QUANTIFYING THE VALUE OF PACKAGING

AS A STRATEGY TO PREVENT FOOD WASTE IN AMERICA

January 2018

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About AMERIPEN

AMERIPEN – the American Institute for Packaging and the Environment – is a coalition of packaging producers, users and end-of-life materials managers dedicated to improving packaging and the environment. We are the only material neutral packaging association in the United States. Our membership represents the entire packaging supply chain, including materials suppliers, packaging producers, consumer packaged goods companies (CPGs) and end-of-life materials managers. We focus on scientifically developed data to define and support public policy positions that address the intersection of packaging and the environment.

This report is the result of a collaboration process involving inputs from AMERIPEN corporate members, technical advisory group members, and subject matter experts.

Acknowledgements

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Kyla Fisher of Three Peaks Consulting served as project lead, coordinating the resources needed to develop this assessment.

Food Waste Subject Matter Experts

Value Chain Management International (VCMI) led the economic analysis and core technical data to complete this assessment. A more detailed report based upon VCMI's analysis is available to AMERIPEN members.

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Executive Summary

Misperceptions of the environmental impact of packaging are obscuring the fact that packaging can be a key solution to our food waste crisis.

The issue of food waste is a growing concern. In just 50 years, we have doubled the amount of food we waste as a nation. On a per capita basis, Americans now waste almost two times more food than their peers in less developed nations and almost one-third more than peers in developed nations, costing the US economy more than $200 billion a year. Food waste is the largest single material type in landfills across the US and is a key contributor to greenhouse gas (GHG) emissions.

Food waste is not only an economic and social concern but the impact of food waste on the environment is significant. Energy, land and water use and GHG emissions add up as food moves through the supply chain from production and harvesting to processing, consumption and disposal. Prevention remains the most impactful form of GHG reduction. The prevention of food waste not only saves food from going to waste, but also results in six times greater GHG emissions savings than composting, seven times greater than anaerobic digestion and three times more than that of redistribution.

Packaging is one of the most economically and environmentally impactful prevention strategies available. By analyzing packaged food waste data, AMERIPEN uncovered a surprising correlation between the foods with the highest percentage of wastage and those with the least amount of packaging. National-level data reinforced the link between packaging and food waste by demonstrating that the regions with the highest rates of food waste (North American and Oceania) also have the least amount of packaged foods. Yet consumers frequently cite packaging over food waste as a top environmental concern—in spite of evidence suggesting otherwise. Packaging's potential for preventing food waste is overlooked both in the investment and policy communities. This needs to be addressed in order to leverage a key strategy in the fight against food waste.

Where packaging has been cited as strategy to prevent food waste, calls for increased investment and efforts have primarily focused on emerging technologies such as active and intelligent packaging and to a lesser degree, on optimization of existing packaging. In a first-of-its-kind study, AMERIPEN surveyed a number of leading packaging designers and food scientists to compare and contrast what consumers and industry representatives suggest are the most effective means to utilize packaging as a food waste prevention strategy. The results imply existing technologies and minor adjustments to optimize existing packaging may be more impactful than investment into new technologies, suggesting the optimal use of packaging as a food waste strategy may require less effort and investment than previously reported.

The ability to reduce or prevent food waste has enormous implications from financial, environmental and societal perspectives that could lead to significant benefits. The understanding and acceptance that packaging is a solution to food waste is quickly emerging, yet there are still a number of negative perceptions associated with the increased use of packaging. As packaging is increasingly recognized as a prevention strategy, AMERIPEN urges the need for further analysis and more holistic thinking in order to understand and develop the most effective measures to ensure success. Arguments for reduced packaging or introduction of new technologies while well-intended, fail to provide the depth of knowledge we need to best assess effective interventions.

The key conclusions from this work are:

1. *Packaging is an under-utilized solution that could significantly reduce food waste*

2. *Additional data is needed to demonstrate how packaging prevents food waste*

3. *Increased collaboration between industry and government will be key to preventing waste*

1. Introduction: Why Packaging Should Be a Strategy to Prevent Food Waste in America

Packaging plays an essential role in creating sustainable food chains. It protects products from damage, spoilage and contamination. Packaging was instrumental in the development of global food systems and is necessary to safely transport food from farms to the household. Yet when we discuss the challenge of food waste in America, packaging tends to play a subsidiary role to other solutions. Much of the emphasis to-date has been on ways to manage the end-of-life disposal of food.[1,2] Strategies like redistribution, composting, and anaerobic digestion have captured the public attention. From a social perspective this is not unsurprising, an emphasis on managing waste would not require a behavioral shift from consumers—the largest source of food waste. While these may be easily adaptable solutions they are not necessarily the most effective solutions. Solutions to *prevent* the wasting of food have been proven to be more cost- and environmentally-effective over the long run.[3]

In a groundbreaking study led by a collaboration between industry, government, environmental organizations and charitable foundations—"Rethinking Food Waste Through Economics and Data" (ReFED) identified the optimization of packaging as one of the top three most effective solutions to reduce the waste of food in America.[4] In addition, a further study released by The Rockefeller Foundation identifies packaging as a key strategy for reducing food waste by changing the way consumers interact with food[5] Packaging can not only extend shelf life, preventing wastage at retail and in homes, but it can also influence consumer behavior through smaller portion size, disposal mechanisms and re-use opportunities. While the value of packaging as strategy to reduce food waste continues to gather attention, as demonstrated by PAC Food Waste's summary of organizations exploring this intersection,[6] packaging still remains an undervalued strategy in comparison to other approaches. AMERIPEN believes a deeper analysis into packaging opportunities and failures in the retail environment, as well as a more comprehensive analysis into consumers' relationship with packaging in the home will provide much more meaningful insight into how packaging can support the fight to reduce food waste. Furthermore, many state-led waste management policies are failing to consider this intersection. In some cases they promote policies which may reduce packaging waste but increase food waste. Integrated policies to consider materials management would help simultaneously address the challenges of both food and solid waste disposal.

The purpose of this paper is to explore the opportunities that packaging could play as a strategy towards decreasing cumulative food waste across America. This paper will examine where and how food waste occurs; explore previous estimates of the economic value and costs of investing in packaging as a strategy to reduce food waste, and identify some of the top packaging priorities for food waste reduction identified by consumers, retailers and packaging professionals. When we explore the relationship of food waste to environmental constraints, it quickly becomes apparent that preventing food waste in the first place may be one of the most effective strategies we can engage to reduce climate impacts, resource depletion and social inequality.[7] AMERIPEN believes that packaging may be one of the more effective solutions for minimizing food waste in America.

1 *Oregon Department of Environmental Quality (2017) "Oregon DEQ Strategic Plan for Preventing the Wasting of Food."*

2 *We note the FWRA 2016 Analysis of US Food Waste Among Food Manufacturers, Retailers and Restaurants notes that the application of prevention strategies to reduce food waste is utilized less than donation or recycling despite its significant cost and environmental advantages.*

3 *USEPA Waste Hierarchy ReFED (2016) "A Roadmap to Reduce U.S. Food Waste by 20 Percent"*

4 *ReFED (2016) "A Roadmap to Reduce U.S. Food Waste by 20 Percent"*

5 *The Rockefeller Foundation (2017) "Reducing Food Waste by Changing the Way Consumer Interact with Food"*

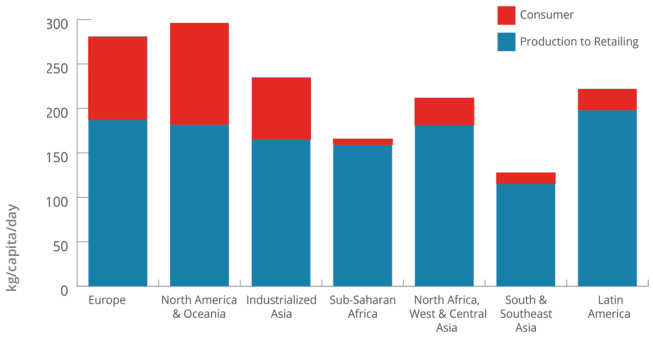
6 *PAC Food Waste (2017) "Who's Who of Food Waste Reduction Initiative"*

7 *ReFED (2016) "A Roadmap to Reduce U.S. Food Waste by 20 Percent"*

2. Exploring the Packaging and Food Waste Nexus

The causes of food waste differ significantly between high- and low-income countries. In high-income countries an estimated 30-40 percent of available food is wasted by consumers;[8,9,10] this is the loss of edible food (referred to as "food waste"). In low-income nations more food is lost in the stages between production and distribution, where food may have spoiled as a result of production and processing technologies (referred to as "food loss").

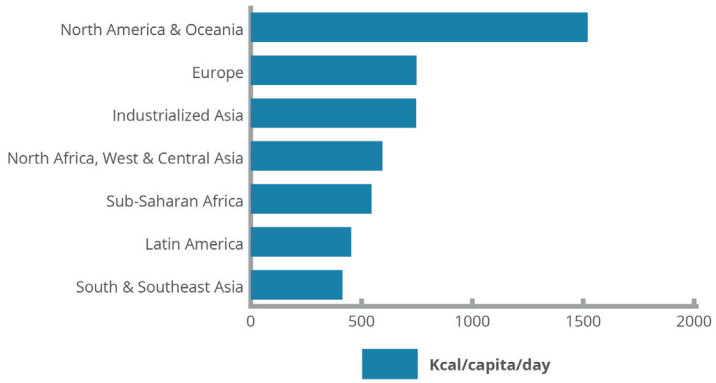
Figure 2.1: Per Capita Food Losses and Waste, at Consumption and Pre-Consumption Stages, in Different Regions (kg/capita/day)



Source: FAO (2011) Global Food Losses and Waste: Extent, Causes and Prevention

Figure 2.1 highlights the shift in waste by region. In Industrialized countries, food waste at the consumer level (~220 million tons) is almost as high as the total net food production in sub-Saharan Africa (~230 million) tons.[11] The NAO region (North America and Oceania) is noted as the greatest contributor of food waste, wasting almost double that of its peers in industrial Asia and nearly one third more than peers in Europe. The majority of this waste occurs at the consumer level.

Figure 2.2: Per Capita Food Loss and Waste by Region (kcal/capita/day), 2009



Source: WRI (2013) Reducing Food Loss and Waste

This discrepancy is even more significant when we assess volumes of food waste by caloric context as seen per Figure 2.2. Measuring by weight alone fails to provide insight into the potential environmental and health impacts of food waste; a ton of meat wasted is viewed as the equivalent of a ton of fruit waste, yet we know significantly more calories, resources and energy are generated from the production of meat over fruit. Again, on a per capita basis, the NAO region stands alone from all other regions, wasting almost double the number of calories of its closest peers.

Digging into food waste across America, ReFED, suggests over 80 percent occurs at the consumer level. Forty (40) percent occurs in restaurants, grocery stores and quick serve retail restaurants and 43 percent comes from households.[12] ReFED estimates this household wastage totals 76 billion pounds per year, however a separate US Department of Agriculture (USDA) analysis suggests it could be closer to 90 billion pounds. Using the USDA analysis this suggest Americans are throwing away

8 *Gustavsson, Jenny, Christel Cederberg, Ulf Sonesson, Robert van Otterdijk & Alexandre Meybeck (2011), "Global Food Losses and Food Waste: Extent, Causes & Prevention"*

9 *FAO Gunders, Dana (2017) "Wasted: How America is Losing up to 40 Percent of Its Food From Farm to Fork to Landfill"*

10 *ReFED (2016) "A Roadmap to Reduce U.S. Food Waste by 20 Percent"*

11 *Lipiniski B, Hanson, C. Lomax, J., Kitnoja L., Wate, R., Searchinger T., (2013) "Reducing Food Loss and Waste: Installment 2 of Creating a Sustainable Food Future" WRI Working Paper.*

12 *ReFED (2016) "A Roadmap to Reduce U.S. Food Waste by 20 Percent"*

nearly 21% of our national food supply.[13] This waste is extraneous when we consider one out of every eight of Americans are food insecure.[14]

Table 2.1. Net Greenhouse Gas Emissions for Food Waste Under Different Management Options

Food Waste Management Method	Metric Tons CO_{2e} per Short Ton of Food
Prevention (Assumes Food is Not Produced)	-3.66
Redistribution to People	-0.43
Anaerobic Digestion	-0.18
Composting	-0.05
Landfill	0.54

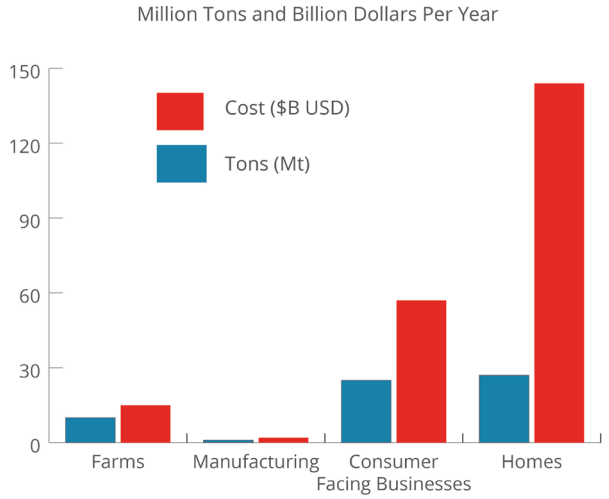
Source: NRDC (2017) "Wasted"

The challenge with wasting food, particularly when near the end of the value chain (i.e. restaurants or household), is the cumulative environmental and economic impacts that occur across the lifecycle. Production, harvesting, transportation, processing, consumption and disposal all contribute environmental impacts. When food is wasted we are also losing the embedded water, land, fertilizer and energy used to produce and manufacture it. Additionally, as it decomposes in landfills we add additional impacts from methane production as the result of decomposition. The further down the value chain food is wasted, the greater the cumulative impacts.

Shown in Table 2.1, preventing food waste in the first-place results in six times greater greenhouse gas (GHG) emissions savings than composting and seven times greater than anaerobic digestion.[15] Redistribution, while valuable, especially from a social perspective, still results in a greater cumulative environmental and economic impact than prevention in the first place.

Furthermore, food waste incurs economic costs across the supply chain. Several studies have suggested preventing food waste in the first place could reduce the cost of food by 10-20 percent.[16,17] Composting and anaerobic digestion require investment into new system development, transportation and education. Their return on investment is calculated to be less than that of prevention.[18] Economically, the further down the food chain we go, the less value food has on the open market as there is less opportunity to monetize it. By the time food gets to disposal, the only opportunity for monetization is through recovery and even that market is small.

Figure 2.3: Food Wasted by Sector, Volume and Cost



Source: Adapted from ReFED (2016)

13 *Buzby, Jean, Hodan F Wells & Jeffrey Hyman (2014) "The Estimated Amount, Value and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States" USDA Economic Research Service Economic Information Bulletin No EIB-121*

14 *United States Department of Agriculture. Economic Research Service (2017) "Food Security in the U.S.: 2016"*

15 *Buzby, Jean, Hodan F Wells & Jeffrey Hyman (2014) "The Estimated Amount, Value and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States" USDA Economic Research Service Economic Information Bulletin No EIB-121*

16 *Gooch, M., Dent, B., Felfel, A.S., Vanclief, L., Whitehead, P. (2016) "Food Waste: Aligning Government and Industry Within Value Chain Solutions"*

17 *Value Chain International RMIF (2002) "Cutting Costs—Adding Value in Red Meat" Red Meat Industry Forum; Food Chain Center, Institute of Grocery Distribution.*

18 *ReFED (2016) "A Roadmap to Reduce U.S. Food Waste by 20 Percent"*

Figure 2.3 compares total tonnage against the cost of food waste—clearly denoting the significant economic impact that occurs with wasting food further down the supply chain. Not only do households waste more, but doing so at this stage creates significant economic costs. It is estimated that this waste not only costs households an average of $1,800 a year,[19] but they also pay more in terms of disposal fees and energy—an estimated $1 billion nationally.[20] These costs are born by all residents through local taxes and increased costs.

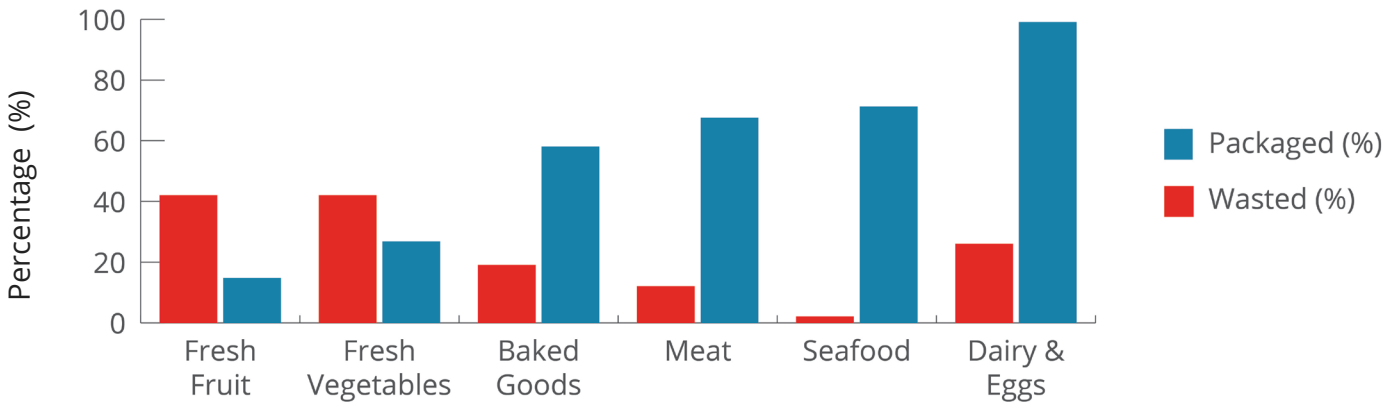
While much attention has focused on the costs of food waste, emerging research on prevention strategies suggests that targeting businesses and homes has the greatest return on investment for Americans. Packaging is cited as one of the top three strategies by ReFED[21] and by The Rockefeller Foundation.[22]

For America the data is clear: We need to place our emphasis on reducing food waste at the consumer level. Prevention of that waste will do more to reduce our environmental and economic impacts than management at end of life.

3. Exploring the Value of Packaging in Preventing Food Waste

When we examine food waste against packaging rates, a strong correlation occurs between the foods with the highest percentage of wastage and the least amount of packaging. According to ReFED, preserved foods such as canned goods, shelf stable and dried foods tend to have the least amount of food waste.[23] To further explore this theory we examined the rates of packaging against the rates of food waste (Figure 3.1). With the exception of dairy and eggs, there appears to be a strong correlation between the foods most frequently wasted and those with the least amount of packaging. Before we draw definitive conclusions, we note that a variety of variables may play into this. Fruits and vegetables are typically less expensive than meats and seafoods which is likely to play a significant role in consumer behavior. Packaging costs are higher for fruits and vegetables than meats and seafoods when broken down into costs per unit. Additionally, we recognize that fruits and vegetables tend to have natural protection barriers such as peels and skins which most consumers view as natural "packaging."

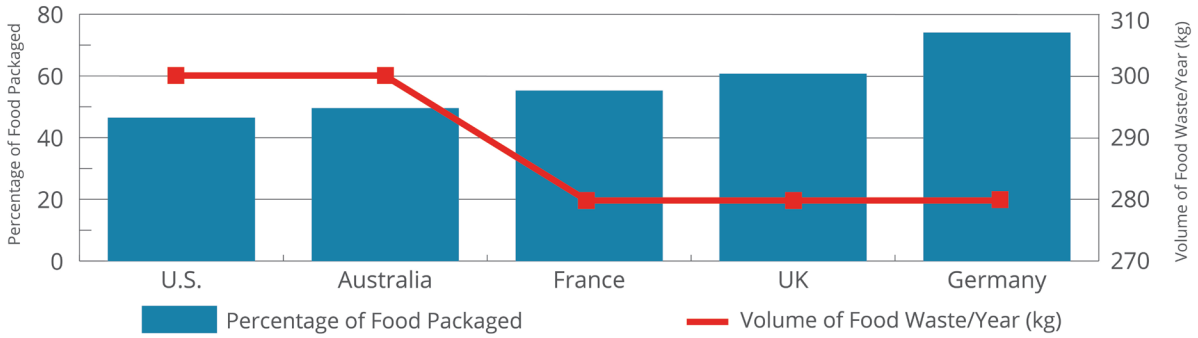
Figure 3.1 US Fresh Food Sales: Percentage Sold Packaged vs Wasted (%)



Adapted: Euromonitor International, 2017 & ReFED 2016

19 *Gunders, Dana (2017) "Wasted: How America is Losing up to 40 Percent of Its Food From Farm to Fork to Landfill"*
20 *Vogliano, Chris & Katie Brown (2016) "The State of America's Wasted Food & Opportunities to Make a Difference."*
21 *ReFED (2016) "A Roadmap to Reduce U.S. Food Waste by 20 Percent."*
22 *The Rockefeller Foundation (2017) "Reducing Food Waste by Changing the Way Consumer Interact with Food"*
23 *ReFED (2016) "A Roadmap to Reduce U.S. Food Waste by 20 Percent."*

Figure 3.2 Fresh Food Sales: Percentage Sold Packaged vs Wasted for Various Countries



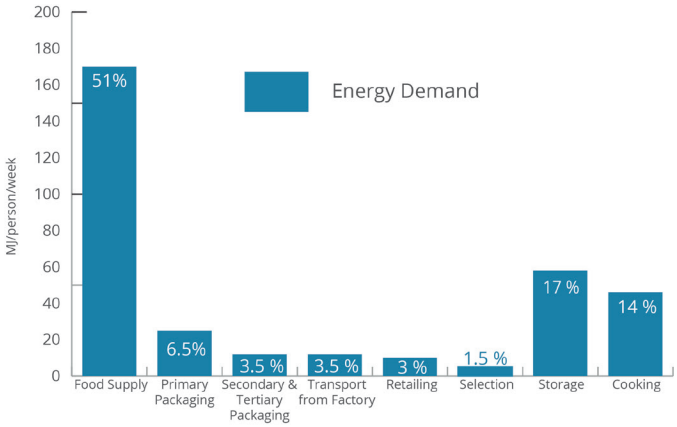
Adapted: Euromonitor International, 2017 & ReFED 2016

When we compare results for various countries, the correlation between food waste and packaging becomes even more significant (Figure 3.2). The two regions with the highest rate of food waste also had the lowest percentages of food packaged. This data further illustrates a correlation with packaging, but we recognize additional variables such as purchasing patterns, light-weighting, regulation, social norms and product needs may influence the volume of packaging sold. Nonetheless, we believe the correlation suggests a hypothesis which warrants further exploration through more extensive data collection and analysis.

3.2 Consumers' Perceptions of Packaging's Role in Reducing Food Waste

Because food packaging is often single use, it is widely perceived as a negative externality and not an environmental solution for many consumers. Consumers widely share a belief that unpackaged food is fresher and more nutritious than packaged products,[24,25] and nine in ten consumers believe that packaging is worse for the environment than discarded food.[26] In one of the first studies of its kind, INCPEN assessed the environmental impact of food consumption at each stage across the food supply chain. Results were reported based upon one person's cumulative energy consumption over the course of a week. Across all food types, the study revealed that primary, secondary, and tertiary packaging represents only 10 percent of the cumulative energy demand associated with producing food for consumption, less than production, storage or cooking. If this study had accounted for food waste, it would have demonstrated that discarded food wastes not only the food, but the resources to produce, transport, package and store that food. This disconnect between environmental impact and consumers' perception is significant and may be a key challenge to address in order to promote the value of packaging as a food waste prevention strategy.

Figure 3.3: Energy for One Person's Weekly Consumption of Food (MJ Demand/person/week)



Source: INCPEN Table for One (2009)

24 *Sealed Air (2015) "Taking Stock: Retail Shrink Solutions" Haspel, Tamar (2017)*

25 *"We Think Fresh is Best. But to Fight Food Waste, We Need to Think Again." Washington Post Feb 16, 2017*

26 *Sealed Air (2015) "Taking Stock: Retail Shrink Solutions"*

Further analysis into the use of packaging as a valued strategy in the fight against food waste suggests that packaging is an efficient means to protect food that has a significantly higher environmental footprint. To illustrate this point, Table 3.1 compares the environmental impact of food to the impact of primary packaging for several food types, expressed as the ratio of GHG emissions of food to the GHG emissions of the primary packaging used to protect it. Results clearly demonstrate that the environmental impact of primary packaging is significantly smaller than that of the food; hence, by preventing food waste, the packaging can reduce the overall environmental impact of the food value chain.

Table 3.1: Typical Examples of GHG Emissions Ratios of Food to Packaging (CO_{2e})

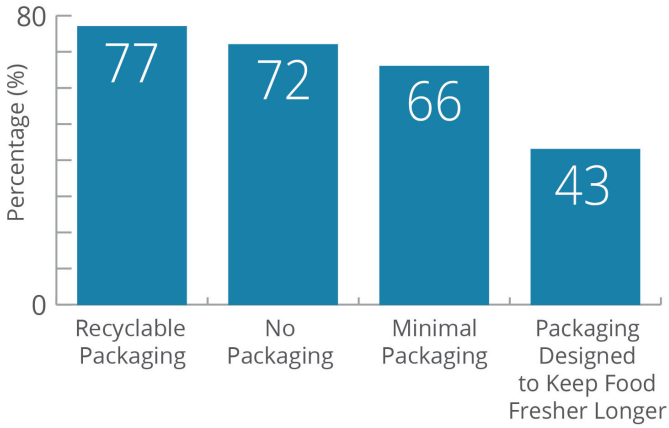
Food Item	GHG Emissions Ratio: Food to Packaging
Ham (cooked)	624:1
Beef	370:1
Cucumber	178:1
Whole Chicken	114:1
Cheese	52:1
Fish	13:1
Pasta	7:1

Source: Sealed Air, Internal Life Cycle Study 2017

The above data illustrates the enormity of opportunities that exist to significantly improve resource use through packaging innovation, resulting in a more sustainable food system.

In spite of this data, when asked to explore the most desired sustainable packaging attributes, consumers failed to note the value of packaging in reducing food waste as a significant environmental indicator (see Figure 3.4). Rather, consumers typically perceive that less packaging is better for the environment than packaging that can reduce the amount of food that they waste.

Figure 3.4: Consumer Perceptions: Attributes Which Define Sustainable Packaging (%)



Source Sealed Air (2015) "Taking Stock: Retail Shrink Solutions"

While consumers are quick to devalue the role packaging can play in reducing food waste, when presented with information on the value of packaging in reducing food waste almost a quarter of them will shift their purchasing decisions towards the package promoting extended value.[27] This suggests we can do more to educate consumers on the role packaging can play in reducing food waste and its associated costs. Having quantifiable data on where packaging could be optimized and how best to communicate that value, might help simplify consumer campaign efforts to reduce food waste.

4. Food Packaging Within Retail and Households

While we understand consumers contribute significantly to food waste, what we're still trying to evaluate is how much of that waste is preventable and the reasons for it.

4.1 The Value of Packaging in Reducing Retail Food Waste

Retailers, due to the nature of business, provide significant insight into the opportunities for packaging to reduce waste at the retail level. A 2010 study of grocery

27 Sealed Air (2015) "Taking Stock: Retail Shrink Solutions"

stores noted that 10-15 percent of revenue is lost due to spoilage, age dating, *package damage* and markdowns.[28] Retailers are increasingly seeing the reduction of food waste as an effective cost-saving strategy—equal or greater to investments into labor, energy or theft prevention.[29] Fully 56 percent of those surveyed identified shelf life as a key attribute when evaluating new products, yet only 27 percent of those retailers felt their companies would pay more for packaging upgrades that would extend shelf life anywhere from two to five days.[30] Furthermore, one additional day of shelf life can equate to five percent of avoidable food waste.[31] This suggests that initiatives to increase shelf life are not only cost effective but may have a significant impact on waste reduction and environmental impact.

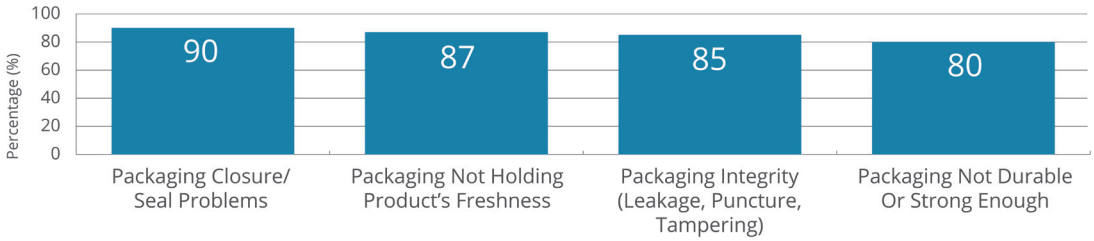
While much attention has focused on shifting packaging to new technologies or packaging previously unpackaged materials, we note there is still significant opportunity to reduce spoilage and extend shelf life through minor shifts in design. When evaluating the causes for retail shrink (i.e. food losses at the store), packaging damage was identified as the second greatest cause.[32] Identifying where packages are most frequently damaged and why would help target optimization strategies and suggest an immediate return on investment. Figure 4.1 helps us identify the most frequently identified packaging failures found by retailers.

Sealability and closure challenges, leakage, puncturing and durability are all easy solutions which could be addressed through minor design shifts.

4.2 The Value of Packaging in Reducing Household Food Waste

While many food waste studies provide insight into the types and volumes of waste from the household, less have explored the rationale for waste. Understanding why food waste occurs could offer valuable insight into intervention areas. We found only one study that explicitly explored the consumer relationship between food and packaging.[33] The authors note that a third of food waste came from cooked meals (leftovers) and two thirds came from storage. While packaging was identified in some cases as a reason for waste, the authors also noted that packaging was never identified unless consumers noticed a direct inconvenience. The absence of a package, for example, was not observed as a problem by consumers. Based on the responses, the authors estimated that a conservative 20-25 percent of household food waste could be reduced through optimized packaging. With more education and more specific questions related to packaging's role, this

Figure 4.1: Packaging Failures Most Cited in Retail Environments (% Identified as an Issue by Retailers)



Source: Sealed Air (2015) Taking Stock: Retail Shrink Solutions

28 *BSR "Food Waste Tier 1 Assessment" for GMA/FMI*

29 *Sealed Air (2015) "Taking Stock: Retail Shrink Solutions"*

30 *Ibid*

31 *Ibid*

32 *Sealed Air (2015) "Taking Stock: Retail Shrink Solutions"*

33 *Williams, Helen; Wikstrom,Fredrick; Otterbring, Tobias; Lofgren, Martin & Gustaffson, Anders (2012) "Reasons for Household Food Waste With Special Attention to Packaging" Journal of Cleaner Production V24: 141-148.*

number could actually be higher. A separate study exploring the relationship of consumers to packaging suggests that nearly half of consumers were removing fresh food from packaging designed to extend storage.[34] Questions, such as how consumers utilize packaging in the home, were not explored in the aforementioned study, and thus inclusion in future studies could uncover more detail on the relationship between consumers and packaging and the role it could play in reducing household food waste.

5. Quantifying the Economic Costs of Utilizing Packaging as a Strategy to Reduce Food Waste

The reduction of food waste represents a clear financial opportunity for consumers, businesses and industry as a whole.[35] The cost of waste occurring along a value chain can exceed the combined margins of the involved companies. In retail for example, a one percent reduction in food waste (termed shrink) can translate to the equivalent of a four percent increase in revenue. Consumers pay for avoidable food waste in the form of 10 percent or more of prices paid, along with municipalities or states charging higher taxes to help cover the cost of organic disposal.[36,37] WRAP estimated that investment in changing production lines to extend the shelf life of foods typically pays off in two to three years.[38] The median monetary benefit that businesses captured through food waste reduction initiatives, including improved packaging, produces a 14-to-1 return on investment.[39] Every $1 in cost results in a benefit of $14 over a five-year period.

AMERIPEN, partnered with Value Chain Management International (VCMI) to extend the work of other reports and produce updated figures on the potential benefits that could be achieved by preventing the waste of several fresh food categories. Prior estimates of the role packaging can play in reducing US food waste appear remarkably conservative. While ReFED explored a cumulative 20 percent reduction in food waste through the application of 27 different strategies across the value chain, we have tried to assess the impact packaging alone could play in the areas of greatest waste (consumer facing businesses and households). To provide an indicative assessment of the potential impact of utilizing packaging to address US food waste, an anticipated reduction of 20 percent and 10 percent were applied to retail, foodservice and consumers. We based this assumption both on the percentages of food wasted against what is already packaged, as well as on William's et al. assessment that easily 20 percent of preventable household food waste could be avoided through better use of packaging.[40]

Annual reduction in waste would save households $17.02 billion, and retail and foodservice $3.87 and $9.69 billion dollars, respectively.

Shown below in Table 5.1, we considered a scenario of a 20 percent reduction in wasted fruits, vegetables and meat, along with a 10 percent reduction in wasted bakery, dairy and eggs. Under these scenarios we calculated total fresh food savings of 7.68 million tons with a value of $30.58 billion dollars. Monetarily, this reduction in waste would save households $17.02 billion, and retail and foodservice $3.87 and $9.69 billion, respectively. Household savings alone is equivalent to the median income of 305,000 US homes.[41]

34 *Sealed Air (2015) "Taking Stock: Retail Shrink Solutions"*

35 *Hanson C. & Mitchell P. (2017) The Business Case for Reducing Food Loss and Waste. Champions 12.3*

36 *ReFED (2016) "A Roadmap to Reduce U.S. Food Waste by 20 Percent."*

37 *Gooch, M., Dent, B., Felfel, A.S., Vanclief, L., Whitehead, P. (2016) "Food Waste: Aligning Government and Industry Within Value Chain Solutions". Value Chain Management International.*

38 *WRAP (2015) "Reducing Food Waste by Extending Product Life"*

39 *Hanson C. & Mitchell P. (2017) The Business Case for Reducing Food Loss and Waste. Champions 12.3*

40 *Williams, Helen; Wikstrom,Fredrick; Otterbring, Tobias; Lofgren, Martin & Gustaffson, Anders (2012) "Reasons for Household Food Waste With Special Attention to Packaging" Journal of Cleaner Production V24: 141-148.*

41 *Based on 2015 median income of $55,775.*

Table 5.1: Reductions in US Food Waste Estimated by Value ($ Billion) and Volume (Million Tons)

Food waste (FW) by market segments	FW Retail		FW Foodservice		FW Household		Total	
	$ Value	Volume	$ Value	Volume	$ Value	Volume	$ Value	Volume
Fruit and Vegetables	1.35	0.52	2.88	1.11	4.76	1.84	8.99	3.47
Bread and Bakery	0.65	0.19	1.07	0.32	1.55	0.47	3.28	0.98
Dairy and Eggs	0.62	0.27	1.12	0.49	1.72	0.75	3.46	1.52
Meat	1.26	0.15	4.61	0.53	8.98	1.04	14.86	1.72
TOTAL	**$ 3.87**	**1.13**	**$ 9.69**	**2.46**	**$ 17.02**	**4.09**	**$ 30.58**	**7.68**

Original AMERIPEN Study conducted in 2017 with VCMI

The conservative nature of the monetary estimates is underlined by two further points. First, the foodservice-related benefits captured by reducing food waste from packaging optimization was based on retail values, which is likely a moderate proxy for the real value of food waste occurring in foodservice (see section 2.2). Second, the estimates do not include additional costs associated with food waste (see section 4.1). In retail and foodservice, associated costs include transaction costs and lost revenue, along with disposal costs. Disposal costs are also incurred from consumer-generated waste, often charged in the form of municipal solid waste taxes.

6. Opportunities to Improve Packaging to Reduce Food Waste

To better understand opportunities to utilize packaging as a strategy to reduce consumer food waste, AMERIPEN engaged VCMI to conduct an additional survey of industry professionals to identify the most effective ways packaging could drive a reduction in food waste. Forty-five packaging experts across the value chain (manufacturers, converters, retailers, technical association staff and environmental non-profits working on packaging) were asked to identify, and list in order of priority, from a defined list of packaging strategies and attributes, what they felt would result in the greatest reduction of food waste. Quantitative data was analyzed to calculate median scores. Median scores were used because they show the middle response, thereby preventing any overly optimistic (or pessimistic) responses to bias the research findings.

As with any strategy initiative, identifying the goal and best approach to achievement is necessary to uncover the specific actions needed to reach success. Rather than simply argue that new technologies or optimization is needed, we wanted to dive deeper into the strategies and opportunities explored by industry against how these compare to what we are seeing identified as priorities by consumers and retailers. In terms of directing a packaging strategy to reduce food waste, designing packaging with the objective of increasing shelf life topped the list in terms of perceived effectiveness. In contrast, retailers suggest decreased damage, including leakage and spillage, remain their top priority[42] and consumers note portion control as a primary strategy through which packaging could reduce waste.[43,44]

In Figure 6.1 all 45 respondents identified shelf life as a priority strategy. The other three categories were identified as effective but with less priority than extending shelf life. We note, in follow-up interviews held with some respondents, decreasing damage

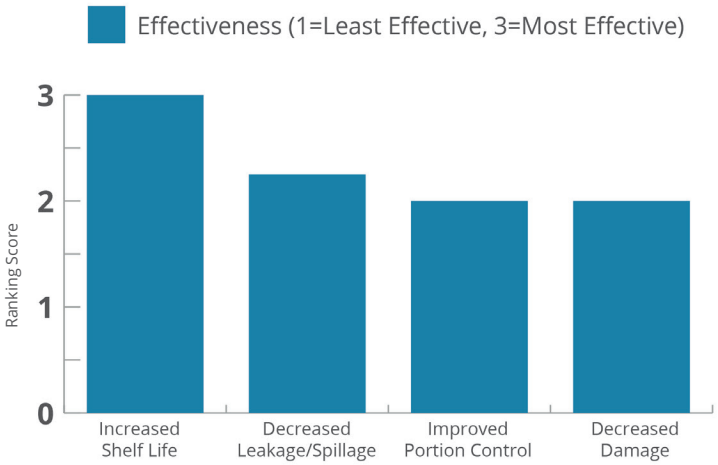
42 *Sealed Air (2015) "Taking Stock: Retail Shrink Solutions"*

43 *Neff, RA, Spiker, ML, Truant PL. (2015) "Wasted Food: US Consumers' Reported Awareness, Attitudes, and Behaviors."*

44 *PLoS ONE WRAP (2015) "Reducing Food Waste by Extending Product Life"*

was ranked as the least effective only because it was commonly felt packaging's primary role for product protection meant designers felt the majority of existing packaging was already serving this objective.

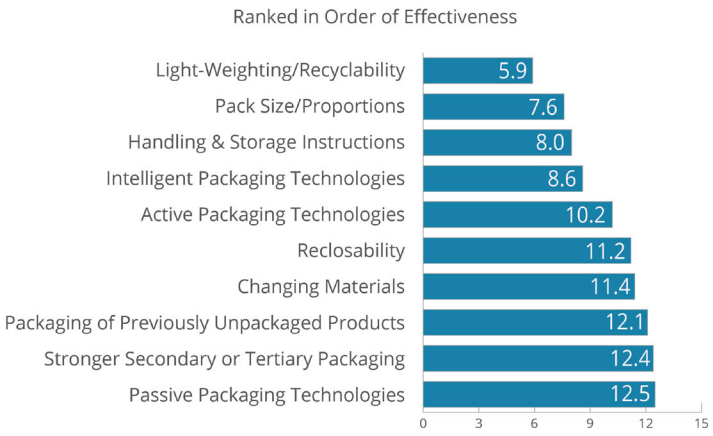
Figure 6.1: Voice of the Industry Matrix: Best Packaging Strategies to Reduce Food Waste



Source: Original AMERIPEN Study conducted in 2017 with VCMI

Packaging attributes are the specific technologies and design aspects applied to a package which reflect the package parameters. With the idea that food waste reduction was a primary objective of the package design, and the extension of shelf life was a top strategy through which packaging could drive prevention efforts, respondents identified passive packaging technologies such as modified atmosphere packaging (the use or removal of gases to serve as a barrier to spoilage) as the top attribute. This was followed closely by packaging products which may not currently be packaged (i.e. fresh produce). When we consider the attributes which rose to the top, they link closely with the strategic objective of increased shelf life.

Figure 6.2: Voice of Industry Matrix: Best Attributes to Apply to Packaging to Reduce Food Waste (Ranking Scale)



Source: Original AMERIPEN Study conducted with 2017 by VCMI

While industry appears focused on efforts to extend food shelf life through packaging optimization, consumers are focused on how they use packaging, citing portion size as the best opportunity for packaging to reduce food waste. As shown in Figure 6.2, portion sizing ranks near the bottom of opportunities by industry. Another interesting finding is the low rank by industry for handling and storage instructions and yet studies have shown consumers will shift purchasing patterns if the package promotes its advantage in reducing food waste.[45,46]

We believe these discrepancies between consumers and industry point to different perspectives. It is likely that industry is inclined to see increased packaging ratios relative to cumulative impact, thus placing a greater emphasis on the role of packaging in preventing food waste. We also note that the closer relationship between manufacturers and retailers would naturally place greater emphasis on retail strategies for food waste and potentially less on household strategies where we have less data on the relationship between consumers and packaging. Having a deeper analysis of consumers'

45 *Annuziata, Azzurra and Paola Pascale (2009) "Consumers' Behaviours and Attitudes Towards Healthy Food Products: The Case of Organic and Functional Foods."*

46 *Paper prepared for presentation at the 113th EAAE Seminar 'A Resilient European Food Industry and Food Chain in a Challenging*

relationship to packaging and food waste may significantly reduce this discrepancy in perception, thus uncovering some of the most effective ways packaging could offer value in the fight against food waste.

These findings also differ slightly from the packaging strategies focus outlined within the ReFED report. While our survey of industry experts identified passive technologies as the preferred approach to leverage packaging to reduce food waste, the ReFED study promotes the use of spoilage prevention measures such as active and intelligent packaging—packaging which either interacts directly with the product through chemical or biological agents to delay spoilage or interacts passively to provide visual indications when food begins to spoil. Further, ReFED estimates packaging adjustments such as optimizing packaging size and dispensing capability as priority opportunity to reduce waste. This aligns with consumer feedback but was identified by our industry respondents as a less effective approach.

Since packaging optimization will require investment, and insights from retailers suggest a hesitancy to invest in novel packaging formats, we believe there is a need for a deeper analysis to develop the business case for the financial benefits that retailers and consumers can realize by adopting new packaging forms, especially for food categories that are underpackaged today. Further analysis should focus on identifying what types of food are most wasted and the environmental and social impact of that waste. Additionally, we need to assess what formats of packaging would be the most effective in reducing waste as this is likely to differ depending on the food product. Understanding how consumers use and discard packaging will provide significant insight into the value of packaging in reducing wastes at the household level, while a deeper analysis into retail damage and shelf life needs will provide further insight into intervention opportunities prior to purchase by consumers. By understanding the financial and behavioral implications of using packaging to prevent food waste, we can develop a more robust business case for packaging, while also helping to improve communications on the benefits to consumers.

World" Chania, Crete, Greece Sept 3-6, 2009 - Sealed Air (2015) "Taking Stock: Retail Shrink Solutions"

7. Conclusion

The ability to reduce, even prevent food waste has enormous implications from financial, environmental and societal perspectives that could lead to significant benefits. The understanding and acceptance that packaging is a solution to food waste is quickly emerging yet there are still a number of negative perceptions of packaging as a core strategy. The results presented in this report quantify the opportunity and potential future directions needed. Key conclusions from the work conducted are:

1. Packaging is an Under-Utilized Solution that Could Significantly Reduce Food Waste

As we analyze food waste across America, we believe that prevention strategies have been under-utilized and of those strategies, packaging specifically has been undervalued. There are a number of fresh food categories that are underpackaged and, if packaging solutions were deployed with a goal to prevent food waste, significant food waste reductions could be achieved. At the store level, packaging is identified as a key solution to reduce nearly 10-15 percent of food waste. At the household level, packaging is promoted to reduce a conservative 20-25 percent of food waste

2. Additional Data is Needed to Demonstrate how Packaging Prevents Food Waste

Ultimately, a lack of robust data restricts our ability to quantify the potential of packaging to reduce food waste in America. Further studies exploring how consumers purchase, store and use food will help uncover more insights into consumers' relationships with packaging as a food waste prevention strategy. More education to inform consumers of the value of packaging in reducing food waste could have a significant impact on shifting behaviors, yet very little has been done to understand what messages would resonate and how best to communicate them. At the retail level, a deeper understanding of reasons for food waste, based on quantitative data not qualitative insights, would provide greater insight into the need for packaging as well as rates of, and where, package failures are occurring.

3. Increased Collaboration Between Industry and Government will be Key to Preventing Waste

We need to engage in a more robust discussion about packaging, between industry and policy-makers, with a goal to reduce the amount of food that consumers waste. The perception by some that packaging is an environmental waste challenge has resulted in pressure to avoid or transition away from technologies proven effective in reducing food waste. Packaging should not be viewed in isolation from the product it preserves and protects. Regulatory strategies aimed at reducing packaging may have unintended consequences leading to an unacceptable increase in food waste. By having open dialogue around strategies for simultaneously reducing packaging and food waste, industry and government can establish priorities to reduce overall impact. A proactive approach, which seeks to prevent food waste, while also considering managing resources and mitigating climate impacts, is needed.

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