Packaging solutions To Reduce fruit and vegetable waste

- Quantified impact of packaging solutions
- Most feasible scalable and pilot packaging solutions
- Motivating forces needed for implementation of the pilot and scalable solutions

Dr. Claire Sand

Created by PTR from research funded by ReFED
Learn more at: www.PackagingTechnologyAndResearch.com

About ReFED

ReFED is an entrepreneurial nonprofit that accelerates solutions to food waste.

Vision: Eliminate food waste in order to increase food security, spur economic growth and protect the environment.

Strategies:

•Thought Leadership: Serve as the leading source of data, insights and guidance to reduce U.S. food waste.

•Stakeholder Engagement: Build awareness, education and engagement of key stakeholders.

•Priority Solutions**:** Drive adoption of priority food waste solutions.

ReFED | Rethink Food Waste *Through Economics and Data*

PTR Approach | Actionable innovation to Minimize food waste with sustainable packaging solutions

The future of more innovative food packaging is **complex, enchanting, and promising**

Numerous choices result in catharsis and focus is needed

Innovation requires a **business case**

A rational, defensible, and achievable strategy is needed

Gaps can be found

Technology can be used to **enable better alignment between consumer needs and market delivery**

Value chain connections **build in agility** for future

Hesitancy can be reduced with **more levers to drive switching**

Summary

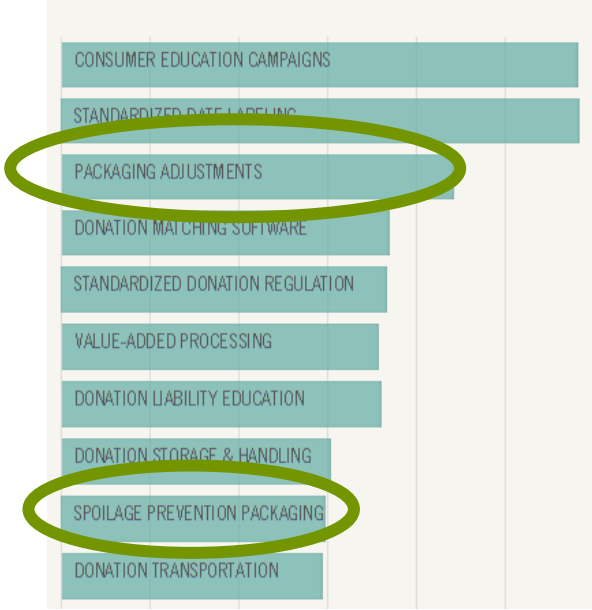
Process and Purpose of the Study

- The ReFED RoadMap quantified Packaging Solutions <u>in general</u> to reduce food waste

- This work:
  - Focused on <u>specific</u> Packaging Solutions
  - Added to the efforts by *Ameripen, SPC, pac,* and numerous other organizations

- Results of this work:
  - Identified and screened **40+** Packaging Solutions
  - Pinpointed **12** Scalable, Pilot, Research-intensive, and Systems Packaging Solutions with the most promise in reducing food waste

- Implementation of this work:
  - Is facilitated by Business Cases, Gap Analysis, and Implementation Plans
  - Requires focused value chain partnerships on decreasing food waste



SOLUTIONS

OVERVIEW

Scalable Solutions	Produce
Resealable Packaging	$423,532,439.00
Improved Water Vapor Barrier	$477,755,081.06
MAP-O2 absorbing sachets, O2 absorbing films and labels, CO2 emitters	$477,755,081.06
Flex-Pack	$72,986,576.92
Edible water vapor and oxygen barriers	$452,183,833.37
Reduce Package Headspace	$3,181,176.92
Time-Temperature indicators (TTI)	$18,185,141.84
Odor Absorbers	$3,181,176.92
Pilot Solutions	
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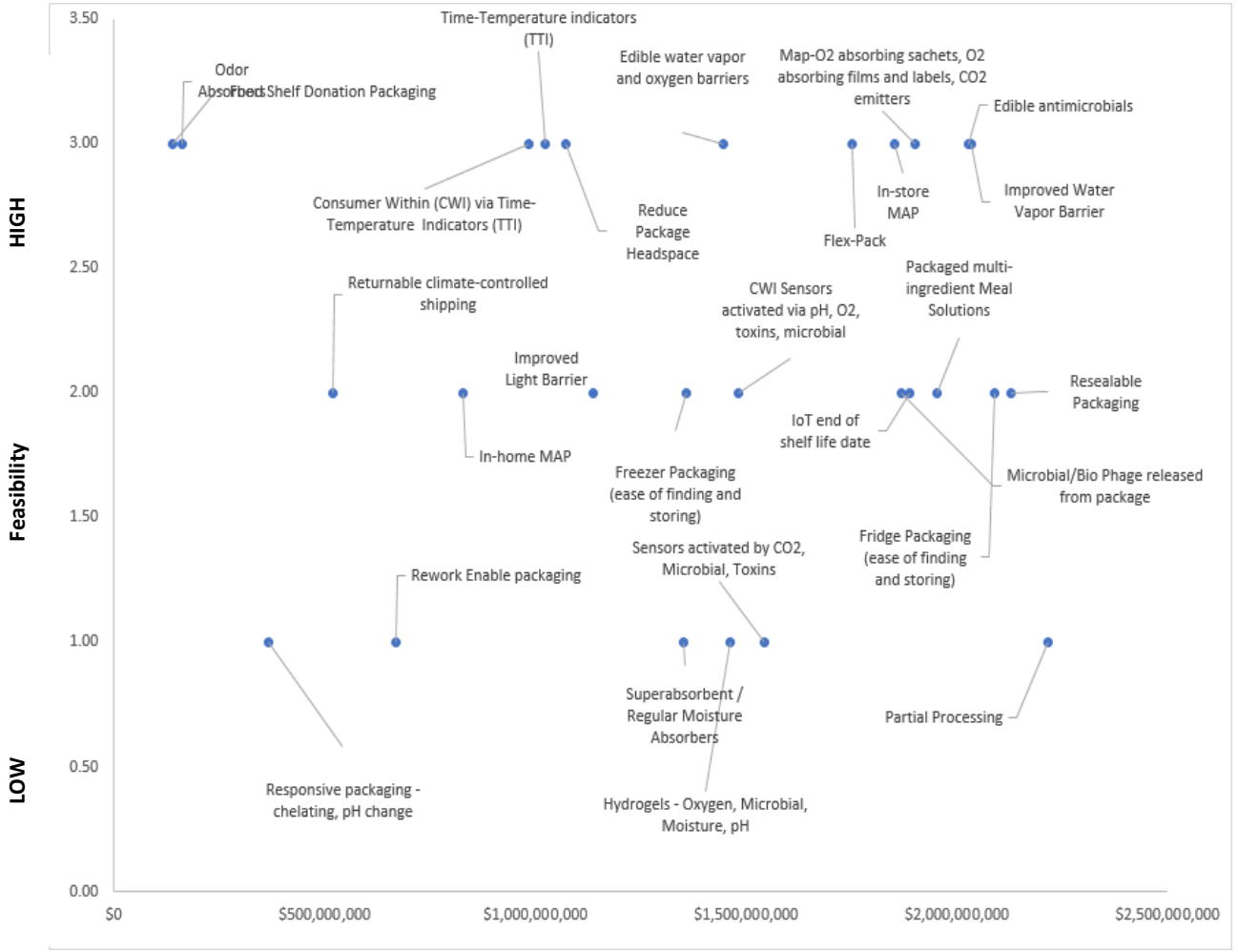
Substantial Research Investment needed	
Partial Processing	$477,755,081.06
IoT end of shelf life date	$477,755,081.06
Microbial/Bio Phage released from package	$477,755,081.06
Hydrogels - Oxygen, Microbial, Moisture, pH	$166,284,017.98
CWI Sensors activated via pH, O2, toxins, microbial	$477,755,081.06
Superabsorbent / Regular Moisture Absorbers	$477,755,081.06
Rework Enable packaging	$69,632,372.16
Responsive packaging - chelating, pH change	$258,479,488.75

Results – Snapshot of Total Food Waste Reduction as a function of Feasibility



Analysis Process

PACKAGING SOLUTIONS TO ADDRESS FOOD WASTE

PACKAGING SOLUTIONS FOR

Oxidation
Spoilage prevention for products that contain unsaturated fat and oxidize

Microbial
Spoilage prevention for products that degrade due to pathogens (e.g., Listeria, E. Coli, Salmonella), molds and yeast

Enzymatic Browning (EB)
Spoilage prevention for products that degrade due to oxygen exposure and polyphenol oxidase

Water loss/gain
Spoilage prevention for products that degrade due to changes in water activity from and within products

Design
Package adjustments using format, material, and shape design

Value Chain
Packaging adjustments including shared value, and value chain optimizations

		SPOILAGE PREVENTION				PACKAGING ADJUSTMENTS	
Category		Oxidation	Microbial	Water loss/gain	Enzymatic Browning	Design	Value Chain
Supermarkets	Bakery	■	■			■	■
	Dairy	■	■			■	■
	Frozen foods			■		■	■
	Meat	■	■			■	■
	Produce		■	■	■	■	■
	Seafood	■	■			■	■
Quick Serve Restaurant			■			■	■
Restaurants			■	■			■
Meal kits delivery		■	■		■	■	■

PROCESS – IDENTIFYING THE TOP SUSTAINABLE PACKAGING SOLUTIONS THAT REDUCE FRUIT & VEGETABLE WASTE

A **Rubric** was developed and used to assess 40+ specific packaging solutions

Opportunity Rubric

1. Fruit & vegetable waste total opportunity
   - Volume and dollars of key categories of application

2. Wide applicability
   - Category and restaurant type and breadth within solutions
   - Consumer
   - Supermarket
   - Restaurants

3. Extent of impact on sustainability versus current packaging

Feasibility Rubric

1. Cost

2. Viability of key value chain elements for success
   - Partners
   - Processes

3. Technical availability
   - Commercial applications
     - Who uses it - company, product
     - Where in use - countries, industries
     - Purpose - what does it do
   - Research & Intellectual Property
     - Who and where work is in process
     - Past and Future work

Determining Dollars of Food Waste Addressed

- **% Food waste by category and from Consumers, Supermarkets, Restaurants**
  - Page 16 ReFED Technical Abstract
- **Amount of food waste that can be addressed by spoilage prevention packaging and packaging adjustments**
  - ReFED values of 72,000 + 208,000 tons to total food waste
- **Sub-category dollars**
  - Updated using 2016-2018 values
  - Market research

Categories Vary By Impact: Consumer-derived Food Waste

Meat

High Cost ($5.73 per pound)
Low Food Waste (16% for consumers)
Lower dollar impact of food waste

Produce

Low Cost ($1.51 per pound)
High % Food Waste (43% for consumers)
Higher dollar impact of food waste

Categories Vary By Impact: Supermarket-derived fruit & vegetable Waste

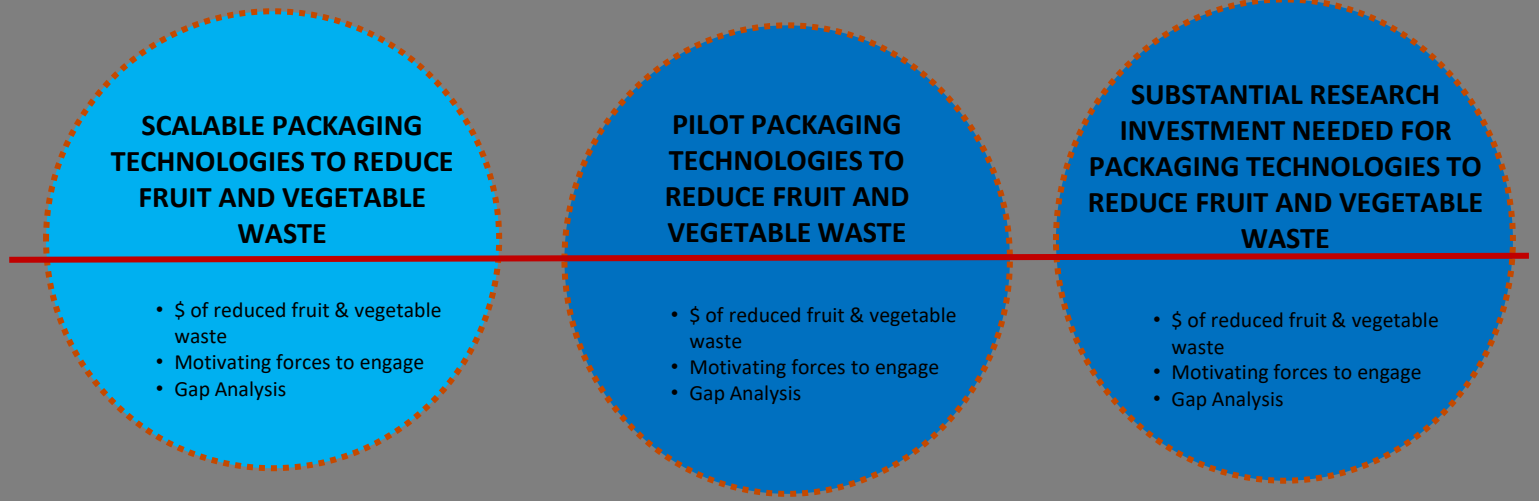
Meat

High Cost ($5.73 per pound)
Low Food Waste (7% for supermarkets)
Lower dollar impact of food waste

Produce

Low Cost ($1.51 per pound)
High % Food Waste (40% for supermarkets)
Higher dollar impact of food waste

Results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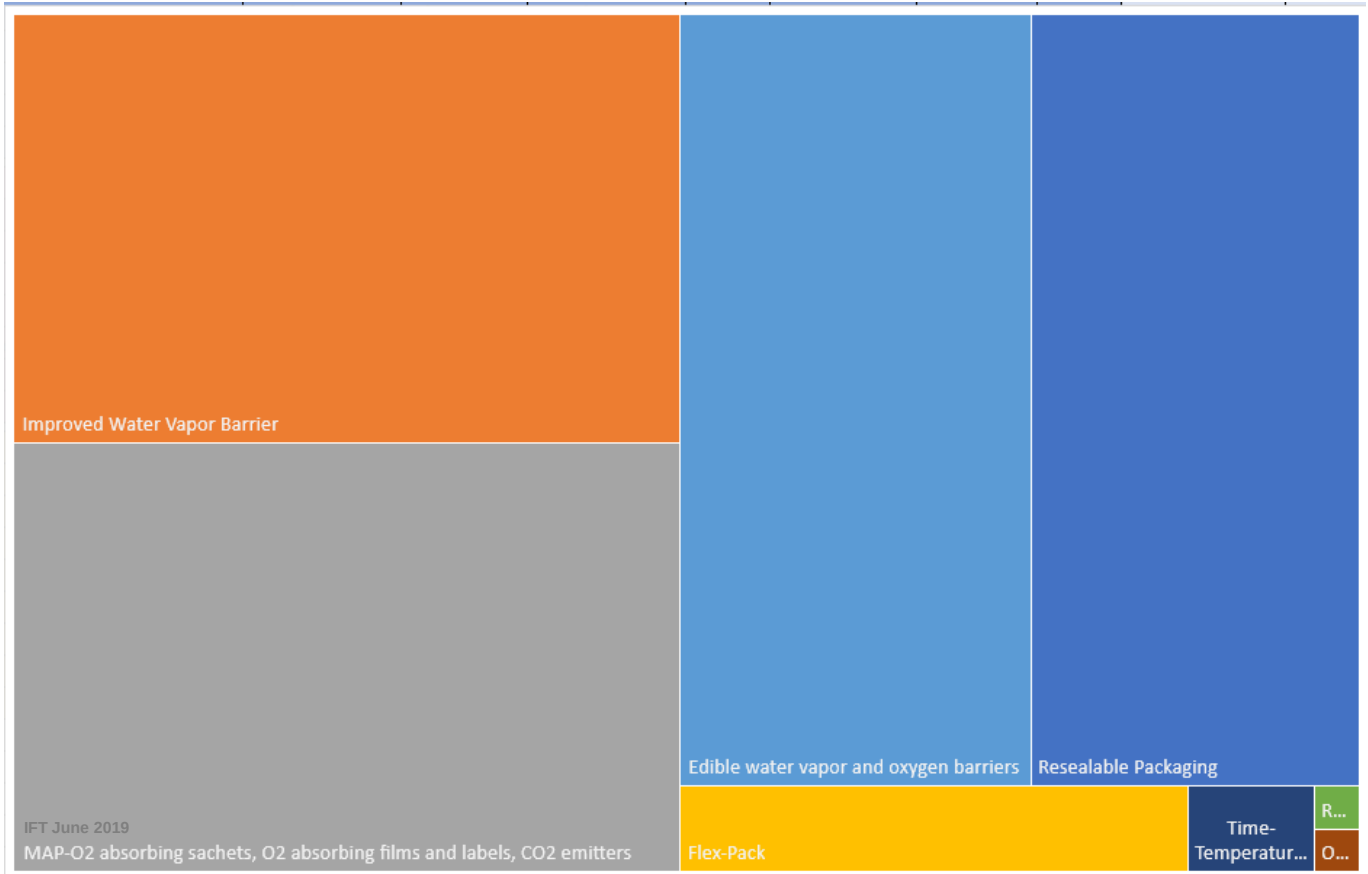
Scalable Packaging Solutions to Reduce Fruit and Vegetable Waste



Scalable Packaging Solutions to Reduce Fruit and Vegetable Waste

Scalable Solutions	Produce	Feasability
Resealable Packaging	$423,532,439.00	2.0
Improved Water Vapor Barrier	$477,755,081.06	3.0
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Low total feasability in reducing more food waste	
Medium total feasability in reducing more food waste	
High total feasability in reducing more food waste	

MAP
Path Forward - Recommendations

1. Reinforce and promote current MAP use in key subcategories

- Engage with current manufacturers who use this now and sales data in high $ fruit & vegetable waste
  - greens
  - Peppers

2. Scale from current and promote future MAP in Produce

Align with manufacturers to promote technology in target categories

Retailers:
Prouce intermediaries and packers: *No preservative manufacturers - small companies for repeat scale*

Align with QSR & Retail Prepared fruit & vegetables to promote technology in target categories

Expand within high $ fruit & vegetable waste categories at retail
Key retailers:

Align with to CO_2 promote technology in target categories

Expand within high $ fruit & vegetable waste categories CO_2 emitters:
Clariant
Mitsubishi
Moxiyo

MAP
MOTIVATING FORCES

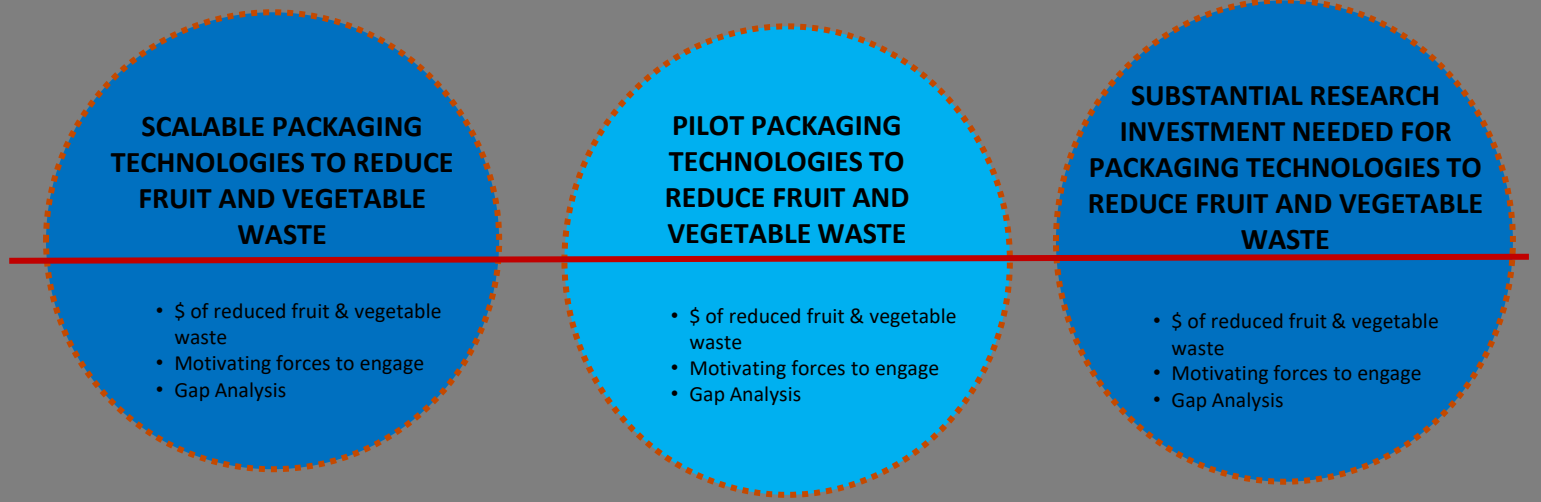
Costs are primarily paid by manufacturers

Post-consumers	Consumers	QSR & Retailers	Food Manufacturers	Absorber and emitters suppliers
Shared value: Specific directions on recyclability are needed	Balance cost: Increased shelf life with little added packaging Shared value: Decreased fruit & vegetable waste losses	Shared value: Less need for stock rotation when longer shelf life	Balance cost: higher per unit cost Shared value: Less unsalables and wider distribution	Balance cost: Invest in research to enable scalable implementation Shared value: Higher sales

Scalable Path Forward – Rationale for working on the top Sustainable Packaging Solutions that Reduce Food Waste

Enable	MAP	
Fuel Consumer Research	Define what is needed to communicate packaging technologies to consumers that reduce their fruit & vegetable waste	
Consumer Communication	Communicate with Consumers to understand MAP and decrease fruit & vegetable waste and increased shelf life	
Consistent Engagement with Retailers	Increase Retail benefit to drive retailer investment Communicate with retailers on stock rotation benefits	
Consistent Engagement among Manufacturers	Engage with manufacturers to uniformly balance costs in value chain Build on seafood success	Engage with manufacturers Need incentive to implement for small manufacturers
Advance Shared Value	Advance Shared Value principles to balance costs throughout Value Chain of information Drive use for fruit & vegetable donations	

Results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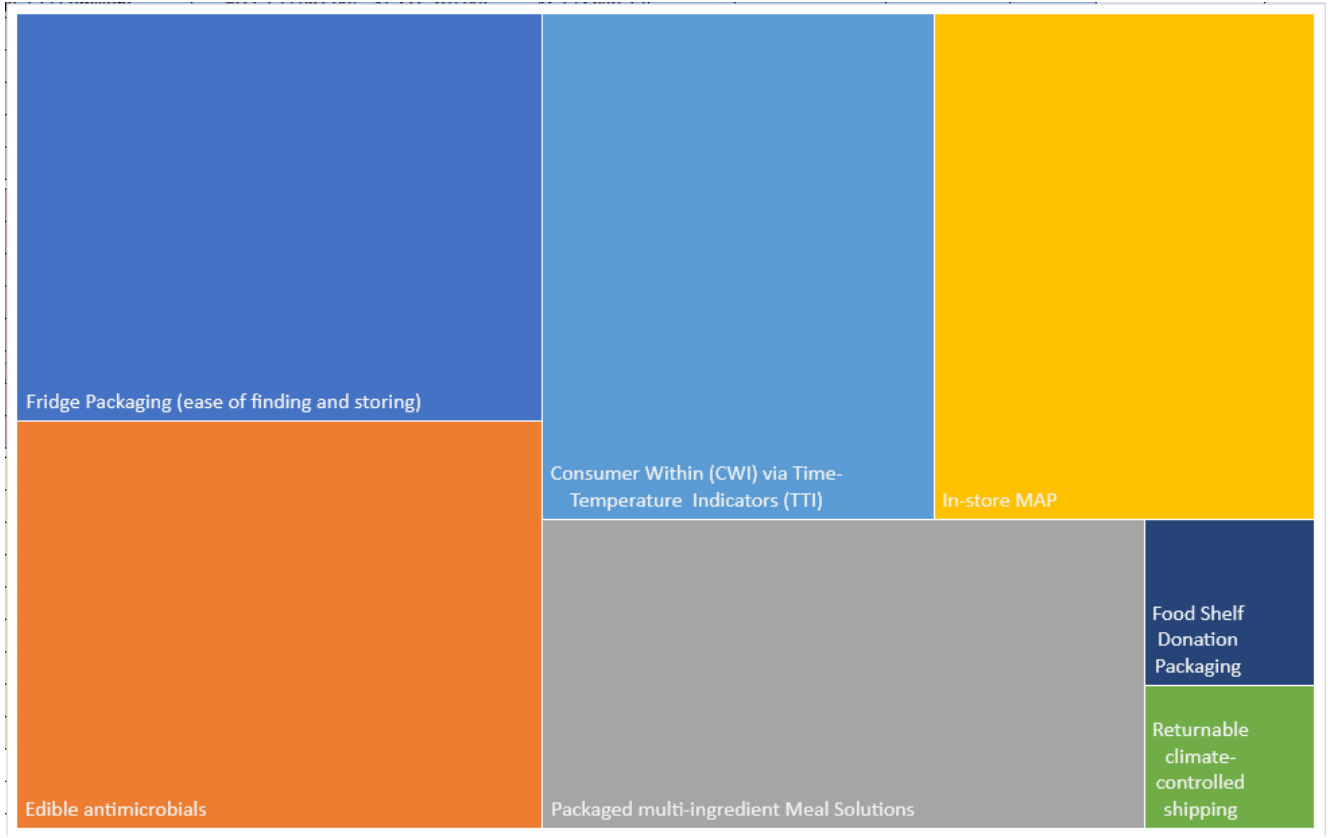
Pilot Packaging Solutions to reduce Fruit and vegetable Waste



Pilot Packaging Solutions to reduce Fruit and vegetable Waste

Pilot Solutions	Produce	Feasability
Fridge Packaging (ease of finding and storing)	$477,755,081.06	2.0
Edible antimicrobials	$477,755,081.06	3.0
Packaged multi-ingredient Meal Solutions	$416,031,633.37	2.0
In-store MAP	$428,359,537.98	3.0
Consumer Within (CWI) via Time-Temperature Indicators (TTI)	$442,203,299.32	3.0
Returnable climate-controlled shipping	$54,222,642.05	2.0
Food Shelf Donation Packaging	$62,892,639.87	3.0

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Fridge Packaging
Path Forward – Recommendations Overview

Scale from current and promote future package design for produce that requires refrigeration

1. Align with manufacturers to promote technology in target categories

- Produce
  - Growers, large retailers

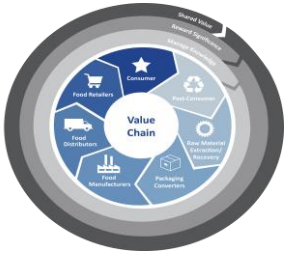
2. Align with QSR & Retail Prepared foods to promote technology in target categories

- Expand within high $ fruit & vegetable waste categories at retail
- Key retailers:
  - Larger Grocerants
  - Smaller retailers with large deli and prepared fruit & vegetables with limited preservatives – Whole Foods, Trader Joes/Aldi, Target

3. **Align with to produce technologies to promote technology in target categories**

- Expand within high $ fruit & vegetable waste categories and key packaging company alliances:
  - Learnings from fridge pack design

Fridge Packaging Motivating Forces



Costs are primarily paid by manufacturers and Retailers

Post-consumers	Consumers	QSR & Retailers	Food Manufacturers
Shared value: Specific directions on proper disposal are needed	Balance cost: Reduced time and know what is in refrigerator Shared value: Decreased fruit & vegetable waste losses	Shared value: Better appeal to envision fruit & vegetable in fridge for consumers	Balance cost: Higher per unit cost Shared value: high design and market appeal Increased sales if use when found in fridge

Edible Antimicrobials

Path Forward – Recommendations Overview

Scale from current and promote future Edible Antimicrobial use in store deli, grocerants, produce and for QSRs

1. **Align with manufacturers to promote technology in target categories**
   - QSR suppliers:
     - When post-package fruit & vegetable handling is high (e.g., Subway)

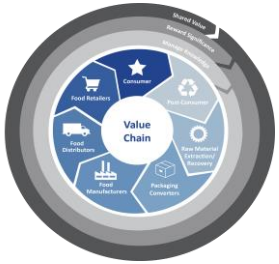
2. **Align with QSR & Retail Prepared foods to promote technology in target categories**
   - Expand within high $ fruit & vegetable waste categories at retail
   - Key retailers:
     - Larger Grocerants and QSRs where fruit & vegetable handling is high
     - Smaller retailers with large deli and prepared foods with limited preservatives – Whole Foods, Trader Joes/Aldi, Target

3. **Align with to O_2 scavengers and CO_2 promote technology in target categories**
   - Expand within high $ fruit & vegetable waste categories O_2 scavengers and CO_2 manufacturers:
     - Phage applications
     - Lactic acid/Citric acid - Chicxide
     - Lysozyme - Inovapure
     - Nisin - Niprosin
     - Natamycin Inovapure

Costs are primarily paid by manufacturers and QSRs

Post-consumers	Consumers	QSR & Retailers	Food Manufacturers	Edible Antimicrobials suppliers
Shared value: Specific directions on recyclability are needed	Balance cost: Increased shelf life with little added packaging Shared value: Decreased fruit & vegetable waste losses	Shared value: Less need for stock rotation when longer shelf life	Balance cost: Higher per unit cost Shared value: Less unsalables and wider distribution	Balance cost: Invest in research to enable scalable implementation and research Shared value: Higher sales

CWI via TTIs - Consumer/QSR Motivating Forces



Costs and value are less balanced when TTI is applied at purchase

Post-consumers	Consumers	QSR & Retailers	Food Manufacturers	Packaging suppliers	TTI suppliers
Balance cost: Clear Chain of Custody for more viable fruit & vegetable Donations Shared value: Ensure recyclability of CWI via TTI when applied to recyclable packaging	Balance cost: Clear use by information to decrease fruit & vegetable waste losses	Balance cost: Clear use by information to decrease fruit & vegetable waste losses/unsalables for consumer Shared value: Add value to consumer purchase	Shared value: Raise importance of connecting time & temperature to product end of shelf life (safety and quality)	Shared value: Demonstrated added value in packaging Shared value: Longer shelf life with better packaging will have more value	Balance cost: Increase volumes with likely lowers per unit cost Shared value: Address universal design to meet needs of all consumers

Pilot Path Forward – Rationale for working on the top Sustainable Packaging Solutions that Reduce Food Waste

Enable	CWI via TTI	Edible Antimicrobials	Fridge Packaging
Fuel Consumer Research	Define what is needed to communicate packaging technologies to consumers that reduce their fruit & vegetable waste		
Consumer Communication	Communicate with Consumers to understand TTIs and decrease fruit & vegetable waste and increased shelf life	Communicate with Consumers on role of edible barriers to decrease fruit & vegetable waste	Provide consistent information to consumers package value
Consistent Engagement with Retailers/QSR/Restaurant	Increase Retail benefit to drive retailer investment Assess retailer applied CWI via TTI		Align with retailers for optimized displays and marketing
Consistent Engagement among Manufacturers	Activation when opened by Consumer/QSR will drive CWI via TTI use through remainder of value chain	Facilitate dialogue to share research and implementation processes to decrease fruit & vegetable waste Guide decision making with uniform technologies Need incentive to accomplish this for small manufacturers	Guide manufacturers in dimensional constraints and design thinking
Advance Shared Value	Advance Shared Value principles to balance costs throughout Value Chain Drive QSR & Retailer CWI via TTI use for COC for fruit & vegetable donations	Blend fruit & vegetable science innovation with edible antimicrobials	Add design value in packaging

Results

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- $ of reduced fruit & vegetable waste
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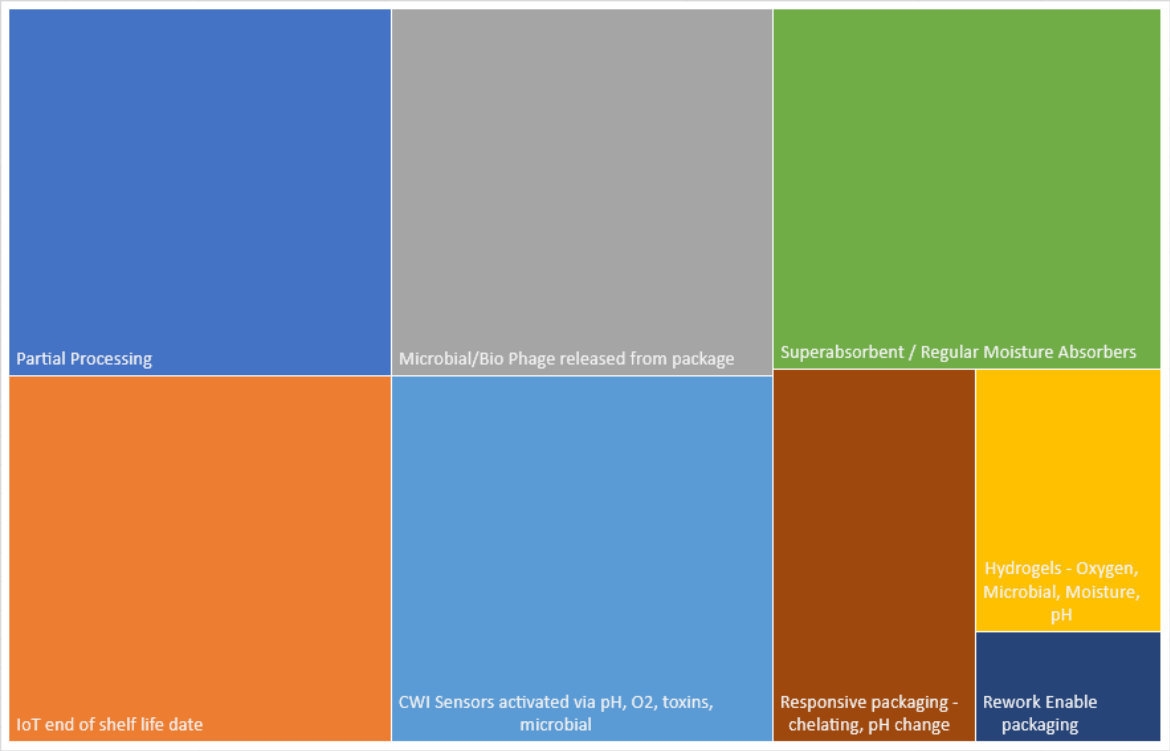
Substantial Research Investment Packaging Solutions to reduce Fruit and vegetable Waste



Substantial Research Investment Packaging Solutions to fruit & vegetable Waste

Substantial Research Investment needed	Feasability	Feasability
Partial Processing	$477,755,081.06	1.0
IoT end of shelf life date	$477,755,081.06	2.0
Microbial/Bio Phage released from package	$477,755,081.06	2.0
Hydrogels - Oxygen, Microbial, Moisture, pH	$166,284,017.98	1.0
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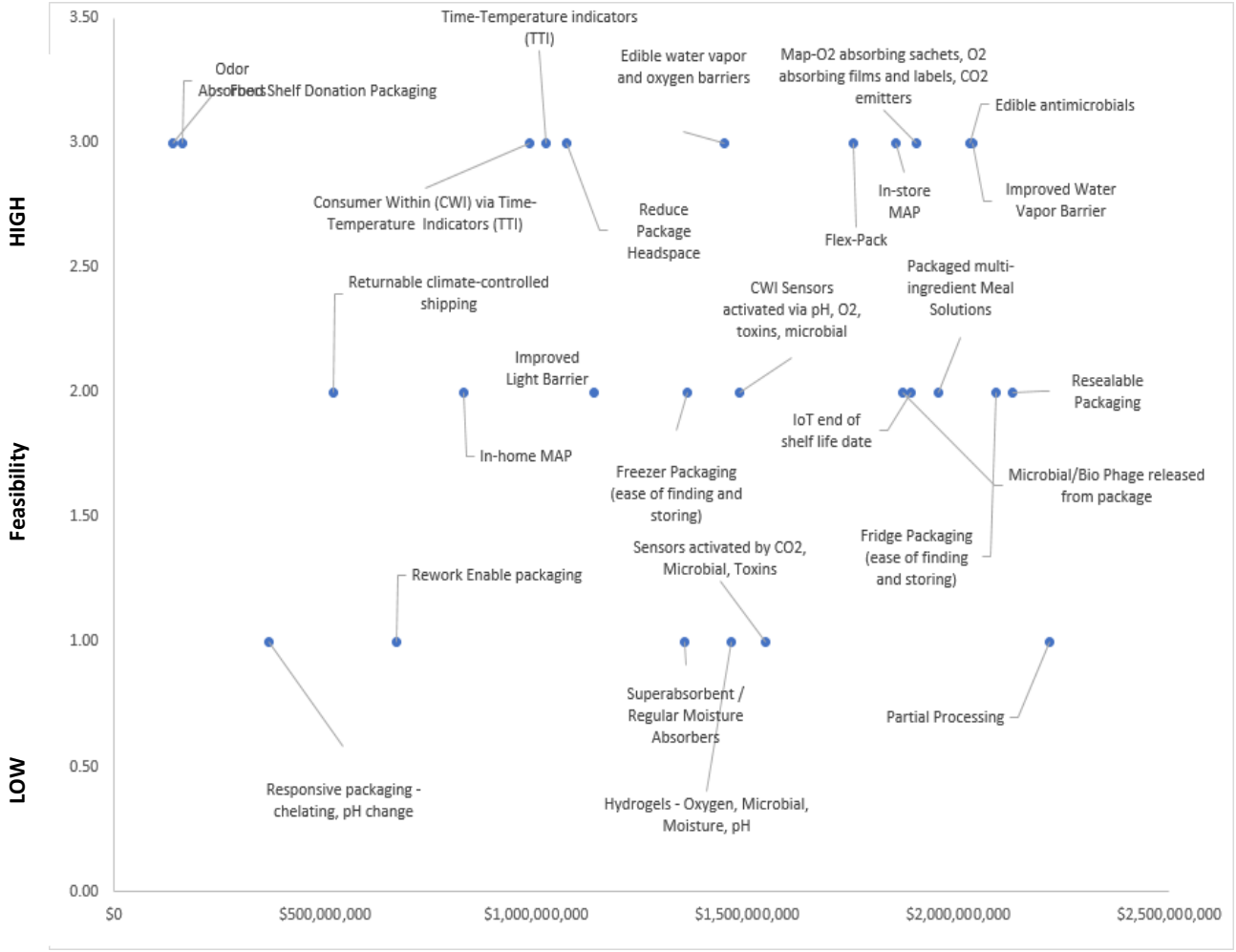
Results – Snapshot of Total Food Waste Reduction as a function of Feasibility



Dr Claire Sand is a Global Packaging Leader with 30+ years of broad experience in the food science and packaging spectrum. Skilled at leading cross-functional efforts, infusing innovative solutions, providing compelling business technology strategies and business cases, and pragmatic implementation roadmaps for the packaging and food industry. Dr Sand is Owner and Founder of Packaging Technology and Research, LLC and an Adjunct Professor at the University of Minnesota, Michigan State University and CalPoly as well as Food Technology's monthly Packaging columnist. Expertise is based on experience in basic research, development market research, and marketing in Germany, Colombia, and Thailand and at Total Quality Marketing, Nestle, General Mills, Kraft Heinz, Safeway, and in academia. Dr. Sand holds a doctorate degree in Food Science and Nutrition from the University of Minnesota and MS and BS in Packaging from Michigan State University.

Current Affiliations:

Owner and Founder

Packaging Technology and Research, LLC

Adjunct Professor

University of Minnesota
Michigan State University
California Polytechnic University (CalPoly)

Columnist

Packaging monthly columnist in Food Technology magazine

Claire@PackagingTechnologyandResearch.com
PackagingTechnologyandResearch.com

Current Leadership:

- Fellow, Institute of Food technologists
- pac, Co-Chair Food Waste
- IUFoST, Chair of Global Food Packaging Curricula
- Packaging Science and Technology, John Wiley and Sons, Editorial Board and Reviewer
- Journal of Food Science Reviewer
- Institute of Food Technologists (IFT) Higher Education Review Board (HERB)
- Institute of Food Technologists (IFT) Executive Board, Food Packaging Division
- Strategic Relations & Chapter Affairs committee Phi Tau Sigma (food science honorary society)
- Lifetime member of *Phi Tau Sigma*
- University of Minnesota Alumni Association and CFANS
- Member of IoPP

Dr. Ziynet Boz is a food and packaging engineer with 10 years of research and development experience. She is involved in national and global academic and industry-based research projects, published scholarly articles and developed and is a US patent holder. Her primary focus is applying engineering principles to food and agricultural systems. Her experience in both food and packaging engineering with a sustainability focus enables the translational science between these two fields. She has been working as a research consultant at PTR since 2017 and is the journal evaluator for the Journal of Food Science. Dr. Boz holds a Doctorate degree as a Fulbright Scholar in Packaging Engineering in University of Florida and MS and BS in Food Engineering from Mersin University with a dual degree in Chemical Engineering at the Institute of Chemical Technology, Prague.

Current Affiliations:

Research Consultant

Packaging Technology and Research, LLC . Stillwater, Minnesota. 2017-present

Journal Evaluator

Journal of Food Science. Chicago / IL

Assistant Professor of Sustainable Food Systems Engineering

University of Florida, Agricultural and Biological Engineering, (*Aug-2019)*

Current Leadership:

- Fulbright Fellow
- Packaging Science and Technology, John Wiley and Sons, Reviewer, 2016-present
- Journal of Food Science Reviewer, 2016-present
- Journal of Food Engineering Reviewer, 2016-present
- Institute of Food Technologists (IFT) Executive Board, Food Packaging Division, 2014-present
- CleanTech Competition Judge 2014-Present
- Lifetime member of *Sigma Alpha Epsilon*
- PPWN Leadership team member
- TAPPI member
- AAUW member
- WISE member

Thank you

Questions

Research funded by ReFED