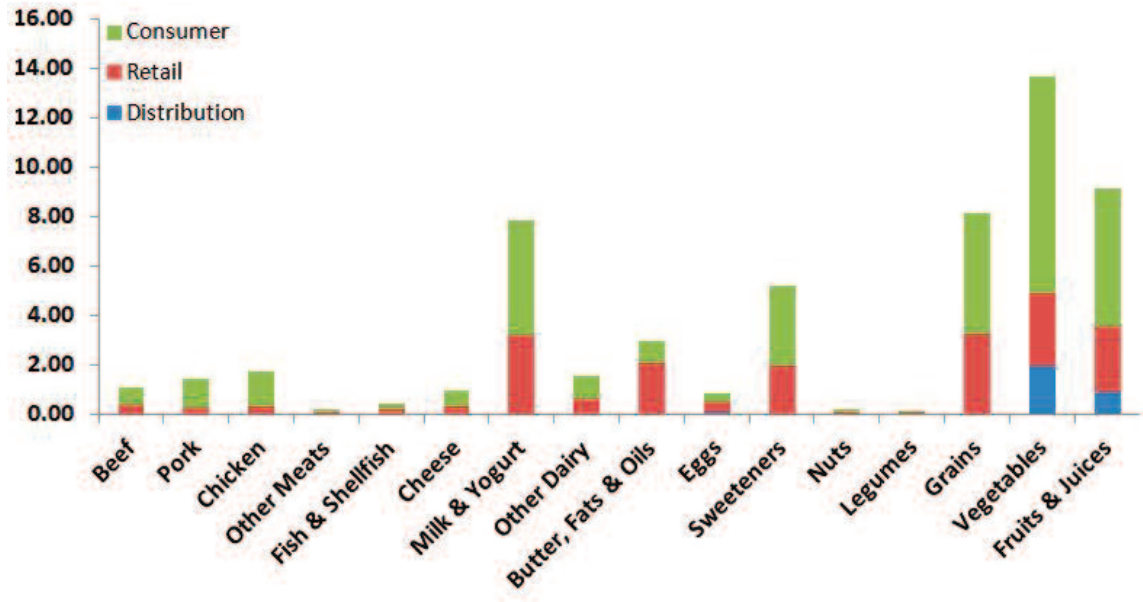


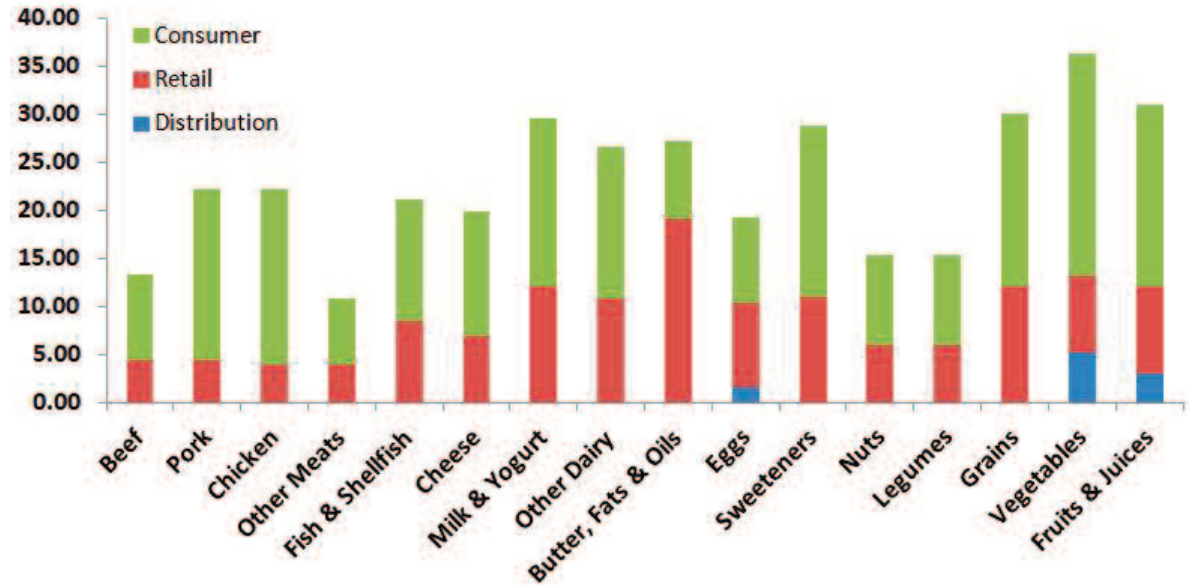
Figure 2. U.S. annual avoidable food waste in 2009 (MMT/yr).



make up approximately 30 percent of all wasted food by weight, but account for nearly 57 percent of emissions. On the other hand, grains, vegetables and fruits make up 56 percent of waste, but contribute just 31 percent of emissions, due to their relatively low emission footprints.

The total GHG emissions from the production, processing, packaging, distribution, retail, and disposal of the avoidable food waste in the U.S. amounts to 112.9 MMT carbon dioxide-equivalent (CO_2e) per year. Figure 5 shows that the emissions are dominated by the production and processing stages which account for 68.6 percent of the waste emissions. These total emissions are equivalent to 2 percent of net U.S. GHG emissions for 2009 based on the national emissions inventory published by the U.S. Environmental Protection Agency (EPA). Note that these emissions represent a conservative lower bound on the actual emissions attributable to food waste, since all consumer-level energy use—including

Figure 3. U.S. annual avoidable food waste in 2009 as percentage of production.



shopping trips, refrigeration, and cooking —has been excluded from the analysis. A similar study in the United Kingdom attributed 3 percent of domestic emissions to food waste.

If food systems account for roughly 25 percent of national emissions, then food waste would be responsible for approximately 10 percent of all food-related emissions, that is, roughly 2.5 percent of total, national GHG emissions. This is an important emissions reduction opportunity. The inherent perishability of food makes it different from almost any other product in that some amount of waste is inevitable. The distribution stage is already fairly efficient in terms of minimizing food waste, leaving the retail and consumer stages to do most of the remaining heavy lifting. Solutions will need to leverage both education and technology.

There are already numerous mobile apps that can help find a home for unsold food from restaurants at the end of the day, or track and reduce food waste in commercial kitchens. We have seen that consumer waste is significant and accounts for

Figure 4. U.S. national GHG emissions from avoidable food waste in 2009 (MMT CO_2e/yr).

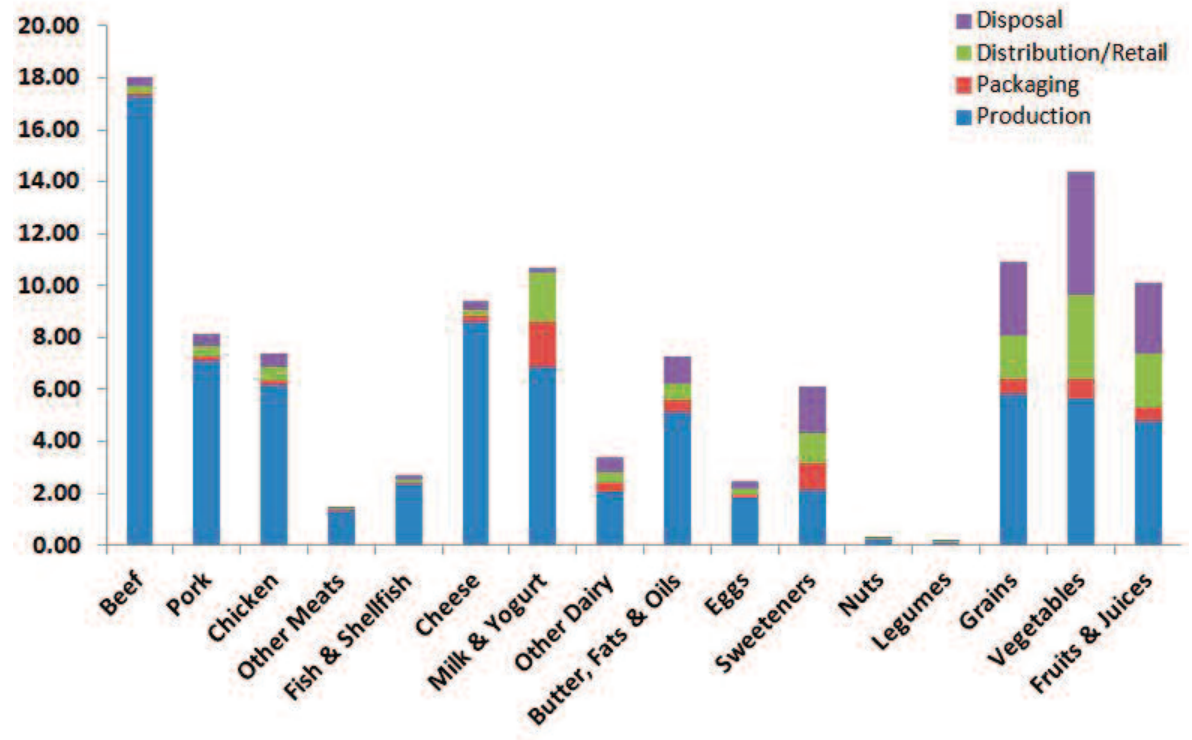
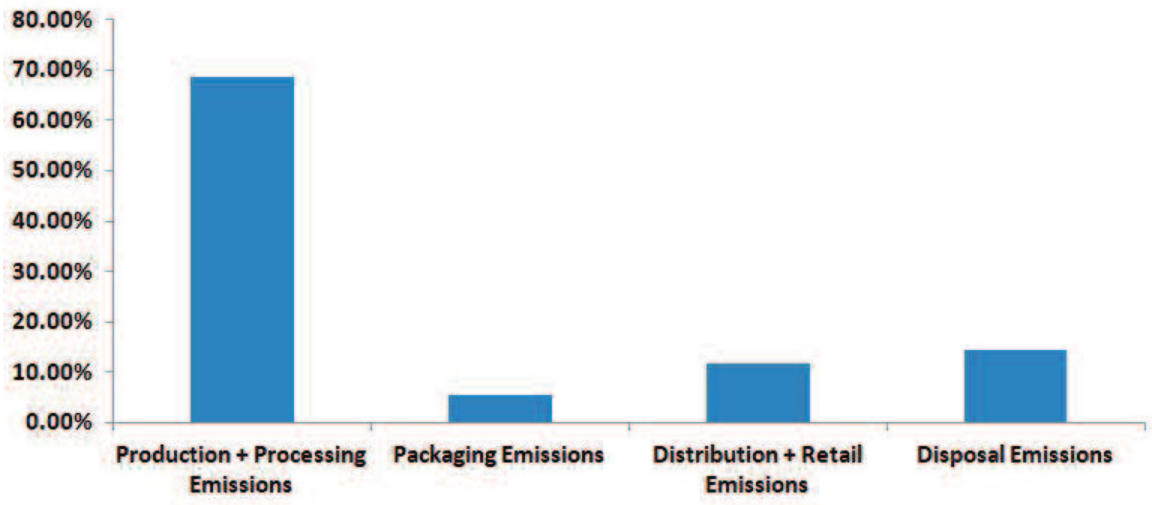


Figure 5. Components of U.S. national GHG emissions from avoidable food waste in 2009.



over 60 percent of the total avoidable waste in the United States; however, it is challenging tackle because it is made up of small amounts of waste spread across a large, diverse population. The Grocery Manufacturers Association is now advising major food manufacturers and retailers to replace the widely misunderstood "expires on" or "sell by" labels—which prompt both retailers and consumers to discard perfectly good food—with a more meaningful "best if used by" label on most foods. Many consumers are also not aware that avoidable consumer waste can save a typical U.S. family of four approximately US$1,600 per year.[4] This economic rationale, combined with improved food labeling, could help turn the tide on consumer waste.

We have discussed the current climate impact of U.S. food waste in detail and touched on the economic impact, but we have not considered other resource impacts such as wasted land use or wasted water. Looking ahead to the demands on food systems in 2050, if food waste can be reduced by half in percentage terms relative to today's levels, then the increase in global food production could perhaps be limited to under 40 percent instead of the 60 percent projected by the Food and Agriculture Organization. This would translate to significant savings in future GHG emissions, fresh water consumption, and land conversions to agricultural use. Waste reduction alone will not come close to making future food systems sustainable, but it can certainly push them in the right direction—and, yes, move the needle on food sustainability. **em**

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