# Meeting Review: Food Waste and Sustainability—Strategies to Improve Food Safety, Food Security

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## OVERVIEW

The Institute for Food Safety and Health (IFSH) and the Food Research Institute (FRI) of the University of Wisconsin-Madison hosted regulators, academics, and industry experts for a symposium entitled "Meeting Review: Food Waste and Sustainability–Strategies to Improve Food Safety, Food Security" on September 27, 2018, near Chicago, Illinois. The meeting discussed the difficulty of feeding a rapidly increasing global population without compromising food safety or the environmental health of the planet. Food waste intertwines with sustainability: in the words of meeting speaker David McInnes (DMci Strategies), food waste is a by-product of an increasingly unsustainable global food system. Reducing or redirecting food waste can increase food supplies while also decreasing the total resources used in food production and food waste disposal. Meeting speakers discussed reasons why food companies are concerned about sustainability and presented case studies of ways in which the food industry and others are reducing or reusing food waste.

### Why should we be concerned about food waste?

The world's population is projected to increase to more than 9 billion by 2050. In order to feed these people, agricultural production will need to increase by 60% *(2)*. How can this be achieved?

Globally, about 1/3 (roughly 1.3 billion tons) of food intended for human consumption is wasted (not used for human consumption) each year *(3)*. In North America, consumers generate most (39%) food waste, with agricultural (pre-harvest) losses accounting for an additional 33% *(8)*. Post-agricultural, processing, and retail operations together contribute to the remaining ~30% of food waste.

Global demands for water will also increase in the coming decades. According to Scott Burnett (Ecolab), a perception exists that water is cheap and accessible, with only a limited awareness of water's full value. Troublingly, worldwide water demand is expected to exceed supply by 40% in 2030, which will significantly increase water costs for the food industry *(11)*. As discussed by Elisabetta Lambertini (RTI International), agricultural water currently accounts for 70% of global water withdrawals and 92% of the total global water footprint (which accounts for the use of surface and groundwater, rain, and pollution of fresh water) (Hoekstra and Mekonnen, 2012). Most of the water spent in agricultural food production is used preharvest. Meat, especially beef, has the largest water footprint, largely because of the water need for animal feed production. Postharvest water use in agriculture can also be significant, especially for some of the value-added products that consumers are increasingly demanding. For an example, pre-washed ready-to-eat (RTE) salads require 1.5 gallons of water to produce 1 lb. of washed product, per Will Daniels (IEH Laboratories).

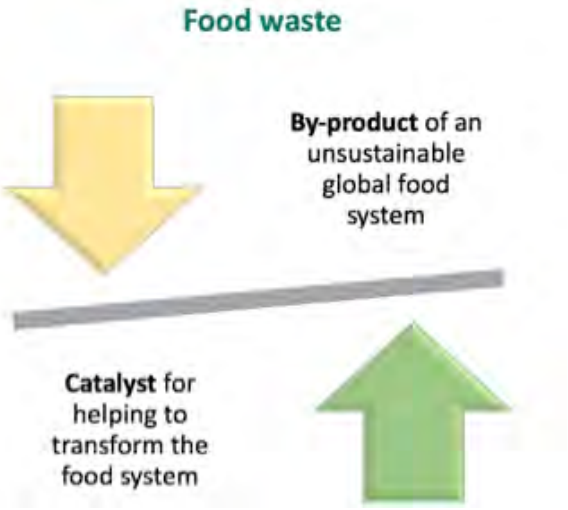


**FIGURE 1. Food waste: both a global food system catalyst and by-product (courtesy of David McInnes, DMci Strategies).**

Food waste also impacts the environment. When factoring in resources used to produce the food as well as its disposal, wasted or lost food has a huge carbon footprint: 3.3 billion tons of carbon dioxide equivalents each year *(4)*. Put in other terms: if food waste were a country, it would generate more greenhouse gas emissions than any other country except China and the U.S. Reducing food waste, therefore, has the potential to significantly reduce greenhouse gas emissions.

As a result of all of these factors and more, the United Nations 2015 Sustainable Development Goals targets a reduction in global food waste by 50% by 2030 *(10)*, a goal endorsed by the United States Department of Agriculture (USDA) and Environmental Protection Agency (EPA) according to meeting panelist Kevin Smith (U.S. Food and Drug Administration).

### What drives a company or organization to reduce food waste?

As David McInnes pointed out, reducing waste can be a catalyst for transforming the food system, as it is good for people and the planet but also (importantly for food companies) for profits. Both carrots (incentives) and sticks (penalties) may steer a company towards food waste reduction efforts.

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**FIGURE 2. Kathleen Glass (University of Wisconsin-Madison).**

Although sustainable goals are embraced and supported by the U.S. federal government and international agencies, there are no government rules to demand and enforce sustainability in our food systems in the U.S. As discussed by Kevin Smith, FDA and CFSAN's missions don't address food waste and sustainability. However, the remits of both of these agencies do intersect with food safety, and the government can bring positive attention to companies that are committed to reducing food waste.

One strong factor driving food companies toward improved sustainability is marketing opportunity. Consumers are increasingly factoring sustainability into their purchasing decisions. In particular, as discussed by panelist Katya Hantel (ConAgra Brands), millennials are driving considerable demand for sustainable food products, with 50% of these younger consumers willing to pay more for products they believe are produced more sustainably.

David McInnes discussed how large food companies are examining the downstream consequences of their food production decisions and making changes that may help both the environment and their business. For example, 85% of General Mills' water footprint is found in its agricultural supply chain. To ensure supply chain resilience, this company is going beyond improving water efficiency across its supply chain; it is pledging to protect the source of water by improving priority watersheds by 2050. Another example is the Canadian grocer Loblaws, Canada's largest chain; it has pledged to eliminate microbeads from their house-brand cosmetic and beauty products because microbeads are hazardous to fish and potentially to those who eat fish, another product sold in their stores (7).

**What are the challenges to reducing food waste and improving sustainability?**

Food companies may understand that it is socially desirable to reduce food waste and improve sustainability, but significant hurdles exist in doing so. In the words of speaker Cole Doolittle (Revelation Waste Partners), it often boils down to the "battle of the greens": money vs. sustainability. It may not always be clear to decision makers how the investment needed to improve sustainability will pay off for the company.

The role that consumers play in driving food companies towards more sustainable practices has already been mentioned. Consumers demand transparency from companies from whom they purchase products; this can be both a help and a hindrance to food companies. Using the analogy of tracking sharks, David McInnes illustrated how consumers perceive food issues. OCEARCH is an organization that monitors the precise location of great white sharks to encourage awareness and the ecological health of oceans. One shark named "Hilton" is tracked in real time by a smartphone app (@HiltontheShark). McInnes made the case that too much information about how food is produced (or where a single shark is located, such as near beaches and ocean front cottages) can generate both unwarranted fear from learning too much and fascination to know more.

Once a technology or an industry has been branded unfavorably by consumers, it can be difficult to change the perception. The animal products rendering industry, as described by David Meeker (National Renderers Association), has gone a long way to making meat for human consumption more sustainable by re-purposing leftovers into products such as pet food, but it still struggles with the negative connotations of "animal byproducts." Caitilyn Allen (University of Wisconsin-Madison) discussed the more recent fears and misunderstanding that consumers have about foods derived from genetically modified organisms (GMOs). Allen suggested that food scientists might learn a lesson from Mary Shelley and her portrayal of the overconfidence of scientists when rushing to use new technologies. While GM crops can significantly improve sustainability (by reducing pesticide usage, increasing yields, etc.) and foods derived from GMOs have been safely consumed for over 20 years, the perception of such products as "Frankenfoods" is hard to change.

Even while they profess to support sustainability, consumers sometimes want food products which are contrary to such goals. Rob Celin (Tilia Holdings) explained that consumers are demanding more convenience and variety in the food they purchase. Fresh foods, in particular, are in high demand. The increasingly global flow of perishable foods means increased use of cold chain (and increased energy costs) for the food industry. More specifically, Will Daniels discussed how consumer demand has pushed the evolution of the fresh produce industry from mainly unbranded, seasonal, local produce (with high waste and a short shelf life) to globally sourced, year-round and fresh-cut products (which results in different types of waste and increased energy inputs).

Many of the speakers addressed the question of whether attempts to reduce food waste could compromise food safety. As explained by panelist Herman Carni (Greater Chicago Food Depository), food safety is critical to their organization and the food pantries they serve, and as a result, they cannot accept certain types of foods (such as restaurant food) that is not already packaged and labeled. In the rendering business, David Meeker explained that the reuse and recycling of meat wastes for animal feed prevents microbial hazards through the use of rendering-specific good manufacturing process, preventive controls, and the use of audits. Consumers rightfully expect food safety to trump food waste considerations, but as David Fikes (Food Marketing Institute) described, consumer confusion regarding date labeling has also led to a lot of food waste: what does "best by" really mean?

Packaging of food further complicates the potential conflict between food safety and sustainability. Will Daniels explained how packaging (bags, plastic shells, etc.) used for value-added fresh produce can provide a perfect environment for microbial growth, which can become especially problematic when trying to maximize shelf life. Packaging itself generates its own carbon footprint, which recycling attempts to minimize, as discussed by Eva Almenar (Michigan State University School of Packaging). By 2030, all packaging in Europe must be reusable or recyclable. The reuse or recycling of packaging may also generate food safety concerns. Almenar commented that the temperature at which plastic melts in some recycling processes might not be sufficiently high to kill pathogens. Additionally, coatings used on packaging to retard microbial growth may interfere with their ability to be recycled.


**FIGURE 3. Eva Almenar (Michigan State University School of Packaging).**

The energy used in food processing, transportation, storage (and in some cases, disposal) is another challenge to a more sustainable food supply. Fresh-cut produce, in greater demand than ever by many consumers, typically requires five days of transport on a truck to cross the U.S. according to Will Daniels. The shipping time reduces shelf life and can increase food waste because there is less time to sell and consume the food before it spoils. Attempts to reduce energy use and costs during transportation may lead to denser packing of pallets of produce during shipping, which can hinder temperature control and air flow, further reducing shelf life.

All food sectors represented at the meeting, including the produce, animal agriculture and rendering, and dairy industries, cited improving energy efficiency (including processing, transportation, and storage) as an important part of their sustainability efforts. Rob Celin described the importance of improvements in the cold chain, in particular, for improving the sustainability of food by reducing energy use.

Several of the speakers provided examples in which government policies or regulations impact food waste and sustainability. U.S. government policies, including subsidies and trade disputes, have resulted in milk overproduction and low milk prices; this has resulted in milk being "dumped" rather than sold as milk or being used in other products. Katya Hantel mentioned the repercussions that China's recent ban on trash importation has had: instead of being recycled in China, much more U.S. waste is heading for landfills. Susan Backus (North American Meat Institute) recommended more liability protection to extend the provisions of the Bill Emerson Good Samaritan Food Donation Act *(1)* so that organizations/companies that donate expired food will be less afraid to donate expired food.

**What solutions have worked?**

A tremendous variety of approaches have been used to try to reduce food waste and increase sustainability in food production. Many of the speakers at the meeting presented ideas and case studies to share with others what they have learned works.

Saving water can be accomplished in many ways. Pre-harvest strategies to reduce the water footprint of crops, discussed by Elisabetta Lambertini, include increasing the efficiency of crop irrigation and increasing crop yield. Local water can be saved by importing water-intensive foods. Scott Burnett discussed post-harvest water conservation by repurposing, reusing, and reducing water consumption. He highlighted the value of tracking and analyzing water usage with water meters to identify sources of lost water (e.g., leaks) during processing. Clean-in-place (CIP) systems can account for up to 40% of total water usage at a food or beverage facility, but technology can be used to optimize CIP schedules and thereby reduce water usage.

Technological innovations can also improve sustainability. Caitilyn Allen discussed several case studies of how "accelerated genetics" with genetically modified organisms can increase food sustainability and reduce waste. Bananas are a key dietary component (30 to 60% of total daily calories) for many people in Sub-Saharan Africa. A bacterial disease, banana *Xanthomonas* wilt (BXW) has had a devastating effect on banana plantations and those who depend on bananas for food. A transgenic banana plant is highly resistant to BXW in field trials; however, African farmers are still awaiting government approval to plant them. In a second example, Allen described how the papaya industry in Hawaii was nearly destroyed by the papaya ringspot virus. A transgenic papaya plant, the "Rainbow Papaya," has been grown in Hawaii since the late 90s; it has been credited with saving the Hawaiian papaya industry while also significantly reducing pesticide use. The Rainbow Papaya is an example of a GMO that is generally well accepted by consumers.

Improvements in packaging are also being explored to help reduce food waste and improve sustainability. Eva Almenar discussed the use of packaging configurations which require less material and the adoption of sustainable materials such as recyclable, bio-based, and biodegradable/compostable plastics in packaging. Her research group is exploring the ability of natural antimicrobial coatings (chitosan with grape seed extract) on a biodegradable polymer, poly(lactic acid) or PLA, to increase the shelf life of fresh fruit. Intelligent packages that can record quality-related parameters such as temperature and time are also being used, as are membranes that can alter the oxygen/carbon dioxide levels in a package to maintain these gases at optimal levels for produce quality.

Much food waste in the U.S. occurs at the level of the consumer. The mantra "when in doubt, throw it out" is still important from a food safety perspective, but that doesn't mean throw out everything, according to FDA's Kevin Smith. As discussed by David Fikes, representatives from a group of U.S. food companies were brought together in an initiative


**FIGURE 4. David Fikes (Food Marketing Institute).**

spearheaded by the Food Marketing Institute (FMI) and the Grocery Manufacturers Association to develop streamlined, voluntary product code date labeling that would be consistently applied and that would generate less confusion for consumers. In early 2017, the group eventually endorsed the following statements:

- "BEST if used by…" for shelf-stable products
- "USE by…" for perishable products

Use of the new statements is voluntary and was recommended to coincide with the new FDA requirements for Nutrition Fact Panels (for which the compliance date has changed several times; currently it is January 1, 2020, for large manufacturers) *(9)*. A white paper and implementation guide on the new date labeling statements are available on the FMI website *(5)*.

Money, not surprisingly, plays a large role in how companies address sustainability. The financial sector itself is recognizing the importance of sustainability; it is key to the "environmental, social, and corporate governance" factors that are being increasingly used to assess the broader ethical implications of investments by many organizations. As discussed by Rob Celin, venture investment in agrifood has increased in recent years, with notable investments in technologies and logistics that promote sustainability and reduce waste.

Underlying the financial sector's interest in sustainability is the realization that not only do sustainability initiatives improve a company's image, they also can improve their bottom line. Several speakers provided case studies of how waste reduction strategies saved companies money. Scott Burnett discussed situations in the food industry where implementing water reduction measures resulted in substantial financial savings. In one case study, careful analysis of water used in washes and rinses during fluid milk processing resulted in changes which conserved large amounts of water, energy, and money. Other examples cited by Burnett included the replacement of water with a dry lubricant for conveyor lubrication and the reuse of wash water during poultry processing.

Saving money by re-design of existing processes or products to be more environmentally friendly was discussed by several other speakers as well. Rob Celin described how food companies can save significant energy costs by updating their cold chain infrastructure with taller warehouse and upgraded insulation. Strategically locating cold storage facilities can also reduce transportation and storage costs. Celin presented a case study


**FIGURE 5. Armand Paradis (Institute for Food Safety and Health).**


**FIGURE 6. Food recovery hierarchy (Reproduced from EPA).**

in which cold-chain warehouses were "multi-purposed" to both freeze (to kill insects) and sterilize (to kill microbial pathogens) in cashews at the same facility, greatly reducing shipping expenses. Eva Almenar described how re-design of Einstein Brothers Bagels "grab and go" bagel buckets saved the company ~$500,000 annually in packaging costs *(6)*.

In addition to saving money, reducing food waste through sustainability efforts can also generate new revenue streams for food companies. Companies can make money by turning by-products into "co-products." Cole Doolittle described the food recovery hierarchy *(Fig. 1)* which delineates a preferred order in which food waste should be handled when possible. A niche use lower in the hierarchy (an industrial use) is the utilization of cherry pits as a road base in orchards. At a higher level, food companies may turn by-products into alternative food ingredients for animals or even humans; these levels are high in the hierarchy and represent areas where the food industry can make a meaningful difference.

Three speakers explored ways by which different food industries (meat/rendering, fresh produce, and dairy) are addressing food waste and sustainability by turning "by-products" into "co-products." As discussed by David Meeker, sustainability in the animal agriculture industry means using all of every animal for the highest purpose. Up to half of the weight of agricultural animals is not used for human food. The meat industry has an exceptionally long history of finding profitable uses for by-products of the meat industry. Protein by-products are used for livestock, poultry, and pet food when possible. The use of rendered fats and proteins as animal feed ingredients replaces corn and soybeans that would require 6.3 million acres of U.S. cropland for production. Industrial uses of rendering products include fertilizer applications, personal care and industrial products, bioenergy, and more.

In the fresh produce industry, Will Daniels described how blemished produce, rather than being discarded, can be used to create value-added products such as pre-cut vegetables. He pointed out that such products do require more processing, packaging, and proper cold-chain management, but consumers want these products and are willing to pay premium prices for them.

The dairy industry generates a significant amount of whey, with 100 pounds of milk generating 10 pounds of cheese (versus 90 pounds of whey, formerly considered a waste product). Rohit

**FIGURE 7. Meeting speakers included (front row, left to right) Susan Backus, Eva Almenar, Elisabetta Lambertini, Caitilyn Allen, Katya Hantel (back row, left to right) Scott Burnett, David McInnes, Kevin Smith, David Meeker, Cole Doolittle, Herman Carni, Rohit Kapoor, and David Fikes.**

Kapoor (National Dairy Council) explained that until relatively recently, whey represented a significant environmental burden. Many of the nutrients in milk (20% of milk protein and 95% of milk carbohydrates) are found in whey and thus are potentially lost when cheese is made. Today, however, whey is a "core product" of the dairy industry, which generates great value as a key ingredient in many food and beverage products such as sports and infant nutrition products.

Moving beyond protein, the dairy industry is now utilizing other components of whey. When protein is removed from whey, the remaining products include whey protein phospholipid concentrate, lactose, and delactosed permeate. Whey permeates are being developed for their ability to enhance the perception of salt in reduced sodium products, while whey protein-lipid concentrates are used in infant formula because of their potential ability to enhance cognitive development and immune defense.

At the very top of the food recovery hierarchy, Herman Carni discussed how a large food bank can operate to distribute food that might otherwise be wasted to people in need. The Greater Chicago Food Depository is one of the top 6 food banks in the U.S., distributing more than 70 million pounds of food each year. Most of the food comes from retail food stores. The organization has a strong focus on nutrition: A large proportion (37%) of the food distributed is produce, while cakes, cookies, desserts are not accepted as donations.

**What is still needed?**

While many success stories of how food companies were able to reduce food, water, and energy waste exist, several speakers mentioned specific issues that still require attention.

Sustainability is a trendy corporate buzzword, but as Cole Doolittle asked, how can it be measured? Similarly, David McInnes emphasized a growing need for transparency so that food company sustainability claims can be validated and traceable. Supply chain metrics related to sustainability need to be comparable between companies in order to make "transparency transparent."

Consumers still generate a large proportion of food waste, but food at the consumer level is hard to rescue. As Herman Carni described, prepared foods that are not packaged and labeled cannot be distributed through food banks because of food safety reasons (for example, potential food allergen content). Caitilyn Allen questioned whether reducing the currently enormous portion sizes found in U.S. restaurants could be addressed as a way to reduce food waste. Kevin Smith pointed out that menu labeling requirements that include calorie information may help with this. Rescuing wasted food from buffets and school lunch programs still needs a solution.

Gene-editing shows tremendous promise to easily and rapidly develop new plants and animals with traits that could significantly improve the sustainability of food products. While the U.S. regulatory approach for products developed from such technologies is streamlined compared to that for traditionally GMOs, some regions such as the E.U. are regulating products developed from gene editing similarly to those developed from traditional genetic modification. As Allen pointed out, this will undoubtedly cause problems since crops or animals created with gene editing are not distinguishable from products of conventional breeding. Besides regulatory hurdles, the court of consumer opinion still needs to be won over. Allen believes the first crop generated from CRISPR gene-edited plants is likely to be cacao, as 20–30% of cacao pods are lost due to disease, and climate change also threatens to reduce cacao yields. But will consumers accept this chocolate?

Lastly, as pointed out by David McInnes, even though the world's food supply is safer and more abundant than ever, "consumers don't pay for the real price of food." The full price of food includes diet-related chronic disease, resource depletion, and food waste factors that are not always considered by consumers. The price charged for foods may be insufficient to cover such social and environmental impacts.

**Looking forward**

Food companies and consumers may be slow to embrace sustainability; it is one thing to give it lip service, but are they ready and willing to really invest in it?

Panelist Katya Hantel is optimistic. Consumers are now holding food companies responsible "farm to fork", even for practices that occur upstream or downstream from in the food chain and are not directly under their control. Consumers are also examining their own food consumption habits and making changes to reduce food waste and improve sustainability. Food products such as meal kits which have the perceived side benefit of generating less food waste are particularly popular among younger consumers.

Sustainability approaches can be tremendous marketing opportunities for food companies. Transparency and collaboration will be essential to help answer consumer concerns about the relative sustainability of the food products that they purchase. However, as Will Daniels remarked, perhaps the well-known adage "food safety is not a competitive advantage" should also apply to sustainability.


## ACKNOWLEDGMENTS

This meeting was sponsored in part by Kikkoman Corporation as well as IFSH and FRI. Many thanks to Renee Anderson of IFSH for providing meeting photographs, Charles Czuprynski, Kathleen Glass, Robert Brackett, and the meeting speakers, panelists, and organizers for review of the manuscript, and Cindy Koschetz for meeting organization and logistics.


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