Standardized Date Labeling Impact Framework Methodology

Measuring the impact of standardized date labels on consumer food waste and resulting greenhouse gas emissions reduction

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ReFED | Rethink Food Waste *Through Economics and Data*

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Historical Context

Over 40% of all U.S. food waste occurs in consumers' homes, where one of the driving factors of consumption is the date code printed on the food product. Current date labeling practices on food packaging cause confusion with "sell-by," "best-by," "use-by," and "best before" dates, leading up to 90% of Americans to occasionally throw out still-fresh food. Food waste caused by date labels equates to approximately $29 billion of wasted consumer spending each year — 5% to 10% of this is expected to be impacted by standardized date labels [1].

In addition to the challenging language on the package, the regulatory landscape across the U.S. is inconsistent and antagonistic to food waste reduction efforts. In the absence of a federal standard, individual states have developed a patchwork of regulations mandating certain labeling verbiage and practices on specific food products. Additionally, 19 states restrict sale of products after the date on the label has passed, even though the majority have no safety risk associated with the date [2].

ReFED's Roadmap highlights standardized date labeling as the highest impact solution based on economic value at $4,547 per ton. Additionally, standardizing date labels leads to 398,000 tons of food waste diverted and a reduction of over 1.5 Million tons of GHG emissions [1].

A significant amount of groundwork is laid for future work to accelerate standardization. In 2017, ReFED, along with over 40 industry experts, developed the Date Labeling Standardization Tool [3] – this tool is intended to help food businesses determine whether food products should receive a quality or safety based label. Also in 2017, the Food Marketing Institute (FMI) and Grocery Manufacturers Association (GMA) announced voluntary guidance on a two-code labeling system – "Best if Used By" as a quality-based label, and "Use By" as a safety or discard-based label [4]. This was followed later that year by a joint announcement between Champions 12.3 and the Consumer Goods Forum to apply a two-code system globally [5].

Since that time, retailers and food manufacturers have started making progress on label standardization, including Walmart's 2016 announcement to standardize date labels on private brand products, making them the first retailer to commit to standardization [6]. This methodology was developed to quantify the greenhouse gas (GHG) emissions reductions associated with the transition to standardized date labels, and aims to support food businesses in developing a business case for action, identifying risks and prioritizing solutions, and reporting total GHG emissions internally and externally. Ultimately, the measurements provided herein will increase accountability and accelerate progress on food waste reduction through standardized date labeling.

Formulas and Data Sources

Formulas

Weight of Food Waste Prevented =

$$\sum_{i=1}^{n} \begin{array}{c} Weight\ sold\ with\ standardized\ date\ labels\ (tons/year) \times \\ \%\ consumer\ waste \times \\ \%\ consumer\ waste\ due\ to\ past\ date\ labels \times \\ \%\ consumer\ waste\ reduction\ due\ to\ standardized\ date\ labeling \end{array}$$

Where i = products 1…n

Source Emissions Reduction =

$$\sum_{i=1}^{n} \begin{array}{c} Weight\ of\ food\ waste\ prevented\ (tons/year) \times \\ Greenhouse\ gas\ emissions\ for\ production\ (MTCO2e/ton) \end{array}$$

Where i = products 1…n

Disposal Emissions Reduction =

$$\sum_{i=1}^{n} \begin{array}{c} Weight\ of\ food\ waste\ prevented\ (tons/year) \times \\ \%\ of\ consumer\ waste\ disposed\ via\ destination\ \times \\ Greenhouse\ gas\ emissions\ for\ disposal\ (MTCO2e/ton) \end{array}$$

Where i = disposal destinations 1…n

Total Emissions Reduction = Source Emissions Reduction + Disposal Emission Reduction

Formulas (Simplified)

Weight of Food Waste Prevented =

$$\sum_{i=1}^{n} \begin{array}{c} Weight\ sold\ with\ standardized\ date\ labels\ (tons/year) \times \\ Tons\ of\ food\ waste\ prevented\ per\ ton\ sold\ with\ standardized\ labels\ (tons/ton) \end{array}$$

Where i = products 1…n

Total Emissions Reduction =

$$\sum_{i=1}^{n} \begin{array}{c} Weight\ sold\ with\ standardized\ date\ lables\ (tons/year) \times \\ Emissions\ reduced\ per\ ton\ sold\ with\ standardized\ labels\ (MTCO2e/ton) \end{array}$$

Where i = products 1…n

Data Sources

Factor	Definition	Source
FACTOR 1: Weight of Product Sold with Standardized Date Labeling	Product-level data, including: - Sales volume in tons, not including packaging weight - Product category	Manufacturer reported data
FACTOR 2: Percent Consumer Waste	Percent consumer waste occurring in the home for each food type	USDA ERS Loss-Adjusted Food Availability [7]
FACTOR 3: Percent Consumer Waste Due to Past Date Labels	Percent consumer home waste due to labels that are past the package date	NRDC Report: Estimating Quantities and Types of Food Waste at the City Level [8]
FACTOR 4: Percent Consumer Waste Reduced Due to Standardized Date Labeling	Percent of consumer waste reduced by transitioning to standardized date labels, accounting for original label verbiage and changes to label dates	Ohio State University Original Research (See Appendix C)
FACTOR 5: Percent Consumer Waste by Disposal Type	Breakdown of consumer food waste by disposal type	EPA Advancing Sustainable Materials Management Fact Sheet [9]
FACTOR 6: Greenhouse Gas (GHG) Emission Factor	GHG emissions associated with food product category production and disposal destination	EPA Waste Reduction Model (WARM) [10]

Methodology Factors

This section discusses each of the methodology factors, including definitions, sources, justification for inclusion, and measurement guidance. Reference the Appendix for all calculation tables specific to each factor, as well as the “Example Calculation” section for a sample step-by-step process.

FACTOR 1: WEIGHT OF PRODUCT SOLD WITH STANDARDIZED DATE LABELING

- Definition: Product-level data, including sales volume by product category in pounds (not including packaging weight)
- Source: Manufacturer reported data, retail sales systems or data providers

Factor 1 provides product parameters to measure the scope of impact, total food waste and GHG emissions factor through manufacturer self-reported data. This data can be collected from manufacturers, or pulled from retail sales systems or third-party data providers as available, understanding that the latter two sources, although perhaps easier to execute, may not have the most accurate or up-to-date product information. ReFED does not endorse or recommend any single source for collecting the data needed for this factor.

FACTOR 2: PERCENT CONSUMER WASTE

- Definition: Percent consumer waste occurring in the home, by food category
- Source: USDA ERS Loss-Adjusted Food Availability [7]

Factor 2 provides the total in-home consumer food waste of the product category identified by Factor 1. Although it is considered preliminary, the USDA ERS Loss-Adjusted Food Availability dataset is recognized as the most comprehensive and credible industry standard on U.S. consumer waste in the home to date. The percent consumer loss numbers (for over 200 commodities) include cooking losses and uneaten food while excluding inedible portions such as stems, cores, and peels. The underlying numbers were estimated via various methods including individual food discard diaries, trained observers examining garbage and plate waste, and research from published studies. Further information about this data source can be found on the USDA website.

FACTOR 3: PERCENT CONSUMER WASTE DUE TO LABELS THAT ARE PAST DATE

- Definition: Percent consumer home waste due to labels that are past the package date
- Source: NRDC Report: Estimating Quantities and Types of Food Waste at the City Level [8]

Factor 3 provides the percent of in-home consumer food waste from Factor 2 that is discarded specifically because the product is past the package date. These numbers are based on a three-city study (Nashville, Denver, and NYC) conducted by NRDC in 2017, based on more than 600 kitchen diaries, where participants documented the weight, type of food, and reason for discard of all food that was thrown away in the home for a week.

The numbers for this factor come from a survey question asking participants what they do with food products after the date provided on the packaging has passed, specifically those responding "throw it away" (See Image 2). Consequently, we recognize this factor may be conservative as there are likely respondents that still throw away food past the package date from other response groups (i.e. "smell or look at it", or "everything is eaten or frozen"). Limiting inclusion to those that respond "throw it away" ensures that the date label is the primary factor in decision making.

IMAGE 2: NRDC STUDY RESULTS TABLE [8]

Q22. MANY FOODS YOU PURCHASE ARE MARKED WITH A "USE BY," "SELL BY," OR "BEST BY" DATE. BY FOOD TYPE, WHAT DO YOU GENERALLY DO WITH FOODS AFTER THE DATE PROVIDED ON THE PACKAGING HAS PASSED? (CONT.)												
TOTAL	DON'T PAY ATTENTION TO DATE LABELS		THROW IT AWAY		SMELL OR LOOK AT IT TO DETERMINE IF IT IS STILL GOOD		EVERYTHING IS EATEN OR FROZEN BEFORE DATE ON PACKAGE		I DON'T CONSUME THIS TYPE OF FOOD		(BLANK)	
	#	%	#	%	#	%	#	%	#	%	#	%
MEAT & FISH	18	2%	177	24%	240	33%	222	31%	50	7%	19	3%
EGGS	125	17%	146	20%	230	32%	178	25%	28	4%	19	3%
MILK	11	2%	158	22%	380	52%	107	15%	54	7%	16	2%
BREAD	55	8%	101	14%	396	55%	132	18%	25	3%	17	2%
CHEESES	52	7%	123	17%	398	55%	101	14%	35	5%	17	2%
YOGURT & SOUR CREAM	22	3%	193	27%	363	50%	83	11%	48	7%	17	2%
FRUITS & VEGETABLES	53	7%	104	14%	464	64%	84	12%	2	0%	19	3%

FACTOR 4: PERCENT WASTE REDUCED DUE TO STANDARDIZED DATE LABELING

- Definition: Percent of consumer waste reduced by transitioning to standardized date labels, accounting for original label verbiage and changes to label dates
- Source: Ohio State University Original Research

Factor 4 takes the percent of consumer food waste by category (Factor 2) that is due to labels that are past the package date (Factor 3) and defines how much of that waste can be reduced through standardized date labeling. The waste reduced also accounts for the original date label verbiage and changes to label dates. For the purposes of this methodology, the *original* date label verbiage is defined as the verbiage being printed on products as of **July 1, 2016** as this is the estimated time when retailers and manufacturers started making progress on standardized date labeling. See Appendix C as well as the Example Calculation section for the data derived from this study and an example application.

When identifying data sources for this factor, we started with the existing industry standard – WRAP's Household Food & Drink Waste – A Product Focus [11]. By design, this study identified the percentage of UK consumers that feel confident they understand the meaning of different food dates; for example, results show that 96% of consumers feel "very" (37%) or "fairly" (59%) confident that they understand the meaning of date labels. We felt this source would overestimate the accuracy of consumer comprehension and, consequently, behavior, such as disposal or consumption.

Consequently, this methodology incorporates data from a new study developed in partnership with Walmart, Inc. and World Wildlife Fund, and led by Ohio State University, specifically quantifying consumers' comprehension and resulting behavior as a result of standardized date labels. The study measured perceptions and behaviors across five product categories with and without standardized date label phrasing. The five product categories were chosen as proxies to represent a total store assortment.

In calculating and using this factor, there are a few key considerations:

1. **Original Date Label Verbiage -** The impact of standardization depends on the original date label verbiage on the package. See Table 1 below for a summary of date label types and examples.

Table 1: Date Label Verbiage Categories

Label Type	"Sell By Dates"	"Quality Dates"	"Discard Dates"	"Date Only"	"No Label"
Labels Included in OSU Study	*Sell By*	*Best Before* *Best if Used By*	*Use By* *Expires On*	*(date only, no verbiage)*	*(no date, no verbiage)*
Other Qualifying Labels not Included in OSU Study	*Packed On* *Baked On*	*Best By* *Better If Used By* *Better if Used Before* *Best When Used By* *Guaranteed Fresh if Used By* *Guaranteed Delicious if Used By* *Best Flavor By*	*Use or Freeze By* *Enjoy By* *Expires By*	*N/A*	*N/A*

2. **Sell-by Dates -** When considering the full impact of standardized date labeling, it is important to analyze the implications of certain language and date combinations and the resulting consumer behavior change. For example, consider a fresh chicken product with the label "Sell By Sept 1, 2018" - if the date label verbiage is standardized, but the date is not changed ("Best if Used By Sept 1, 2018"), there is data to show that this could actually slightly increase consumer food waste as most consumers view the quality of the product to be at full maturity on September 1st, when this date was originally intended to guide store operators on inventory management. Consequently, we strongly encourage all products transitioning from a "Sell By" (or equivalent) date to a standardized date to also change the date to communicate the extended shelf life post-purchase.
3. **Consumer Education -** The research conducted with Ohio State University was scoped to measure the implications of consumer education on perceptions and behavior. However, to date there is no coordinated or widespread industry efforts to educate consumers on date labels, and we believe this methodology should reflect the actual state of industry. Consequently, in calculating and measuring GHG impact, we strongly encourage reporting companies to not include the impacts of education at this time. Once industry and individual food businesses start to take on the challenge of consumer education, likely over the next year, and it can be demonstrated that U.S. consumers understand what the standardized labels mean, we highly recommend including this variable in the methodology.

FACTOR 5: BREAKDOWN OF CONSUMER FOOD WASTE BY DISPOSAL TYPE

- Definition: Percent consumer waste disposed via landfill, incineration, composting, etc.
- Source: EPA Advancing Sustainable Materials Management Fact Sheet [9]

Factor 5 provides the percentage breakdown of consumer food waste disposed via landfill, incineration, composting, etc. EPA's Advancing Sustainable Materials Management 2015 Fact Sheet is widely recognized as the best U.S.-wide estimation of municipal waste, broken down by weight and material type (including food). ReFED converted the weight numbers from this study into a percentage breakdown by disposal type (see Appendix D).

According to the EPA's methodology for this fact sheet, the food waste weight by disposal type numbers were "estimated using factors based on data from sampling studies in various parts of the country in combination with demographic data on population, grocery store sales, restaurant sales, numbers of employees, and numbers of students, patients, and prisoners in institutions." [12]

One limitation of this dataset for the purposes of this methodology is that it includes commercial, institutional, and residential waste. Residential numbers may be skewed by the commercial and institutional waste streams. Also, this dataset does not include an estimate of waste that is fed to animals, anaerobically digested or disposed via sewer. Consumer waste fed to animals and anaerobically digested is negligible. However, consumers may dispose up to 16% of food waste down the drain [8], so this is an unaccounted for limitation at this time. As new and improved data sources become available, ReFED will continue to update this methodology accordingly.

FACTOR 6: GHG EMISSION FACTOR

- Definition: GHG emissions associated with food product category production and disposal destination
- Source: EPA Waste Reduction Model (WARM) [10]

Factor 6 provides the GHG emissions factors associated with the production and disposal method of different food types (See Appendix E for a list of emissions factors). EPA's Waste Reduction Model (WARM) tool is widely recognized and used as a defensible industry standard and is best suited to quantify Factor 6. The WARM tool does have important limitations. There is a need to expand food categories and disposal types in the existing methodology. For example, food categories currently include "poultry", and do not differentiate between fresh and frozen categories. Additionally, current disposal destinations do not include animal feed or sewer disposal. We highlight these specific limitations as a priority for future research, but do not see them as impeding current uses and needs of this methodology.

Consistent with past methodologies, including those used in the *Roadmap to Reduce U.S. Food Waste by 20 Percent*, ReFED recommends attributing 100% of the EPA WARM source reduction, or production, emissions to each pound of food waste prevented.

Current research has confirmed that consumer food waste reduction may lead to reduced consumer purchasing in terms of weight, validating the inclusion of source reduction emissions [11] [13]. However, the WRAP study provides evidence of consumers spending all or a portion of this savings on "trading up" to higher priced items so that the overall dollar spend remains fairly consistent, while the weight of food purchased decreases. More research is needed to fully understand and quantify the effects that reduced consumer food waste will have on the weight and value of consumer food purchasing, and impacts on upstream production and food waste rates. Until then, ReFED recommends assuming a one-to-one ratio of food waste reduction weight and upstream source reduction and emissions reductions realized.

Example Calculation

Inputs

- Product type: Spoonable yogurt
- # units sold: 5,000,000
- Lbs per unit: 1
- Prior date label text (being printed on products as of July 1, 2016): SELL BY
- Current date label text (being printed on products today): BEST IF USED BY (standardized label)
- Prior package date (as of July 1, 2016): 11 days after manufacturing print date
- Current package date (as of today): 14 days after manufacturing print date

Assumptions

Assumption		**Value**	**Rationale**
FACTOR 2 Percent Consumer Waste		21%	Proxy USDA category: Refrigerated yogurt See Appendix A for more information on where to find this data.
FACTOR 3 Percent Consumer Waste Due to Past Date Labels		27%	Proxy NRDC category: Yogurt & sour cream See Appendix B for data table
FACTOR 5 Percent Consumer Waste by Destination	Landfill	76.14%	See Appendix D for more information on how these percentages were calculated.
	Combustion	18.58%	
	Compost	5.29%	
FACTOR 6 GHG Emission Factors for Food Waste by Destination (MTCO2e / ton of food waste)	Source Reduction (Upstream)	-1.743017188	Proxy EPA category: Dairy See Appendix E for emissions factors
	Landfill	0.54323160	
	Combustion	-0.141128341	
	Compost	-0.17601202	

Calculations

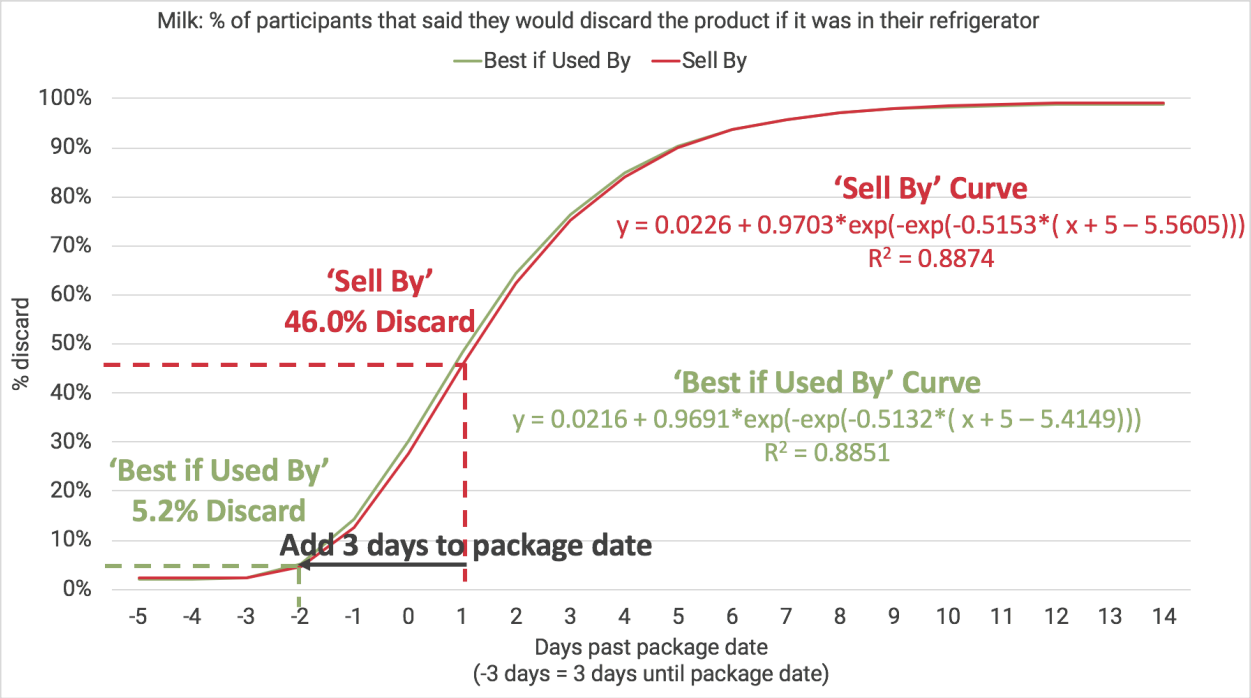
Tons Sold with Standardized Labels (FACTOR 1)

= # units sold with standardized labels * lbs per unit / 2,000 lbs per ton
= 5,000,000 units * 1 lb per unit / 2,000 lbs per ton
= **2,500 tons**

Percent Consumer Waste Reduced Due to Standardized Date Labeling (FACTOR 4)

FACTOR 4 is a function of product type, prior and current date label text, and the # of days added to the package date:

- Proxy OSU category: Milk
- Prior and current date label text: SELL BY --> BEST IF USED BY
- # of days added to package date = 14 days - 11 days = 3 days



% discard for yogurt, SELL BY, 1 day past package date

= 0.0226 + 0.9703*exp(-exp(-0.5153*(x + 5 – 5.5605))), where x = 1 day past package date
= **45.97%**

% discard for yogurt, BEST IF USED BY, 3 days added to package date

= 0.0216 + 0.9691*exp(-exp(-0.5132*(x + 5 – 5.4149))), where x = -2 days past package date
= **5.23%**

% less likely to discard

= (45.97% - 5.23%) / 45.97%
= **88.63%**

Tons of food waste reduced due to standardized date labels

= Tons sold with standardized labels *
  % Consumer waste *
  % Consumer waste due to past date labels *
  % Waste reduced due to standardized labels *

= 2,500 tons sold with standardized labels *
  21% of yogurt wasted by consumers *
  27% of consumer yogurt waste due to past date labels *
  88.63% reduction in waste when moving from SELL BY to BEST IF USED BY for yogurt and adding 3 days to package date
= **126 tons of food waste reduced**

Upstream GHG Emissions Reduction

= Tons of food waste reduced *
  -1 ton of food produced / ton of food waste reduced *
  GHG emissions factor for source reduction of <insert food type>

= 126 tons of food waste reduced *
  -1 ton of food produced / ton of food waste reduced *
  -1.743017188 MT CO2e / ton of dairy source reduction

= **219 MTCO2e**

Downstream GHG Emissions Reduction

= Tons of food waste reduced *
  % of consumer waste that would have been <insert destination> *
  GHG emissions factor for <insert destination>

Landfill:
= 126 tons of food waste reduced *
  76.14% that would have been landfilled *
  0.543231608 MTCO2e / ton of food waste landfilled
= **51.97 MTCO2e**

Combustion:
= 126 tons of food waste reduced *
  18.58% that would have been combusted *
  -0.141128341 MTCO2e / ton of food waste combusted
= **-3.29 MTCO2e**

Compost:
= 126 tons of food waste reduced *
  5.29% that would have been combusted *
  -0.17601202 MTCO2e / ton of food waste combusted
= **-1.17 MTCO2e**

Total Downstream GHG Emissions Reduction:
= Emissions reduction from Landfill + Combustion + Compost
= 51.97 MTCO2e + -3.29 MTCO2e + -1.17 MTCO2e
= **47.5 MTCO2e reduced due to standardized labels**

Total GHG Emissions Reduction

= Upstream GHG Emissions Reduction + Downstream GHG Emissions Reduction
= 219 MTCO2e + 47.5 MTCO2e
= 267 MTCO2e Total GHG Emissions Reduction

Example Calculation (Simplified)

The following calculation is based on the same example scenario starting on page 11. Note that the results from this methodology arrive at the same numbers calculated in the more complex Example Calculation starting on page 10, but the calculations are simplified by using precalculated factors from Appendix F.

Inputs

- Product type: Spoonable yogurt
- # units sold: 5,000,000
- Lbs per unit: 1
- Prior date label text (being printed on products as of July 1, 2016): SELL BY
- Current date label text (being printed on products today): BEST IF USED BY (standardized label)
- Prior package date (as of July 1, 2016): 11 days after manufacturing print date
- Current package date (as of today): 14 days after manufacturing print date

Assumptions

Assumption	**Value**	**Rationale**
FOOD WASTE FACTOR Tons of Food Waste Reduced per Ton of Food Sold with Standardized Labels	0.050258360	Proxy ReFED subcategory: Yogurt Previous verbiage: SELL BY Current verbiage: BEST IF USED BY # Days added to package date: 3 See Appendix F for information on where to obtain these factors.
GHG FACTOR MTCO2e per Ton of Food Sold with Standardized Labels	0.106603481	

Calculations

Tons of food waste reduced due to standardized date labels

= Tons sold with standardized labels * Tons food waste reduced per ton sold with standardized labels
= 5,000,000 units * 1 lb per unit / 2,000 lbs per ton * 0.050258360
= **126 Tons of food waste reduced**

Total GHG Emissions Reduction

= Tons sold with standardized labels * MTCO2e per ton sold with standardized labels
= 5,000,000 units * 1 lb per unit / 2,000 lbs per ton * 0.106603481
= 267 MTCO2e GHG Emissions Reduction

Limitations of the Methodology

Although based on the most current and widely accepted data currently available, this methodology still measures the impact of initiatives and behaviors that are largely unstudied in the world of food sustainability. With that in mind, a few specific limitations are accounted for here, although there are likely others. We recommend continued analysis of the methodology and updates as new and improved data becomes available.

1. **Consumer Decision-Making** - a significant gap in current consumer data is at what point consumers make a decision regarding consumption or discard based on date labels; for example, on the day of the package date compared to “x” days after the package date. Furthermore, this behavior is likely highly variant by product type and consumer. For the sake of this methodology and consistency in making data calculations, we’ve made the assumption that the point of decision is one day past the package date.
2. **Consumer Behavior** - as with all studies and metrics used measuring consumer behavior, we cannot account for key decisions made by consumers post-purchase that may affect product quality. This would include behaviors such as product storage, how long groceries are left in a hot vehicle, etc. These behaviors may impact product quality and invalidate the need of or use for date labels to determine consumption or discard decisions.
3. **Standardized Date Label Definition** - for the sake of this methodology, a date label is considered standardized if it is either “Best if Used By” or “Use By”, and does not differentiate between products that should have a quality (“Best if Used By”) or discard (“Use By”) date. We encourage retailers and manufacturers to reference ReFED’s Date Labeling Standardization Tool [3] to determine which products should receive which label.

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Appendix

Appendix A: Data for FACTOR 2 - Percent Consumer Waste

The USDA ERS Loss-Adjusted Food Availability data tables were too large to include in this methodology, but can be downloaded from the USDA website [7]. Note that the percentages used for this methodology are the “Percent Loss at the Consumer Level, Other (cooking loss and uneaten food)” numbers for the most recent data year.

Appendix B: Data for FACTOR 3 - Percent Consumer Waste Due to Labels that are Past Date

This data was obtained from Table 20 on page 28 of NRDC’s report, “Estimating Quantities and Types of Food Waste at the City Level” [8].

NRDC Food Category	**% of people that throw food away when it is past the package date**
Meat & Fish	24%
Eggs	20%
Milk	22%
Bread	14%
Cheese	17%
Yogurt & Sour Cream	27%
Fruits & Veg	14%

Appendix C: Data for FACTOR 4 - Percent Waste Reduced Due to Standardized Date Labeling

In December 2018, Ohio State University conducted a nation-wide, online survey to quantify consumer discard behavior in response to different date label verbiages and package dates for five food products (milk, clamshell lettuce, fresh chicken, bread, and cereal). In addition to testing consumer response to various date label verbiages and package dates, the study also quantified the impact of education by exposing some groups of participants to education information about what the standardized labels mean and how the package dates are determined before taking the survey.

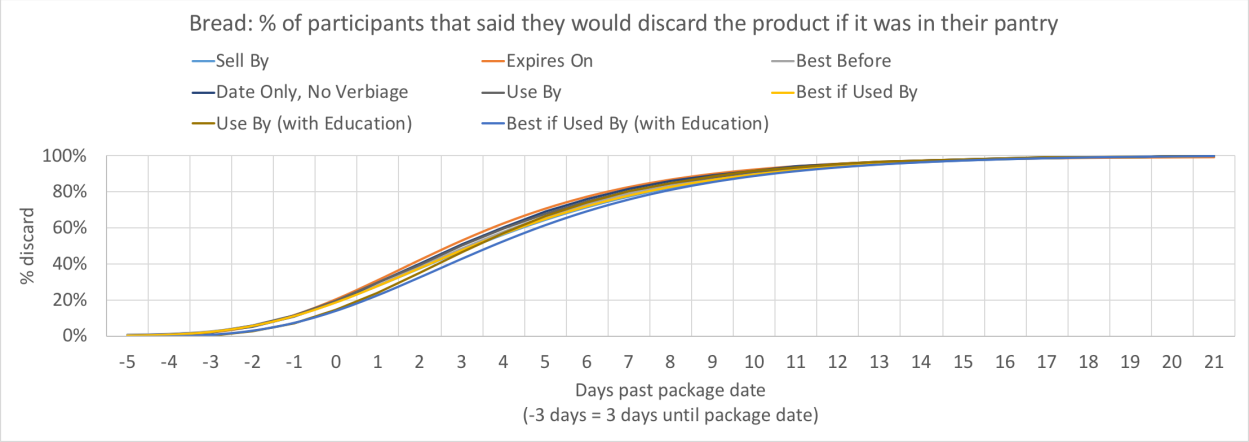
These were the major takeaways from the online survey:
As noted previously in the methodology, up to 25% of TOTAL consumer food waste is attributable to confusion over date labels, depending on food category [8]. Of that 25% waste, standardizing date labels, paired with education and adding dates to the package, has significant impacts on waste reduction. To show the scale of comprehensive impact, all findings here are quantified as a percentage of the TOTAL 100% consumer food waste numbers, not the 25% of consumer food waste attributable to confusion over date labels.

1. *Major Takeaway*: Consistent with previous research on the subject [1], the study found that standardizing the date label verbiage plus education could reduce TOTAL consumer waste that occurs due to confusion over date labels by up to 5%.
    a. *Key Finding: Standardizing the date label verbiage can reduce TOTAL consumer waste by up to 2%, and education can reduce TOTAL consumer food waste by an additional 1-3% depending on the product category.*
        i. 40% of people say they would discard lettuce in their pantry with a package date of 1 day past and the verbiage 'Expires On', but only 35% of people would discard the same lettuce with the verbiage 'Best if Used By'. Furthermore, when educated about how to interpret 'Best if Used By' labels, only 30% said they would discard the lettuce.
        ii. 46% of people say they would discard fresh chicken in their refrigerator with a package date of 1 day past and the verbiage 'Expires On', but only 43% of people would discard the same chicken with the verbiage 'Use By'. Furthermore, when educated about how to interpret 'Use By' labels, only 42% said they would discard the bread.
    b. *Resulting Call to Action*: The industry should adopt standardized labels at scale and launch a coordinated, widespread effort to educate consumers about how to use the standardized labels.
2. *Major Takeaway*: A landmark finding of the study was that adding days to the package date is the most impactful way to reduce consumer waste due to date label confusion.
    a. *Key Finding*: Adding just 3 days to the package date could reduce TOTAL consumer waste by up to 25%, depending on the food product category. For example:
        i. 45-50% of people say they would discard milk in their refrigerator with a package date of 1 day past, but only 3-6% of people say they would discard the same milk with a package date of 2 days left.
        ii. 23-31% of people say they would discard bread in their pantry with a package date of 1 day past, but only 5-6% of people say they would discard the same bread with a package date of 2 days left.

b. *Resulting Call to Action*: 'Sell By' dates and similar dates (e.g., 'Packed On', 'Baked On') are the most obvious opportunity to standardize the verbiage (move to 'Best if Used By' or 'Use By') and add days to the package date as these dates are intended to be communication to the retailer as to when the product should be sold, as opposed to 'Best if Used By' or 'Use By' dates which are intended to be communication to the consumer. By switching from a communication to the retailer to a communication to the consumer, manufacturers should naturally add days to the package date. Note that it is critical for manufacturers to add days to the package date when moving away from 'Sell By' dates. Otherwise this could actually lead to an increase in waste of up to 2%.

The following pages display the consumer discard curves for each product by package date and date label verbiage. These curves were fitted to the data results from the study using a four-parameter Gompertz model. Researchers also used their best judgement to estimate the dates at which consumer discard would hit 0% and 100% to force the tail ends of the curve in the Gompertz model accordingly. The R^2 values indicate the degree to which the estimated curves fit the data results from the study. See the earlier Example Calculation section for an example of how to apply these curves to calculate the consumer waste reduction that can be expected from a shift to standardized labels.

Results for Bread



6% of participants said they would discard the product if it had no date or verbiage.

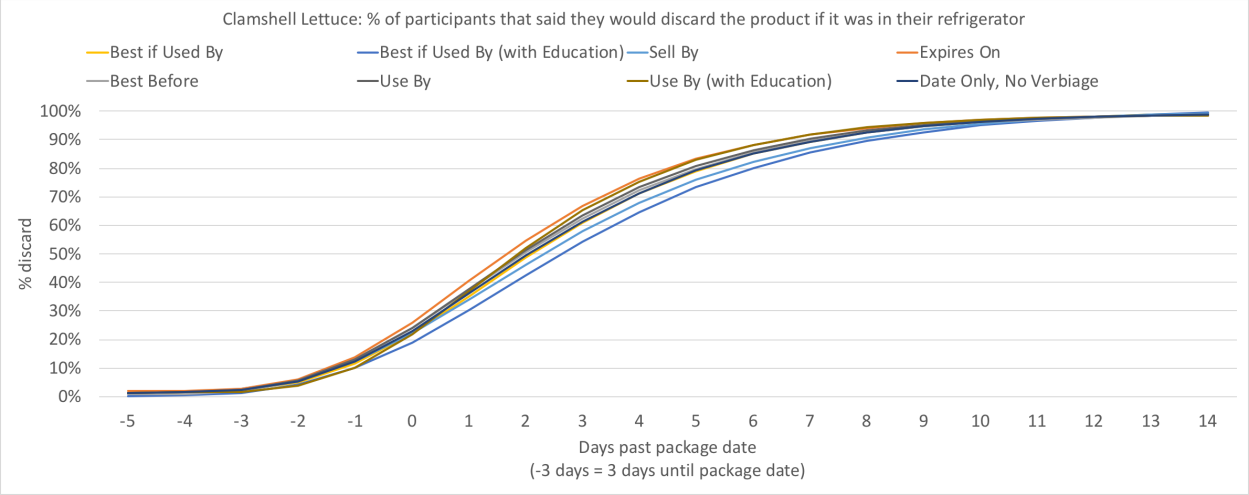
Curve:

y minimum = 0%, y maximum = 100%, otherwise
y = b0 + b1 * exp (-exp (-b2 * (x + 5 - b3))), where
y = % of participants that said they would discard the product if it was in their pantry
x = days past package date

Verbiage and Information Treatment			Curve Parameters				R^2
			b0	b1	b2	b3	
Unstandardized Verbiages	Placebo Education	Sell By	-0.0024	1.0057	0.2651	6.9377	0.9839
		Date Only, No Verbiage	-0.0002	0.9996	0.2974	6.6866	0.9883
		Expires On	-0.0015	0.9987	0.3063	6.4997	0.9852
		Best Before	0.0063	0.9964	0.2798	6.8994	0.9909
Standardized Verbiages		Best if Used By	-0.0024	1.0055	0.2699	6.9209	0.9898
		Use By	-0.0027	1.0031	0.2833	6.6909	0.9864
	Date Label Education	Best if Used By	-0.0037	1.0068	0.2760	7.3935	0.9825
		Use By	-0.0048	1.0039	0.3101	7.0947	0.9874

The coefficient of determination, or R^2 value, is a measure of how well the estimated curve fit the actual results from the survey data. An R^2 value of 1.0000 would indicate a perfect fit.

Results for Clamshell Lettuce



14% of participants said they would discard the product if it had no date or verbiage.

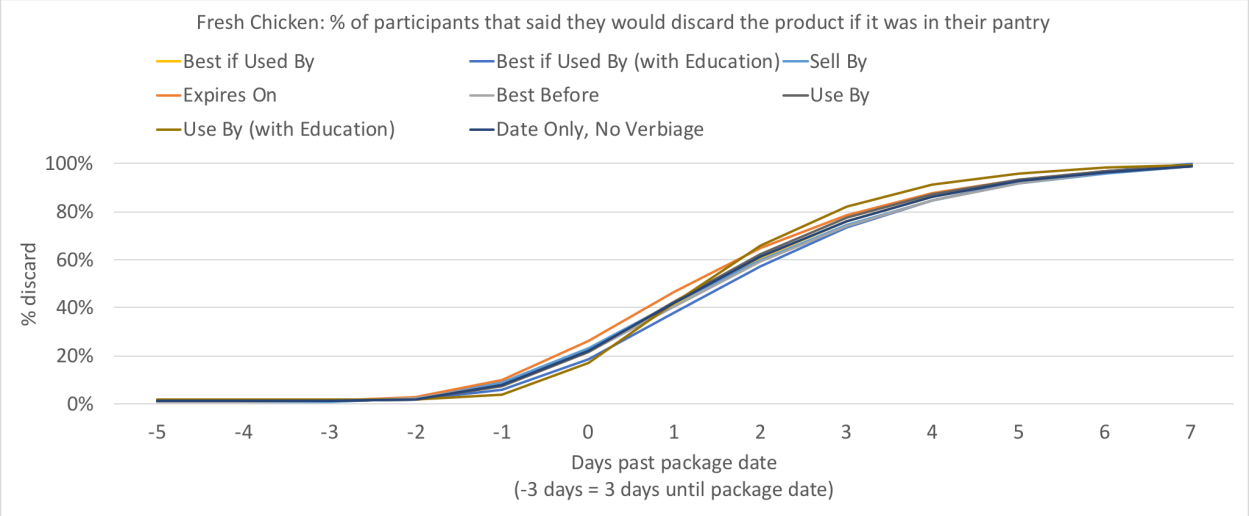
Curve:

y minimum = 0%, y maximum = 100%, otherwise
y = b0 + b1 * exp (-exp (-b2 * (x + 5 - b3))), where
y = % of participants that said they would discard the product if it was in their pantry
x = days past package date

Verbiage and Information Treatment			Curve Parameters				R^2
			b0	b1	b2	b3	
Unstandardized Verbiages	Placebo Education	Sell By	0.0123	0.9933	0.3400	6.3109	0.9779
		Date Only, No Verbiage	0.0138	0.9841	0.3721	6.1130	0.9821
		Expires On	0.0190	0.9715	0.4126	5.8079	0.9848
		Best Before	0.0084	0.9855	0.3752	5.9788	0.9785
Standardized Verbiages		Best if Used By	0.0139	0.9840	0.3767	6.1719	0.9825
		Use By	0.0137	0.9820	0.3852	5.9767	0.9841
	Date Label Education	Best if Used By	0.0024	1.0081	0.3296	6.5708	0.9862
		Use By	0.0141	0.9740	0.4347	6.0274	0.9813

The coefficient of determination, or R^2 value, is a measure of how well the estimated curve fit the actual results from the survey data. An R^2 value of 1.0000 would indicate a perfect fit.

Results for Fresh Chicken



7% of participants said they would discard the product if it had no date or verbiage.

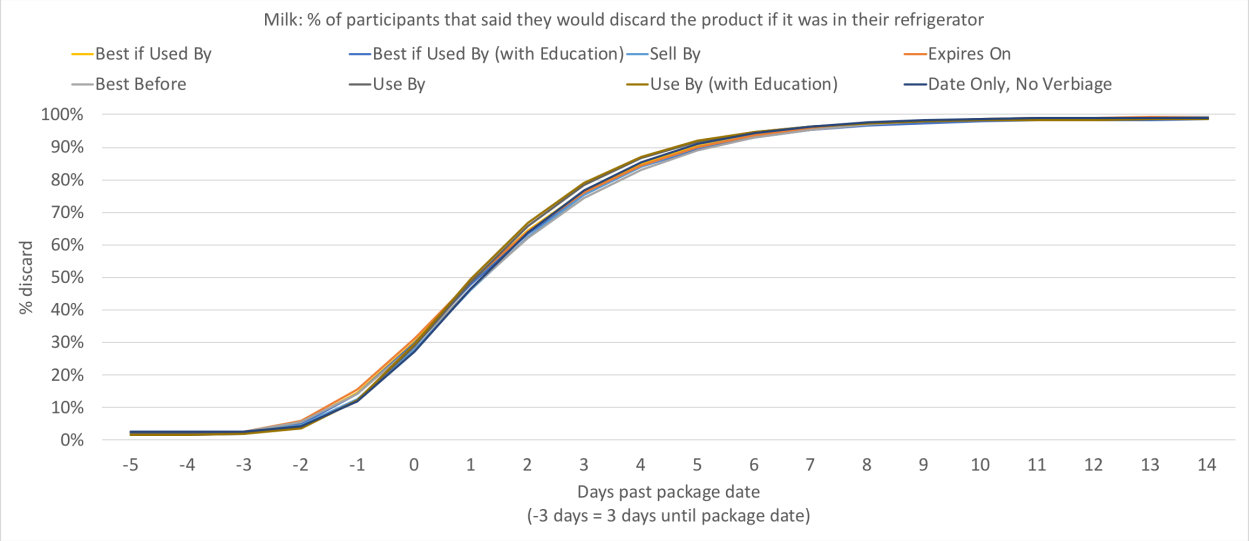
Curve:

y minimum = 0%, y maximum = 100%, otherwise
y = b0 + b1 * exp (-exp (-b2 * (x + 5 - b3))), where
y = % of participants that said they would discard the product if it was in their pantry
x = days past package date

Verbiage and Information Treatment			Curve Parameters				R^2
			b0	b1	b2	b3	
Unstandardized Verbiages	Placebo Education	Sell By	0.0071	1.0258	0.5066	5.8179	0.8616
		Date Only, No Verbiage	0.0113	1.0114	0.5499	5.8135	0.8766
		Expires On	0.0138	1.0036	0.5563	5.6042	0.8980
		Best Before	0.0104	1.0222	0.5161	5.8959	0.8552
Standardized Verbiages		Best if Used By	0.0123	1.0130	0.5510	5.8474	0.8863
		Use By	0.0147	1.0003	0.5850	5.7955	0.8873
	Date Label Education	Best if Used By	0.0116	1.0271	0.5388	6.0601	0.8843
		Use By	0.0179	0.9897	0.7316	5.8644	0.9447

The coefficient of determination, or R^2 value, is a measure of how well the estimated curve fit the actual results from the survey data. An R^2 value of 1.0000 would indicate a perfect fit.

Results for Milk



13% of participants said they would discard the product if it had no date or verbiage.

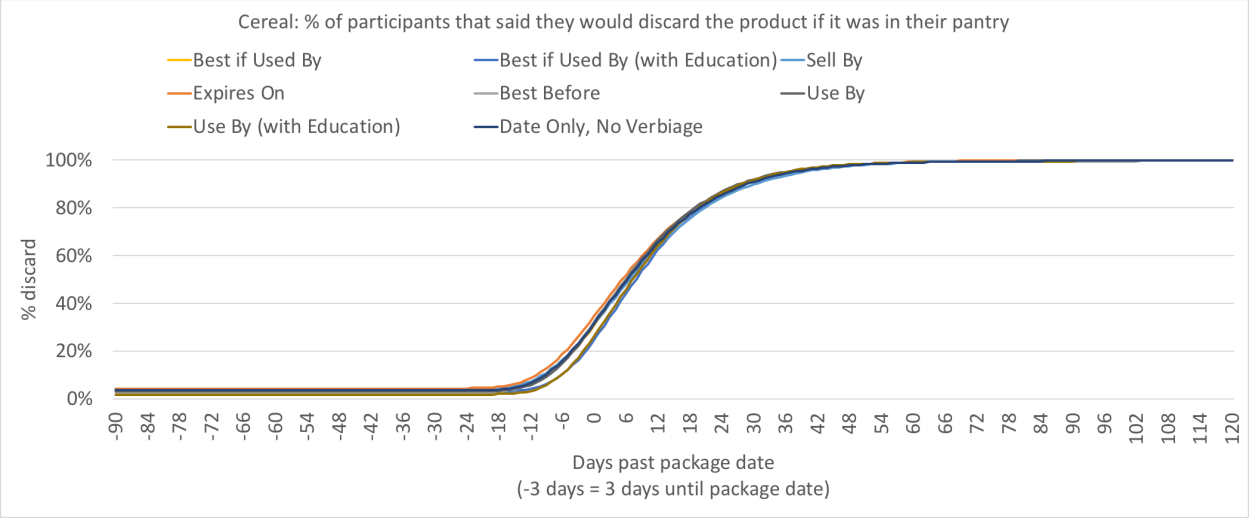
Curve:

y minimum = 0%, y maximum = 100%, otherwise
y = b0 + b1 * exp (-exp (-b2 * (x + 5 - b3))), where
y = % of participants that said they would discard the product if it was in their pantry
x = days past package date

Verbiage and Information Treatment			Curve Parameters				R^2
			b0	b1	b2	b3	
Unstandardized Verbiages	Placebo Education	Sell By	0.0226	0.9703	0.5153	5.5605	0.8874
		Date Only, No Verbiage	0.0244	0.9676	0.5435	5.5666	0.8919
		Expires On	0.0217	0.9721	0.4954	5.3854	0.8933
		Best Before	0.0221	0.9716	0.4876	5.5085	0.8697
Standardized Verbiages		Best if Used By	0.0216	0.9691	0.5132	5.4149	0.8851
		Use By	0.0214	0.9648	0.5676	5.4470	0.8871
	Date Label Education	Best if Used By	0.0165	0.9698	0.5031	5.4135	0.8632
		Use By	0.0165	0.9694	0.5733	5.3929	0.9007

The coefficient of determination, or R^2 value, is a measure of how well the estimated curve fit the actual results from the survey data. An R^2 value of 1.0000 would indicate a perfect fit.

Results for Cereal



13% of participants said they would discard the product if it had no date or verbiage.

Curve:

y minimum = 0%, y maximum = 100%, otherwise
y = b0 + b1 * exp (-exp (-b2 * (x + 90 - b3))), where
y = % of participants that said they would discard the product if it was in their pantry
x = days past package date

Verbiage and Information Treatment			Curve Parameters				R^2
			b0	b1	b2	b3	
Unstandardized Verbiages	Placebo Education	Sell By	0.0400	0.9598	0.0813	92.8971	0.9445
		Date Only, No Verbiage	0.0357	0.9625	0.0849	92.4700	0.9547
		Expires On	0.0445	0.9563	0.0835	91.7326	0.9774
		Best Before	0.0269	0.9705	0.0865	91.9966	0.9524
Standardized Verbiages		Best if Used By	0.0433	0.9562	0.0873	92.8115	0.9603
		Use By	0.0324	0.9659	0.0895	92.4074	0.9609
	Date Label Education	Best if Used By	0.0312	0.9669	0.0930	94.3632	0.9372
		Use By	0.0192	0.9784	0.0934	93.5763	0.9437

The coefficient of determination, or R^2 value, is a measure of how well the estimated curve fit the actual results from the survey data. An R^2 value of 1.0000 would indicate a perfect fit.

Based on the study results, ReFED recommends using the following curves as proxies for other verbiages not included in the OSU study:

Proxy Curve from OSU Study	**Use for These Verbiages**
Sell By	Sell By Packed On Baked On
Date Only, No Verbiage	Date Only, No Verbiage
Expires On	Expires On Expires By
Best Before	Best Before Best By Best Flavor By
Best if Used By	Best if Used By Better if Used By Best when Used By Guaranteed Fresh if Used By Guaranteed Delicious if Used By
Use By	Use By Freeze By Use or Freeze By Enjoy By

Several steps were taken by the research team at OSU to ensure quality results. Researchers ensured that the study results could be generalized to the U.S. population by making sure that the participants were comprised of a representative mix of demographics (e.g., geography, race, age, and income levels). Sample sizes were fairly large (769 participants for bread, clamshell lettuce, and fresh chicken; 514 participants for milk and cereal). Participants were pre-filtered from participating if they said their household did not regularly consumer the products in the survey. Participants were required to answer questions about the information treatment given at the beginning of the survey to encourage them to carefully read the information. The survey was designed so that the average completion time was less than sixteen minutes (average completion time of fifteen minutes thirty seconds for bread, clamshell lettuce, and chicken; five minutes for milk and cereal) to ensure that it was not too burdensome and mentally fatiguing. Also, special questions were inserted throughout the survey to make sure participants were paying attention.

Experiment groups included in the survey:

Bread, Clamshell Lettuce, and Fresh Chicken Surveys		Milk and Cereal Surveys	
Group 1	Group 2	Group 3	Group 4
Information Treatment: Placebo	Information Treatment: Date Label Education	Information Treatment: Placebo	Information Treatment: Date Label Education
Date Label Verbiages: ● No date, no verbiage ● Date only, no verbiage ● Sell by ● Expires on ● Best Before ● Best if Used by ● Use by	Date Label Verbiages: ● No date, no verbiage ● Date only, no verbiage ● Sell by ● Expires on ● Best Before ● Best if Used by ● Use by	Date Label Verbiages: ● No date, no verbiage ● Date only, no verbiage ● Sell by ● Expires on ● Best Before ● Best if Used by ● Use by	Date Label Verbiages: ● No date, no verbiage ● Date only, no verbiage ● Sell by ● Expires on ● Best Before ● Best if Used by ● Use by

Placebo information treatment:

Adolescents and young people are the most connected generation ever. Consider these statistics.

- Children under 18 represent 1 in 3 internet users worldwide
- 98% of households with children 8 and under, rich and poor, now have access to a mobile device, such as a tablet or smartphone
- Some families pledge to put off giving kids a smartphone until the end of middle school to avoid some risks associated with screen and smartphone use
- The question of whether screen media use can be a true "addiction" is not yet settled among mental health professionals
- Research is mixed in terms of the effects of screen use. One large study found limits on screen time over the course of a month were not necessarily associated with positive outcomes in children.

Answer the questions below when you have finished reading the material above.

Date label education information treatment:

Today you will see several packages of food purchased from local stores with a date printed on the label.

- Any package dates are chosen by the company making the product and are not regulated by any government rule or scientific agency.
- If the label says **Best if Used By, Best Before**, or just contains a date with no phrase
  - The company making this product thinks the taste and freshness of their product may decline after this date
  - These dates do not indicate product safety – products often remain safe to eat after this date so long as they look and smell appropriate
- If the label says **Use By** or **Expires On**:
  - The company making this product thinks the product may be unsafe if consumed after the this date
- If the label says **Sell By**:
  - The date suggests when store managers should consider removing the product from their shelves to ensure that the product will be fresh when consumers get around to using the product in their home

Answer the questions below when you have finished reading the material above.

Example survey question for fresh chicken (note that the actual dates were coded to automatically change based on the date the participant was taking the survey):

Ingredients: fresh chicken breast
Serving size: 4 OZ (112g)
Calories per serving: 110
Serving per package: varied

If the package were in your refrigerator and you were deciding whether to keep or discard the package, what would you do if the date on the package were the following:

	Keep	Not Sure	Discard
Best if Used By 18 Jan 2019 (3 days from today)	○	○	○
Best if Used By 16 Jan 2019 (1 day from today)	○	○	○
Select "Discard" to ensure you are paying attention	○	○	○
Best if Used By 15 Jan 2019 (Today)	○	○	○
Best if Used By 14 Jan 2019 (1 day ago)	○	○	○
Best if Used By 12 Jan 2019 (3 days ago)	○	○	○

Limitations

There are some limitations that should be considered when interpreting the results of the online survey.

These results still need to be replicated in an in-person setting. While the study did include both an in-person portion in Ohio and a nationally-representative online portion, changes were made to the online survey based on learnings from early results indicating that a wider variety of verbiages and package dates needed to be tested. The original study design, which was used for the in-person survey and for a small online national replication survey, utilized a between-subjects design where participants only saw a single date label verbiage and three package dates for each product. After reviewing the preliminary results, researchers decided to redesign the survey to a within-subjects design where each participant saw multiple date label verbiages and a wider range of package dates for each product. The new design enabled comparison of how a single participant responded to multiple verbiages, and it also allowed for more verbiages and package dates to be tested. The results communicated in this document are the results from the newer online survey design, but because the survey was altered, these results still need to be replicated in an in-person setting.

Another limitation to consider is the lack of product aging. When participants were shown food products, in both the in-person setting as well as the online portions, all of the products were actually the same age even though the package date indicated otherwise. To better reflect reality in future experiments, these products would ideally also be aged accordingly.

Appendix D: Data for FACTOR 5 - Breakdown of Consumer Food Waste by Disposal Type

This data is found in EPA's Advancing Sustainable Materials Management 2015 Fact Sheet [9].

Material	**Million Tons in 2015**			
	Weight Composted	**Weight Combusted with Energy Recovery**	**Weight Landfilled**	**Total Weight Generated**
Food, other*	2.10	7.38	30.25	39.73

*Includes collection of other municipal solid waste organics for composting. Yard trimmings are excluded.

The values above were used to calculate the following percentages for use in this methodology. (Example: 2.10 Million Tons Composted / 39.73 Million Tons of Food Waste Generated = 5.29% Composted)

% of consumer food waste that is...		
Composted	**Combusted**	**Landfilled**
5.29%	18.58%	76.14%

Appendix E: Data for FACTOR 6 - GHG Emission Factors

This data is found in EPA's Waste Reduction Model (WARM) [10].

Note that the upstream (source reduction) emission factors vary by food type, and the downstream emission factors vary by disposal type. Also note that while there is a GHG emission factor for anaerobic digestion, this factor is not used in this methodology as consumer food waste that is anaerobically digested is determined to be negligible and because it wasn't included in the estimates for Factor 5.

Material	**MTCO2E**				
	GHG Emissions per Ton of Material Source Reduced	**GHG Emissions per Ton of Material Landfilled**	**GHG Emissions per Ton of Material Combusted**	**GHG Emissions per Ton of Material Composted**	**GHG Emissions per Ton of Material Anaerobically Digested**
Food Waste (non-meat)	-0.757803107	0.543231608	-0.141128341	-0.17601202	-0.063693766
Food Waste (meat only)	-15.09811384				
Beef	-30.05203163				
Poultry	-2.473048242				
Grains	-0.618253095				
Bread	-0.668857417				
Fruits and Vegetables	-0.439757231				
Dairy Products	-1.743017188				

Appendix F: Food Waste and GHG Emission Factors for Standardized Date Labeling Impacts

ReFED used the methodology described in the Example Calculation starting on page 10 to calculate a set of simplified food waste and greenhouse gas emission factors in order to simplify the calculations required to quantify the impacts associated with standardized date labeling. An example application of these factors is described in the Simplified Example Calculation on page 14.

The full list of factors can be found on the ReFED website at <insert link>.

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