# Food Waste, Healthy Diets, and Environmental Sustainability

## *A Guide for Nutritionists*

Zach Conrad, PhD, MPH

Food is wasted at various points in the US food system, but the greatest amount of food waste occurs at the consumer level. Emerging research now shows a connection between consumer food waste, healthy diets, and environmental impacts, with implications for food security and hunger. In the United States, the average consumer wastes nearly 1 lb of food every day—approximately one-quarter of edible food purchased. Those who consume healthier diets waste more food than people who consume diets that are less healthy. This food waste accounts for vast amounts of wasted cropland, irrigation water, fertilizers, pesticides, and energy, as well as greenhouse gas emissions and other environmental impacts. These inefficiencies can reduce agricultural productivity and undermine efforts to feed an expanding global population and reduce food insecurity in the United States and globally. Nutrition professionals can help move consumers toward healthier diets and reduce food waste simultaneously. Nutr Today. 2020;55(1):5–10

Food is lost and wasted at various points in the US food system, including on the farm, within transportation networks, at wholesale points, and at retail outlets. Yet consumers are responsible for the greatest amount of waste in the food system—within households, restaurants, eateries, bars, schools, and at all other places where people acquire food.[1]

***Consumers are responsible for the greatest amount of waste in the food system.***

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Emerging research now shows a connection between food waste, healthy diets, and environmental impacts.[2–4] The evidence is relevant to nutrition professionals because a better understanding of how food waste relates to healthy diets and environmental sustainability will enable them to better serve their patients and society.

This article describes how food waste is defined, and then discusses the latest evidence on how much and what types of food are wasted, as well as the relationship between food waste, healthy diets, and environmental sustainability. The primary focus is on food wasted by consumers in the United States, but a broader context is provided where relevant.

## FOOD WASTE VERSUS FOOD LOSS

### Confusion About How to Define Food Waste

A satisfying definition of food waste cannot be offered without also differentiating it from food loss, because these terms are related but distinct and are often confused. There are no standardized definitions for these terms, which is surely the cause for much of this confusion.[5] Here, the varied definitions of food waste and loss currently circulating in the scientific literature will be briefly considered, after which definitions that may be most relevant to nutrition professionals will be offered.

Some consider the term *food loss* to include natural shrinkage (resulting from moisture loss), inedible portions (such as seeds and pits), spoilage (resulting from mold, pest damage, and inadequate storage), and food waste (discarded edible portions). In this definition, food waste and spoilage are distinct, and both are subcategories of food loss.[6] Others consider food waste to include discarded edible portions as well as inedible portions, depending on cultural context.[7] Still others define food loss as any food that is removed from the food system prior to reaching the consumer (due to spoilage, bruising, or any other factors), whereas food waste refers to food that is discarded by the consumer.[8] Some have even suggested that definitions of food loss and waste should vary across institutions, but that these terms should not include food that is distributed through nonmarket channels, such as food banks.[9] Even more definitions abound.[5,7]

### Toward Clarity

In the present article, food waste is defined as the edible portions of food that are discarded for any reason

(including spoilage, bruising, distaste for leftover food, and lack of knowledge about cooking or storage options), and food loss is defined as the inedible portions of food that are discarded. While the utility of these definitions may be debated by professionals across diverse fields, they clearly distinguish between food that would otherwise contribute to the nutritional status of individuals (had it not been spoiled, for example) and therefore are likely to be most relevant to nutrition professionals

## HOW MUCH FOOD WAS WASTED?

### Globally

The point in the food system (agriculture, transportation networks, wholesale, and retail) at which most food is discarded varies across regions of the world. In lower-income regions, most food is discarded prior to reaching the consumer, whereas in higher-income regions, most food is discarded at the consumer level. Much of this can be explained by premature harvesting and inadequate cold-storage technology in lower-income regions and to an imbalance between the production and demand of food in higher-income regions.[10]

The amount of food wasted by consumers varies across regions of the world as well, with higher-income regions wasting considerably more than lower-income regions. Consumers waste approximately 0.48 lb per person every day in industrialized Asia (Japan, China, and South Korea), 0.60 lb per person every day in Europe, and 0.73 lb per person every day in North America and Oceana (United States, Canada, Australia, and New Zealand).[10] The situation elsewhere is starkly different. Daily per-capita food waste accounts for approximately 0.27 lb in North Africa and West/Central Asia, 0.15 lb in Latin America, 0.09 lb in South and Southeast Asia, and 0.03 lb in sub-Saharan Africa. To put this into perspective, the total annual amount of food wasted by consumers in higher-income countries (490 billion lb) is about as much as total food production in sub-Saharan Africa (507 billion lb).[10]

***In the United States, the average consumer wastes about 0.93 lb of food every day—about 26% of edible food.***

### United States

In the United States, the average consumer wastes approximately 0.93 lb of food every day, representing approximately 26% of edible food (by weight) acquired at all locations.[2] The majority of food waste is fruits and vegetables (39%); dairy (17%); meat, seafood, and poultry (14%); and grains (12%). All told, consumer food waste in the United States accounts for approximately 29% of edible calories available for consumption.[2]

### Schools Participating in Food Assistance Programs

Food waste within schools participating in the National School Lunch Program and School Breakfast Program has received considerable attention among researchers and policymakers, considering that annual program costs exceed $18 billion and reach more than 30 million children across the country.[11] These programs provide free and reduced-price meals to children from low-income households, thereby providing a critical safety net for this vulnerable population.[12,13]

According to a recent review, most studies conducted over the past several decades have found that approximately 30% of food is wasted in these programs.[14] Following implementation of the Healthy, Hunger-Free Kids Act of 2010, which introduced updated nutrition guidelines for schools participating in these programs, both programs have received enhanced scrutiny over food waste. Although several studies have found no change in food waste attributable to the updated nutrition standards, the amount of waste remains high, and continued efforts are still needed to find effective solutions.[15,16]

## HEALTHY DIETS, FOOD SECURITY, AND HUNGER

### Types of Food Wasted

Recently, researchers demonstrated a linear relationship between diet quality and food waste, but not in the direction that some might expect—healthier diets were associated with greater amounts of food waste (Figure 1).[2] In fact, individuals consuming the lowest diet quality wasted 295 g of food per day (0.65 lb), whereas those

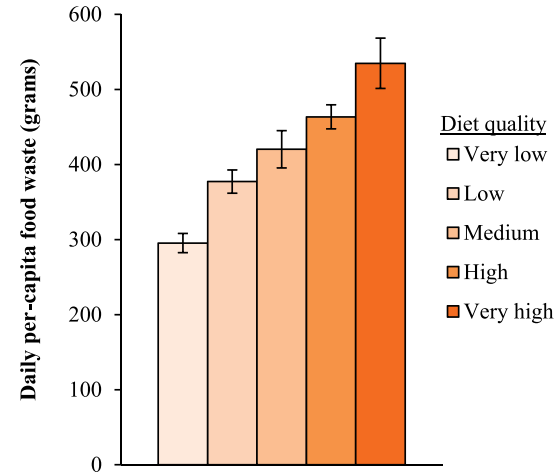


**FIGURE 1.** Daily per-capita food waste by diet quality. Diet quality assessed using the Healthy Eating Index 2015. Reproduced with permission from Conrad et al.[2]

consuming the greatest diet quality wasted 535 g of food per day (1.18 lb)[2] How can this be?

Much of this can be explained by fruits and vegetables, which are consumed in greater amounts by people who consume healthier diets, but are also wasted in higher amounts (Figure 2). In the study mentioned previously, the group that consumed the most fruits and vegetables (which was also the group with the healthiest diet) wasted 4.7 times more of these foods than the group that consumed the least fruits and vegetables (which was also the group with the least healthy diet).[2] Many fruits and vegetables are highly perishable and require time, kitchen resources, and knowledge about how to choose, prepare, and store them, which can make waste reduction efforts challenging. In short, people who purchase more fruits and vegetables tend to consume more of them (and have healthier diets) but also waste more of them, compared with people who purchase fewer fruits and vegetables. Clearly, efforts by nutrition professionals to improve diet quality among their patients and the general public should coincide with guidance to reduce food waste.

***Efforts by nutrition professionals to improve diet quality should coincide with guidance to reduce food waste.***

## Waste of Nutrients

Food waste also accounts for substantial amounts of wasted nutrients.[2,17] Some of these nutrients, such as dietary fiber, calcium, potassium, and vitamin D, are considered nutrients of public health concern by the Dietary Guidelines for Americans, because intakes are suboptimal and are associated with adverse health outcomes. The amount of food

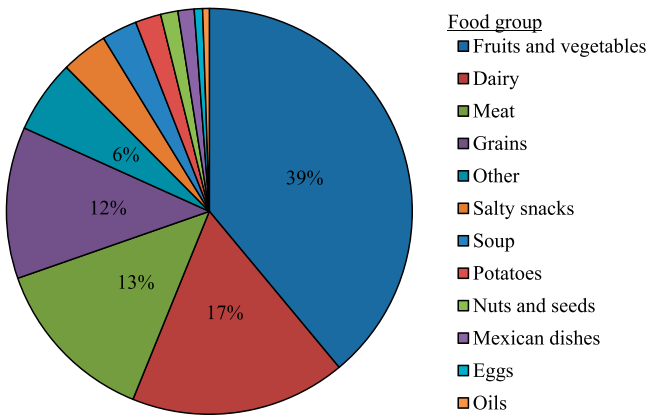


**FIGURE 2.** Daily per-capita food waste. All food groups are mutually exclusive (eg, potatoes are not counted in the fruits and vegetables group). Adapted with permission from Conrad et al.[2]

the average US consumer wastes each day contains 3.9 to 7.4 g of dietary fiber, 203 to 324 mg of calcium, 626 to 1062 mg of potassium, and 1.2 to 1.6 µg of vitamin D.[2,17] It stands to reason that reducing food waste could make these nutrients available for consumption and would therefore improve nutritional status among the general population. For example, eliminating food waste could close the gap between actual and recommended intakes of potassium for more than 120 million adults.[17] However, this interpretation of the evidence warrants caution for several reasons, as discussed below.

## Interpreting the Evidence: Wasting (Un)Healthy Foods and Nutrients

Although reducing food waste could increase the intake of some underconsumed foods and nutrients, it could simultaneously increase the intake of some overconsumed foods and nutrients, such as processed foods that are high in sodium, saturated fat, and added sugar, which are associated with negative health outcomes.[18] Evidence shows that approximately 30% of the daily availability of sodium, saturated fat, and added sugars are discarded along with wasted food,[2] along with more than 750 calories.[2,17] This further speaks to the need to reduce waste and improve diet quality simultaneously: nutrition professionals should support their clients to waste less of all of the foods they purchase, while at the same time increase their intake of foods such as fruits, vegetables, and whole grains, which are rich sources of many underconsumed nutrients.

## Interpreting the Evidence: Hunger and Food Security

For many Americans with sufficient financial resources, food that is wasted is simply replaced by other food. Of course, this likely does not apply to the roughly 12% of American households with limited financial resources who experience food insecurity or the 4.5% who experience food insecurity with hunger.[19] Food banks and pantries provide an opportunity for low-income individuals to improve their food security, which also provides an opportunity to avoid waste for those who donated the food.[20] Low-income individuals may also be eligible for federal food assistance programs such as the Supplemental Nutrition Assistance Program (SNAP); the Special Supplemental Nutrition Program for Women, Infants, and Children; National School Lunch Program; and School Breakfast Program, which provide supplemental food for individuals and families to improve diet quality and reduce food insecurity.[21–23] Although there is currently no evidence that links the amount of food waste (or type of food waste) with food security status or income level in the United States, these programs offer a key opportunity to reduce food waste by including practical waste reduction strategies into existing, related educational

platforms such as SNAP-Ed.[23] Some locales have already incorporated these curricula into their SNAP-Ed programs by focusing on building time-saving skillsets around food selection, preparation, and storage methods that can be particularly useful to parents of young children with diverse (and transient) food behaviors. Continued expansion of these existing programs is needed. If successful, these efforts could allow consumers to avoid the monetary costs associated with discarded food and thereby provide greater financial flexibility to choose healthier foods.

## ENVIRONMENTAL SUSTAINABILITY

### State of the Science

Producing food for the global population requires massive amounts of resources such as land, irrigation water, pesticides, fertilizers, and energy, with downstream impacts such as biodiversity loss, water pollution, and greenhouse gas emissions.[24,25] Consumer food waste therefore represents waste of agricultural resources and is a key indicator of environmental sustainability.[26,27] Several notable studies have examined the amount of agricultural resources and environmental impact associated with food loss and waste at the consumer and retail levels in the United States and globally.[3,4,28] More recently, others have developed methods to estimate the agricultural resources associated specifically with food waste at the consumer level, in order to examine the relationship between diet quality and waste of agricultural resources[2]—concepts that are increasingly of interest to nutrition professionals.

### Relationship Between Food Waste and Environmental Impacts

Researchers have found that approximately 30 million acres of cropland are used to produce the food that is wasted by US consumers every year, which represents approximately 7% of total US cropland.[2] More than one-half of the cropland used to produce fruits and vegetables is wasted. Annual food waste in the United States also accounts for approximately 4.2 trillion gallons of irrigation water, 780 million lb of pesticides, and 5.6 billion lb of fertilizer.[2] To put this into perspective, this represents the equivalent of more than 6 million Olympic-sized swimming pools of irrigation water, more than 1000 pools of pesticides, and nearly 8500 pools of fertilizer. These findings have important implications for environmental sustainability, food production, and human health. Irrigation practices can contribute to groundwater depletion and competition for drinking water, and pesticide exposure has been associated with public health harms, wildlife mortality, and groundwater contamination. These environmental insults can reduce agricultural productivity, making it more challenging to feed a growing population and reduce food insecurity and hunger in the United States and globally.

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Animal-based foods, such as beef, account for a small fraction of total waste but are the single largest contributor to greenhouse gas emissions from food waste.[29] Although animal-based foods can be a part of healthy diets, reducing their consumption can help Americans meet recommendations for daily saturated fat intake, while simultaneously reducing environmental burden.

### Relationship Between Diet Quality and Waste of Agricultural Resources

Healthier diets are associated with less cropland waste but greater waste of irrigation water and pesticides (Figure 3).[2,3] These findings are largely due to fruits and vegetables,[2] which contribute to healthier diets and have lower land requirements than other crops, but require greater amounts of agricultural resources per unit of land area. Indeed, fruit and vegetable waste accounts for only 14% of wasted cropland, but more than 55% of wasted irrigation water and pesticides.[2] Similarly, others have found that the use of energy, irrigation water, and fertilizer, as well as greenhouse gas emissions, associated with food loss and waste at the consumer and retail levels would increase if US consumers adopted recommended diets.[3] Clearly, continued efforts are needed to increase fruit and vegetable consumption and improve overall diet quality, while reducing food waste and environmental impact.

## MOVING FORWARD

### Nutrition at a Critical Juncture

The issue of food waste has garnered increased attention among the nutrition community as of late, at a time that presents a critical juncture for the field. On the one hand, the concept of food waste fits squarely within the traditional purview of nutrition professionals, because it has direct relevance to food and nutrient intake on an individual and household level. On the other hand, wasted food presents consequences that spread far beyond the traditional scope of nutrition professionals, into the neighboring fields of agriculture and environmental sustainability.

And herein lies the critical juncture through which nutrition professionals must navigate. Nutrition is no longer a purely traditional health profession, in which the primary focus is on the relationship between the biological etiology that connects food intake with nutrient status and health

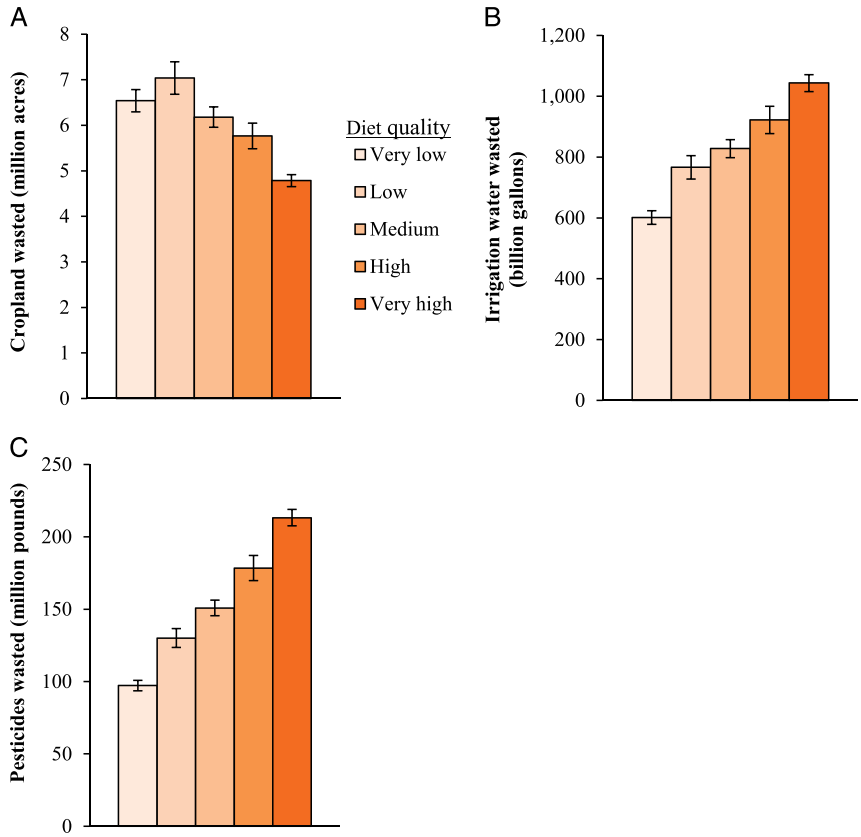


**FIGURE 3.** Annual amount of wasted (A) cropland, (B) irrigation water, and (C) pesticides, by diet quality. Diet quality assessed using the Healthy Eating Index 2015. Reproduced, with permission, from Conrad et al.[2]

outcomes. Rather, the field of nutrition is being extended far beyond these traditional diet-disease relationships into more interdisciplinary domains that consider the linkages between food choice and downstream impacts, such as environmental sustainability.

***The field of nutrition now extends into consideration of the links between food choice and environmental sustainability.***

## Expanding the Skillset for Nutrition Professionals

As evidence mounts, it is increasingly clear that food behaviors have environmental consequences that can reduce agricultural productivity and undermine efforts to feed an expanding global population and reduce food insecurity—in the United States and globally. Consumers are also increasingly making food choices based on the perceived environmental attributes of their food options. Therefore, nutrition professionals will be better able to serve their patients and the general public if they are able to incorporate a broad understanding of the emerging evidence that links diet quality with environmental sustainability into their diverse skillset.

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