Leveraging Packaging Within a Cluster

FaB
FOOD and BEVERAGE WISCONSIN

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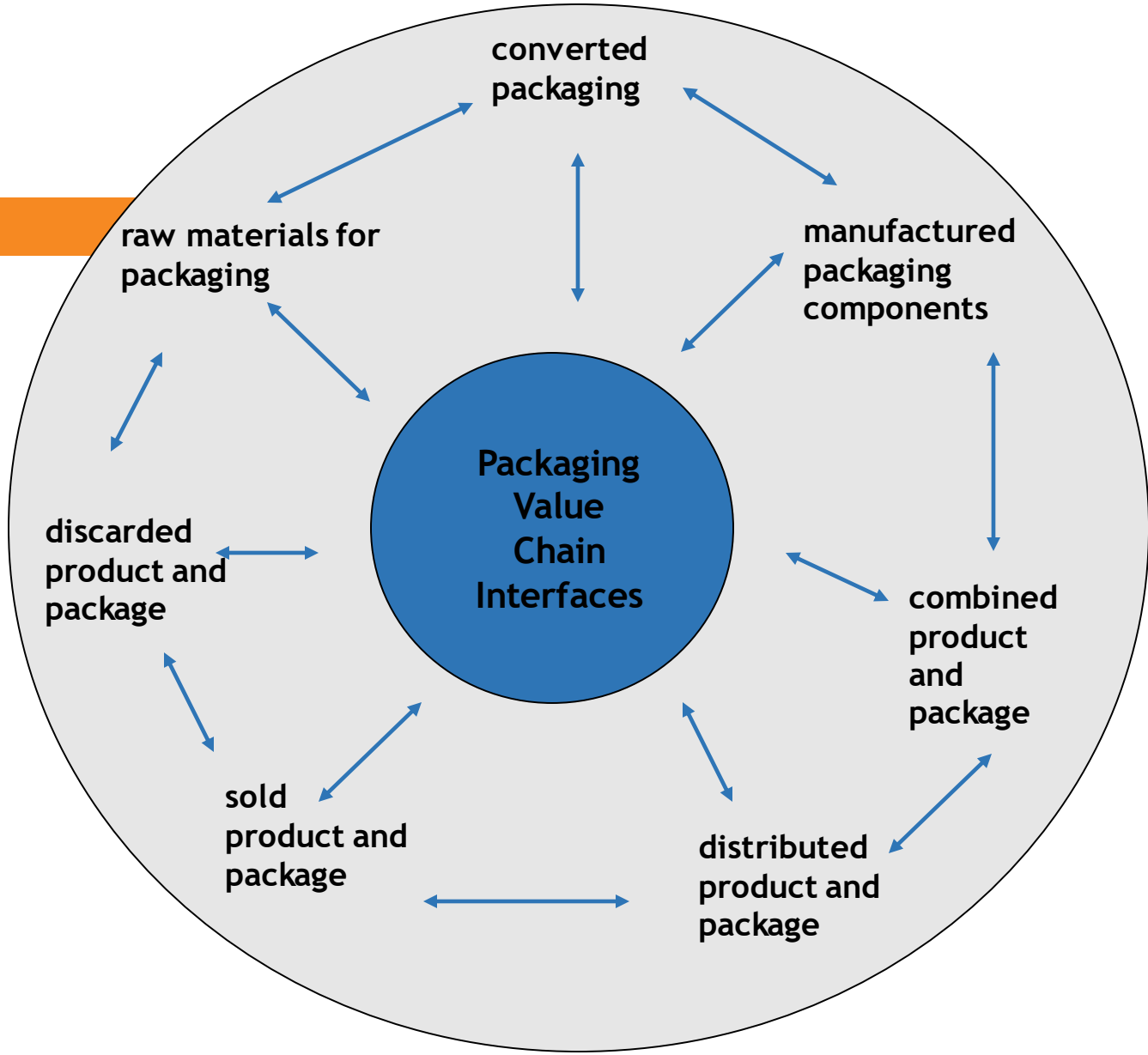
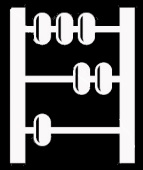
Leverage Packaging



Outline

Create Sustainable links

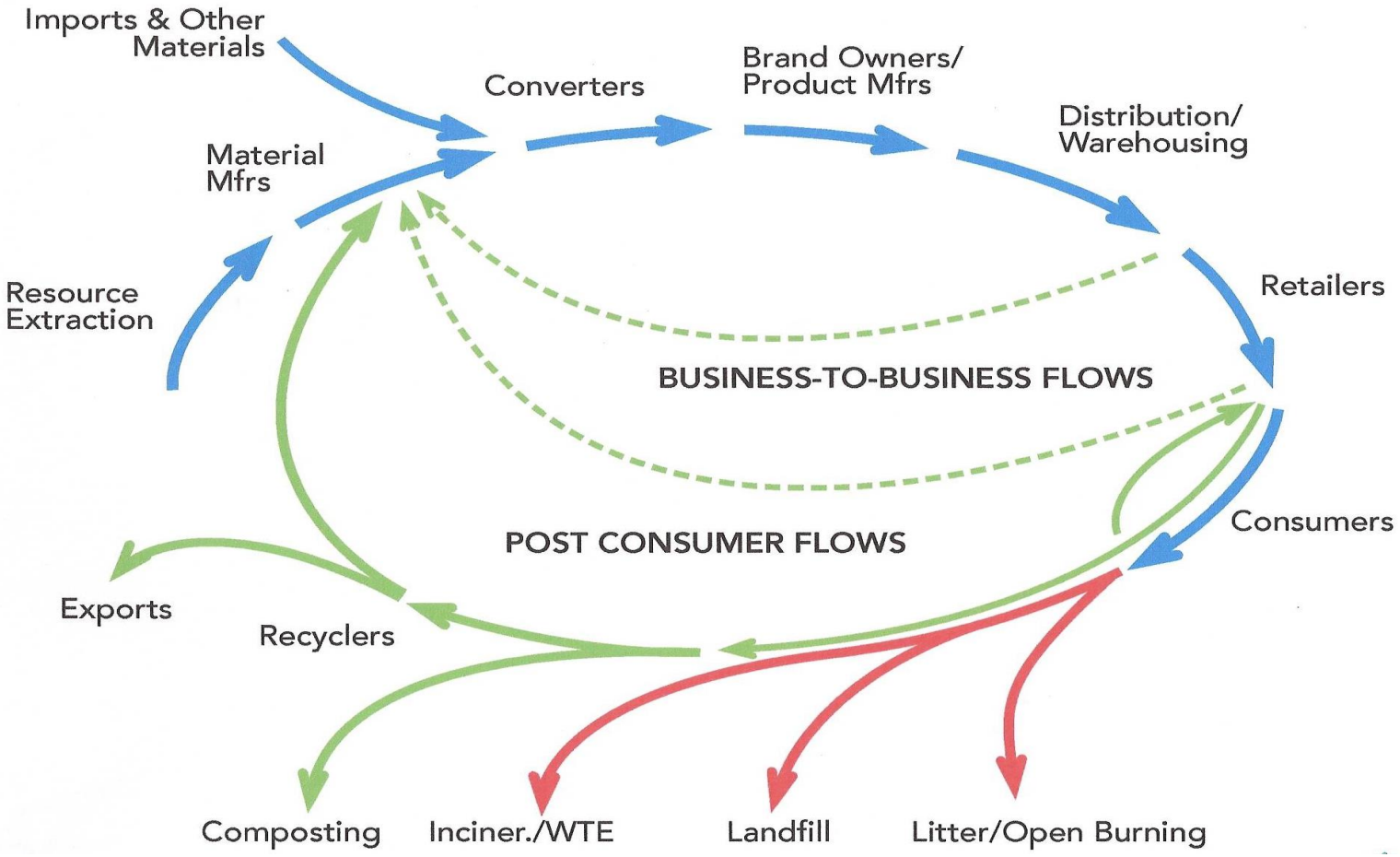
Build Intelligent links



Innovate with agility

Create Sustainable links

Packaging Life Cycle



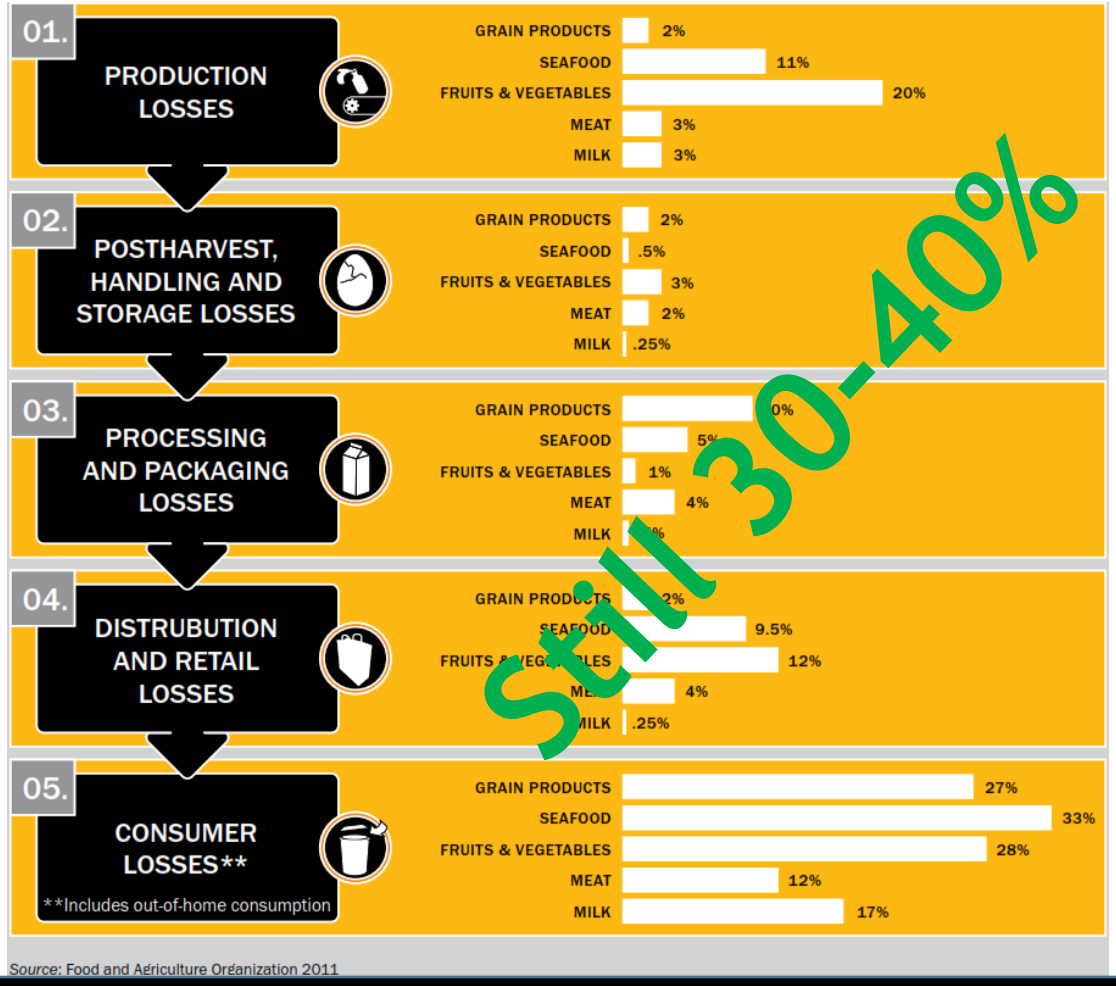
The Waves of Sustainability

- 2nd Wave
  - 1969 and the Cuyahoga River was burning
  - Silent Spring
  - Weather inversions in London and NYC
  - Earth Day and EPA 1970
  - Ended in USA in 1990s
  - 26th anniversary of *Grune Punkt*
    - near-infrared separators, eddy flow separators and metal separators reduced the cost of recovering plastics 95%
- 3rd Wave
  - Benefits of global supply, TBL, PPP, CSR

4th Wave – Sustainability: Age of Reason

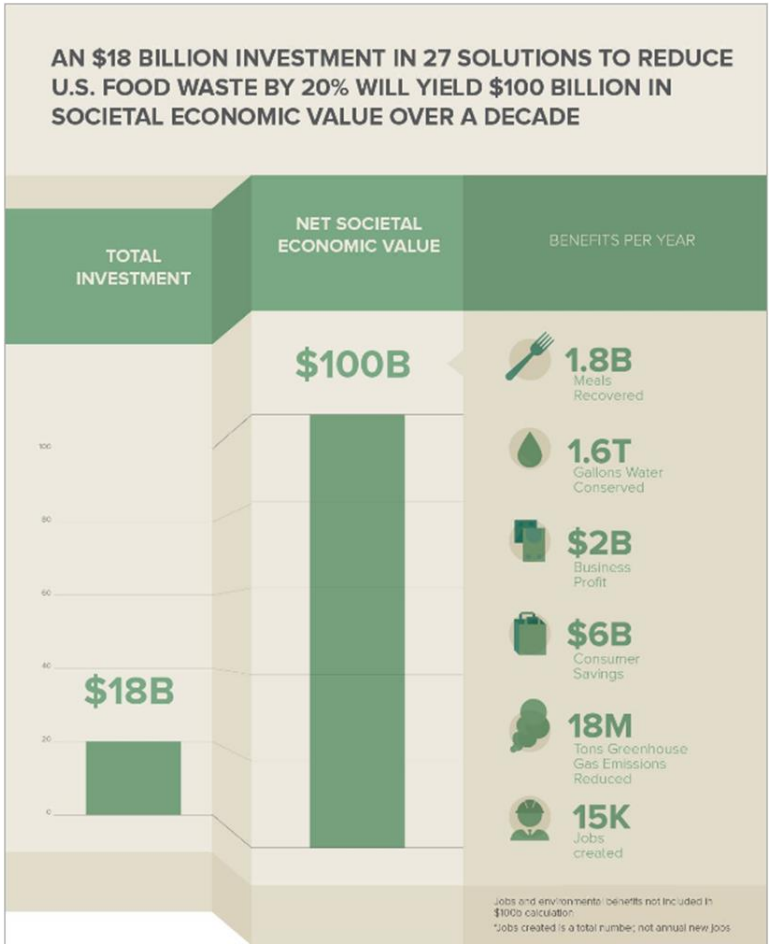
- Motivated by negatives:
  - Greenwashing
  - LCA mania
- Motivated by positives:
  - Food waste awareness
  - Global brands & packaging supplies

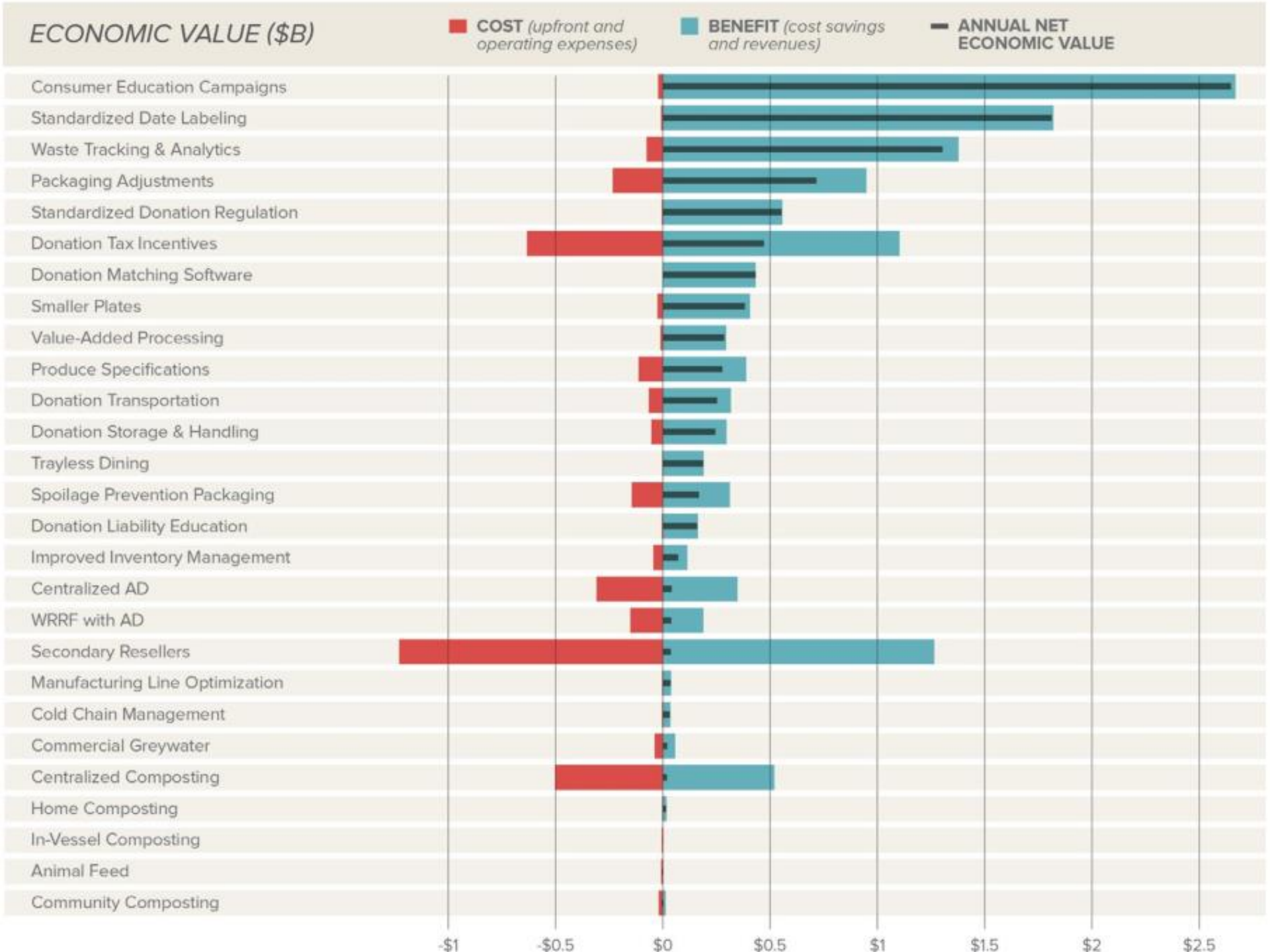
Sustainability: Food waste awareness



Sustainability: Food waste rationale

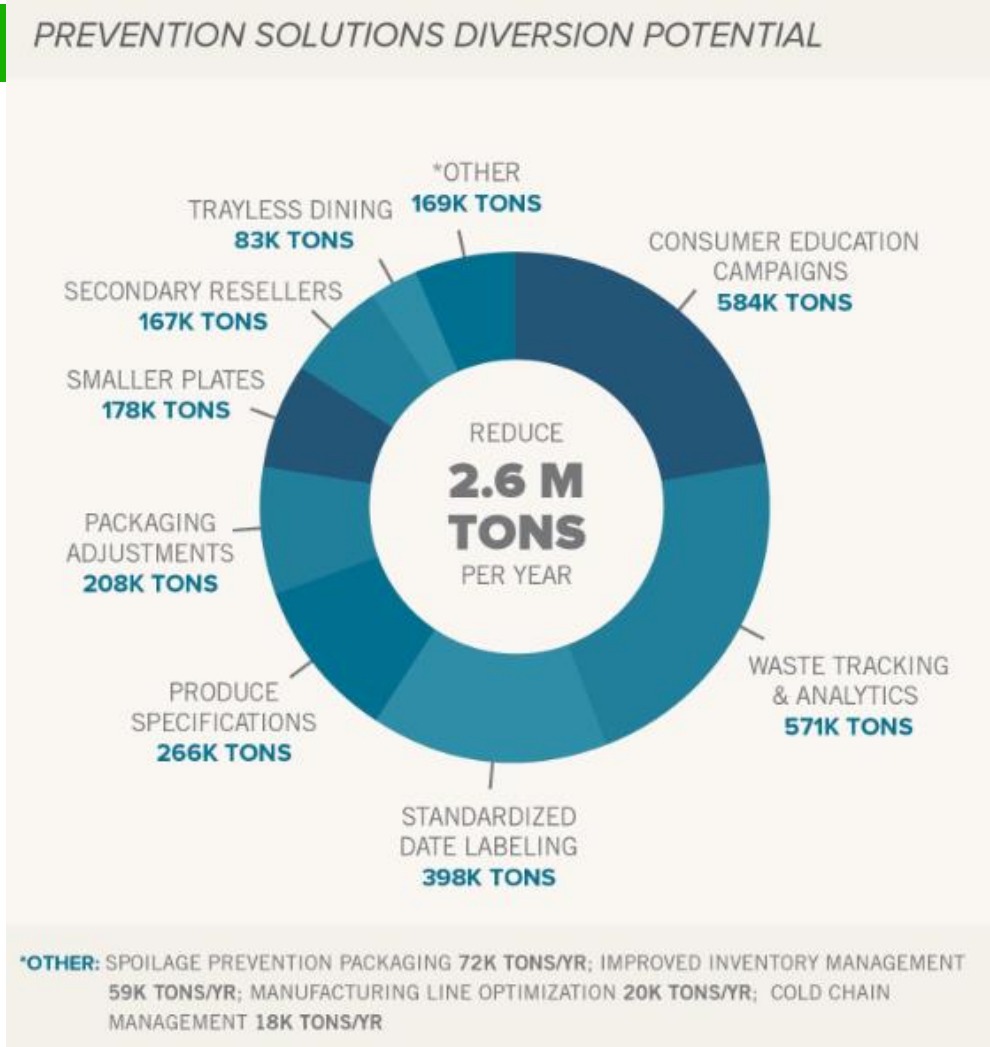
- Business case for reducing food waste




ECONOMIC VALUE ($B)
COST (upfront and operating expenses)
BENEFIT (cost savings and revenues)
ANNUAL NET ECONOMIC VALUE
Consumer Education Campaigns
Standardized Date Labeling
Waste Tracking & Analytics
Packaging Adjustments
Standardized Donation Regulation
Donation Tax Incentives
Donation Matching Software
Smaller Plates
Value-Added Processing
Produce Specifications
Donation Transportation
Donation Storage & Handling
Trayless Dining
Spoilage Prevention Packaging
Donation Liability Education
Improved Inventory Management
Centralized AD
WRRF with AD
Secondary Resellers
Manufacturing Line Optimization
Cold Chain Management
Commercial Greywater
Centralized Composting
Home Composting
In-Vessel Composting
Animal Feed
Community Composting
-$1
-$0.5
$0
$0.5
$1
$1.5
$2
$2.5

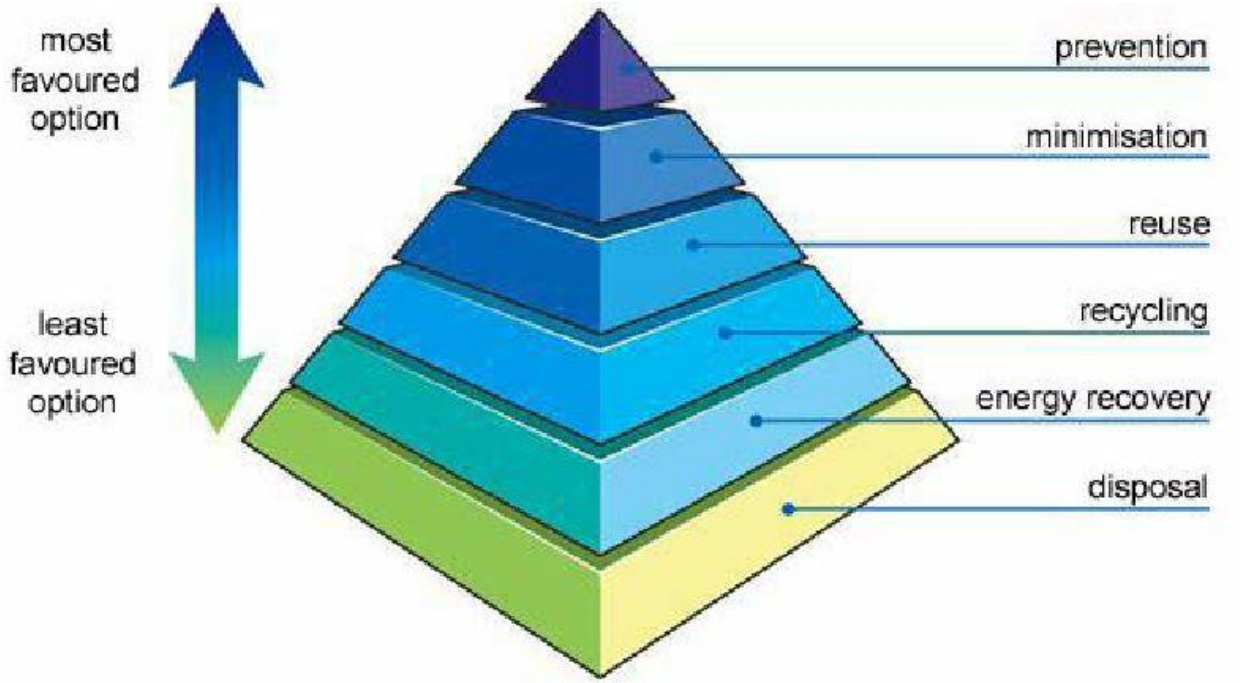
Sustainability: Business potential in reducing food waste

- Drives packaging investments
- Shared value alters costs and benefits
  - LiquiGlide, a nontoxic food packaging coating that increases the consumers ability to get all of the food out of containers (e.g. ketchup bottles)
- Hello Fresh!
- BluWrap

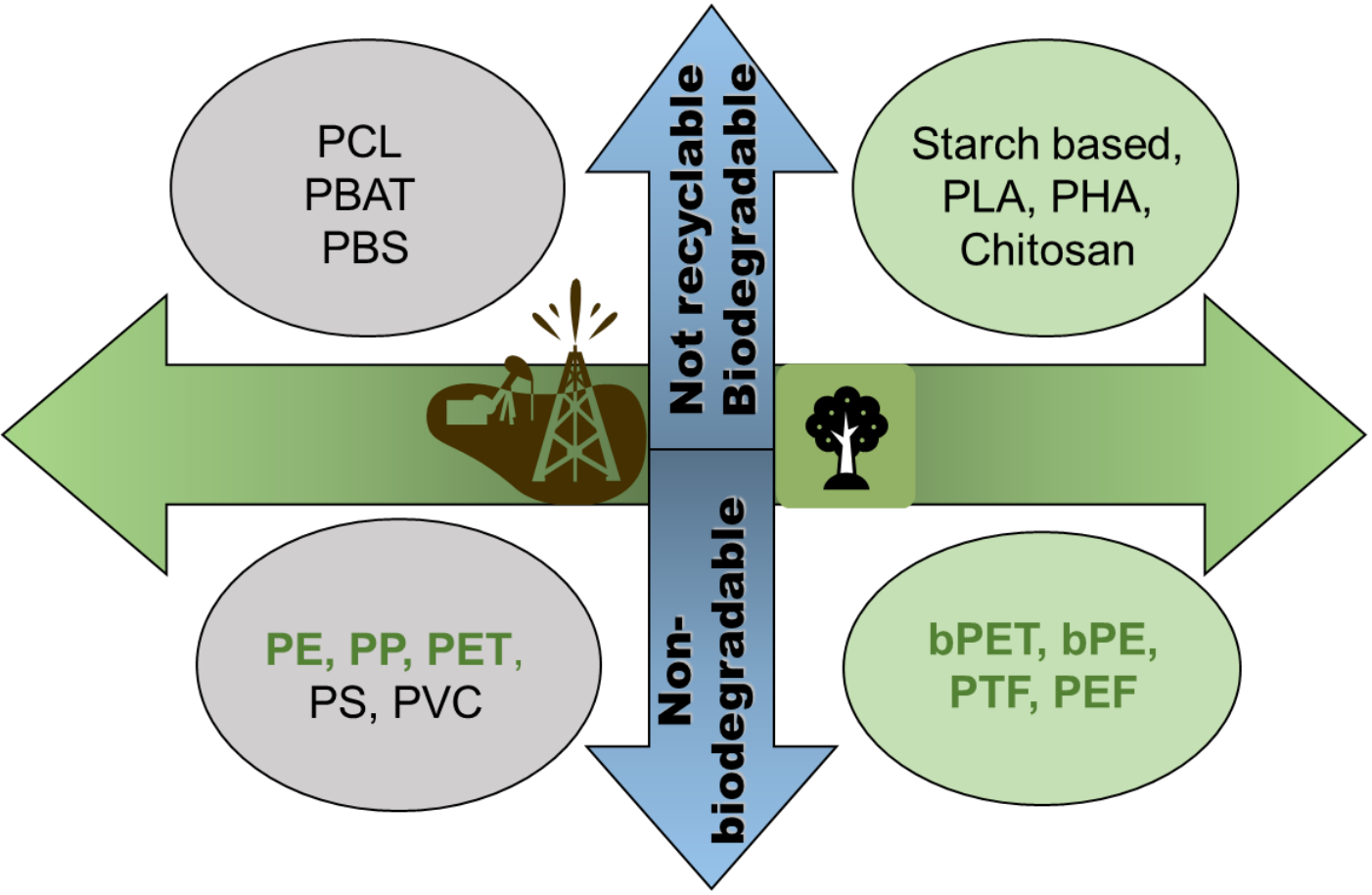


Sustainability: Global brands & packaging suppliers

- Same situations-small families, no families
- Packaging material development

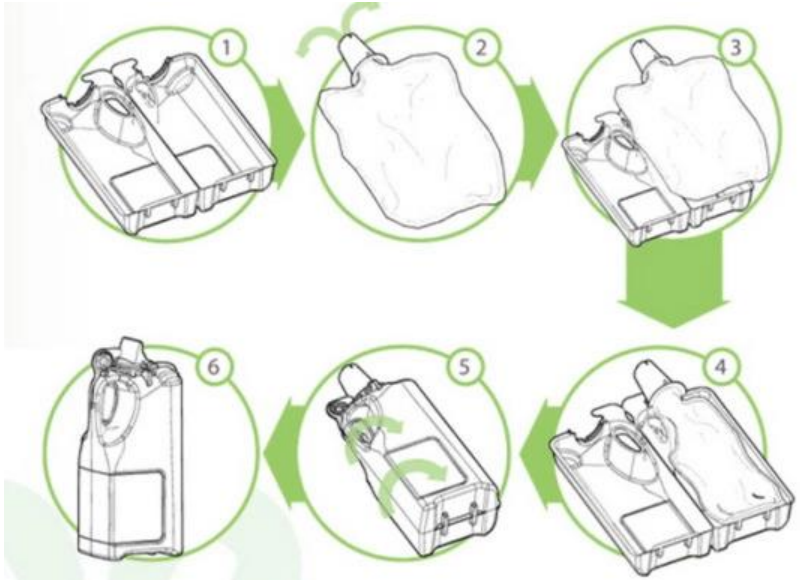


Sustainability: Alphabet soup



PCL = Poly (e-caprolactone)
PBAT= Poly(butylene adipate-*co*-terephthalate)
PBS = Polybutylene succinate
PE = Polyethylene
bPE = Bioderived Polyethylene
PP = Polypropylene
PS = Polystyrene
PET = Polyethylenterephthalate
bPET = Bioderived Polyethylenterephthalate
PVC = Polyvinylchloride
PLA= Polylactic Acid (Polylaktate)
PHA = Polyhydroksyalkanoate
PTF = Polytrimethylene furandicarboxylate
PEF = Polyethylene furanoate

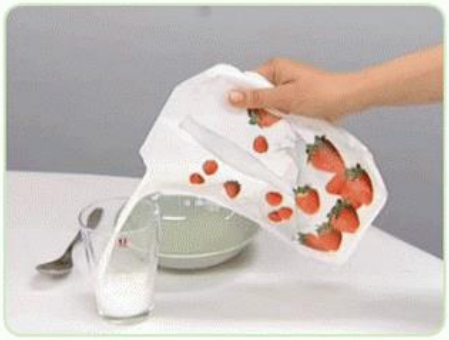
Sustainability: More sustainable choices



Seventh Generation bottle
Consumes about 33% less energy to produce
Carbon Footprint that is 48% lower than plastic

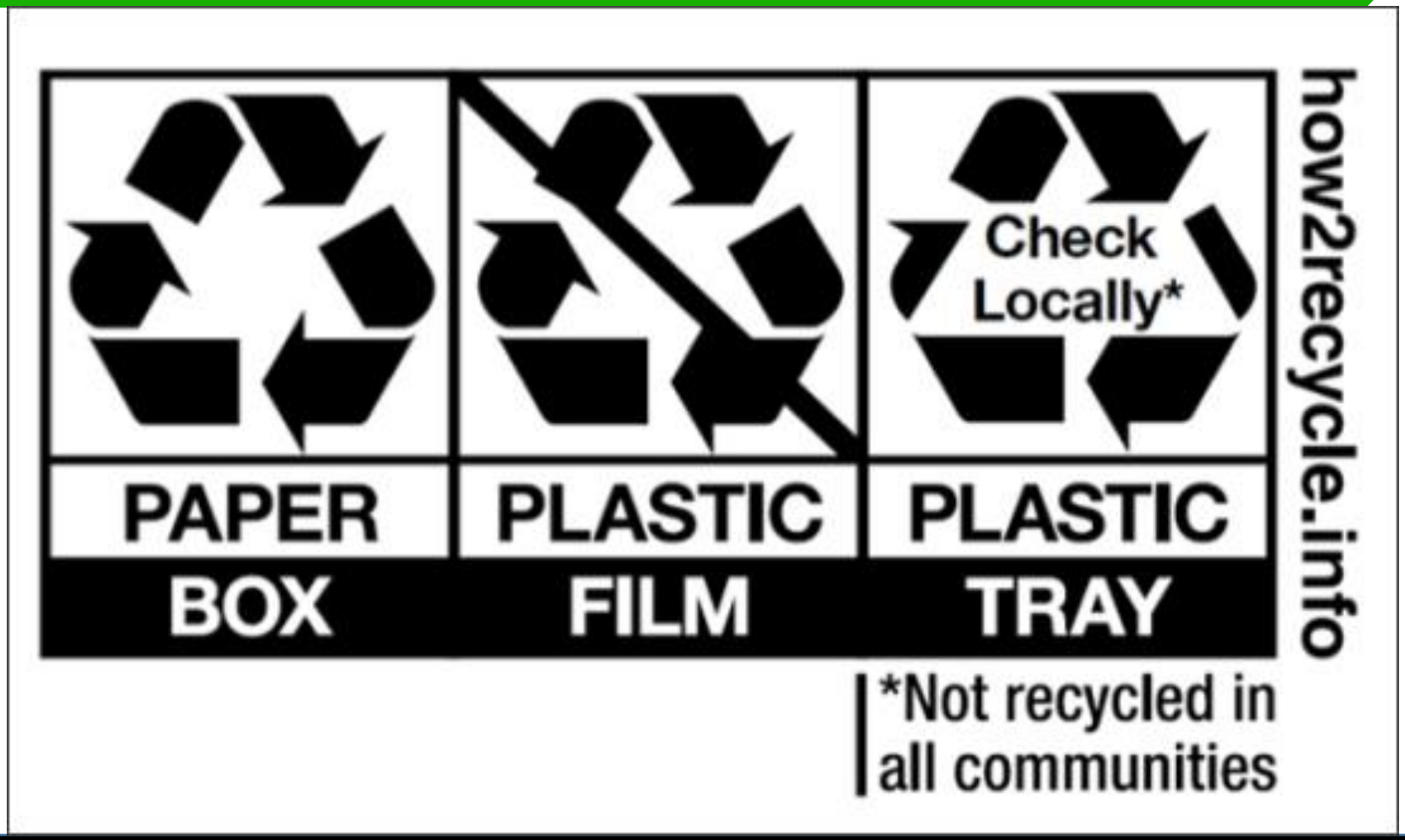
Sustainability: More sustainable choices

ENERGY	GREENHOUSE GASES	FOSSIL FUELS	CRITERIA AIR POLLUTANTS	ACIDIFICATION POTENTIAL	WATER USAGE
REDUCED COMSUMPTION 19%	REDUCED EMISSIONS 13%	REDUCED USAGE 15%	SOx REDUCED 15% NOx REDUCED 13% PARTICULATES REDUCE D 11%	REDUCED EMISSIONS 14%	SAVED 7%



Calcium Carbonate stiffens HDPE

Sustainability: VC derived labels



Sustainability: Links with packaging

- New partnerships address shared value
  - Resources
    - Coke and BFS
    - Earthwise Environmental-water
    - Design for Recovery
    - Build Composting and Recycling Infrastructure
  - Retailers & Distributors
    - Enable recycling on site
    - EVOH and Dow
    - Closed loop returnables
    - DC optimization (rings)

How to leverage sustainable links in FaB

- Identify new partnerships as a group that address shared value in sustainability (for example):
  - Manufacturing
    - Common resources and learning curves in lowering energy costs
  - Resources
    - Common resources and sustainability goals
  - Retailers & Distributors
    - Link with retailers to help solve joint issues with packaging and product solutions-mutual benefit to address e-commerce
    - E-commerce-link with to meet packaging and product needs
  - Packaging suppliers
    - New materials with common packaging structures

Outline

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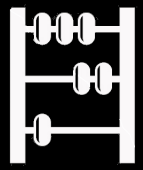
Build Intelligent links



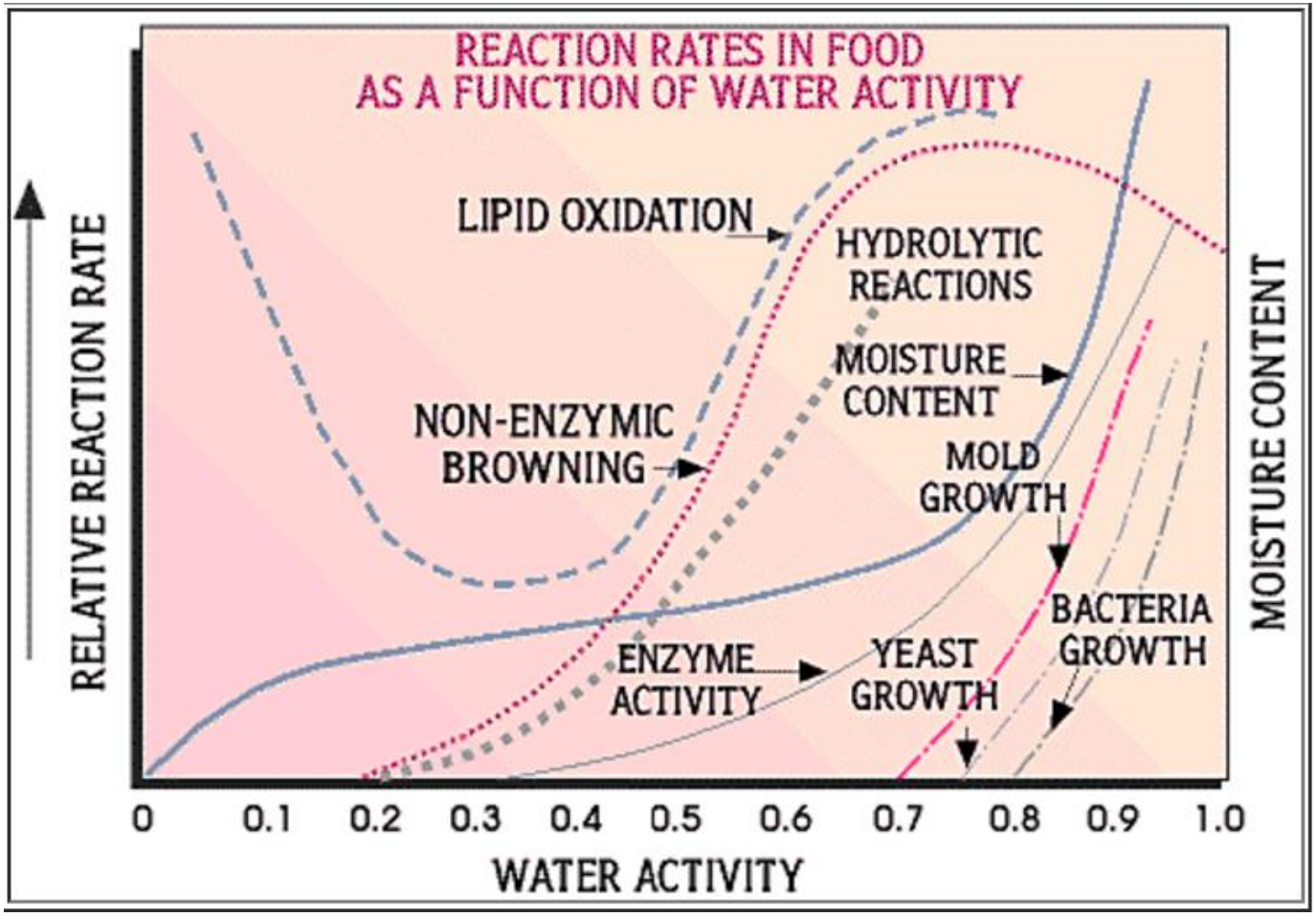
Innovate with agility

Build Intelligent links

Build intelligent links

- Connect food spoilage solutions
  - Barriers
  - Technology in packaging and process
- Access to intelligent packaging
  - Branding and communication
  - Fraud
  - Value chain

Intelligence: Food spoilage commonalities

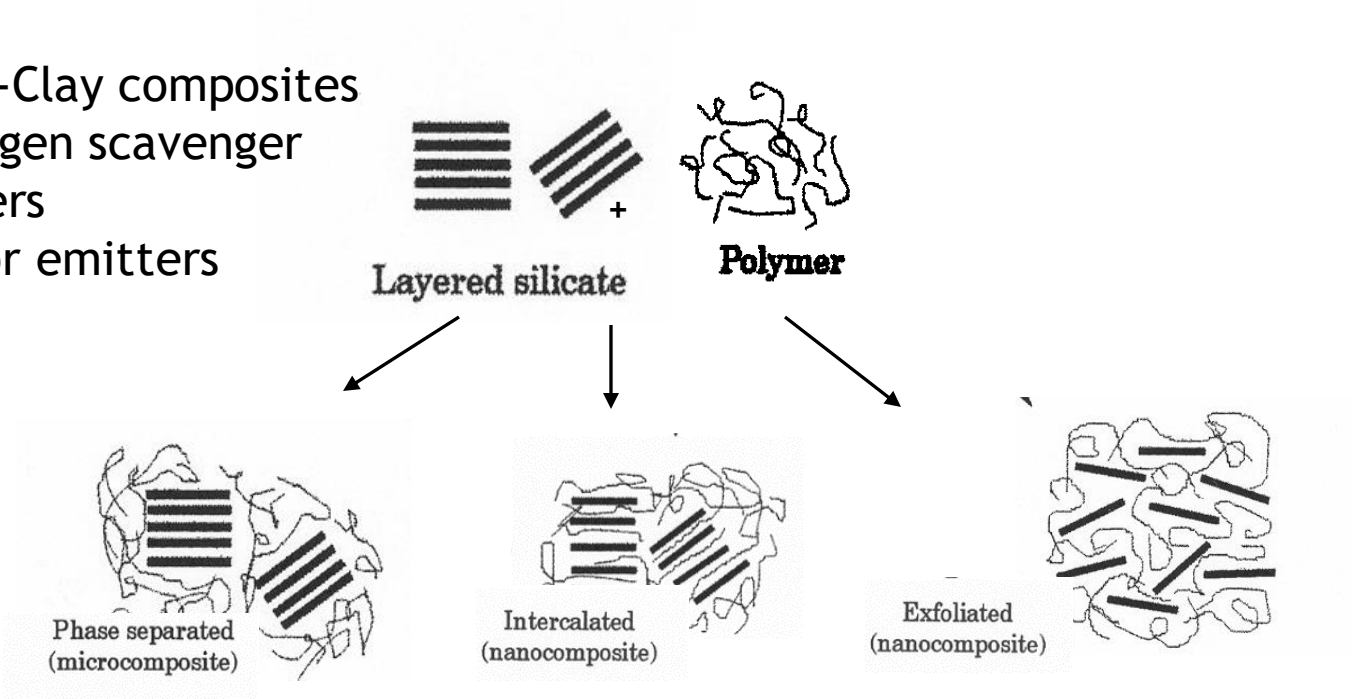


Intelligence: Common barrier technologies

- Common OTRs (cc/m^2dayatm)
  - PET – 0.22
  - HDPE - 2.6
  - PP – 11
  - LDPE - 20
  - Paper/polymer – variable
  - Combinations paper-metal-polymer - ~0

Intelligence: Better barriers w nanotech

- Polymer-Clay composites
  - Oxygen scavenger layers
  - Odor emitters



Intelligence: Barriers and controlled release

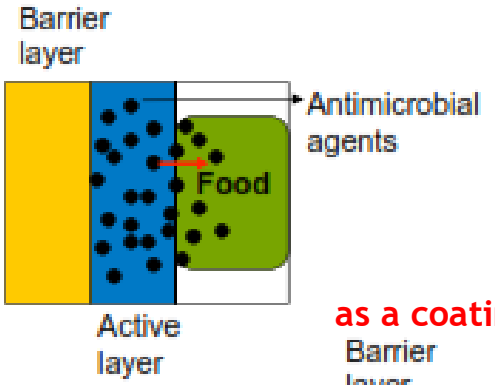
- Humidity from respiring produce triggers the release of ClO_2 at low, sustained doses to enhance product safety, shelf-life, and quality
- Controlled release of ClO_2 in polymers

Intelligence: Edible film tech

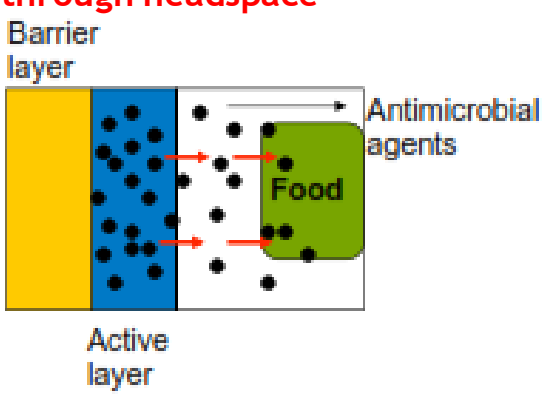
- Films and coatings
  - Moisture barriers
  - Antimicrobials
  - Glazes, etc.

Intelligence: Antimicrobial tech

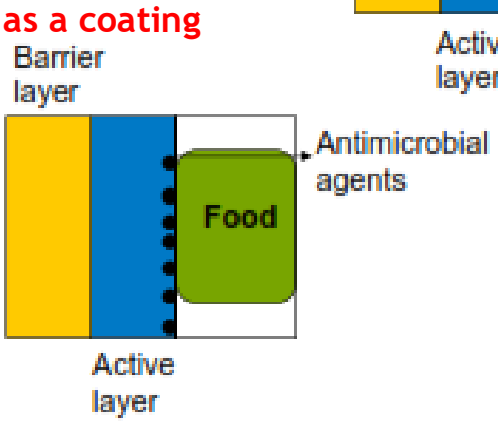
within a structure



through headspace



as a coating



Intelligence: Antimicrobial

Antimicrobial	Food Safety Microbes	Food Quality Microbes	Categories Tested	Packaging Materials Tested	FDA	EU	FAO/WHO	Manufacturers	Economic	Social Issues	Technology	Innovation	Recommendation
Nisin	Listeria (with Lysozyme); E. coli (with EDTA); Salmonella	Not assessed	Meat, cheese, seafood, perishable processed food	Cellulose and SPI, zein, WPI, LDPE, cellophane, paper, chitosan	GRAS	E234; Restrictions to cheese, eggs, puddings	Approved	Numerous	Costs are not standard and are based on desired result; concern with resistance promotoes use of other bacteriocins in tandem	Increased resistance possible; considered natural	Abundance of studies due to nisin's commercial availability	Use bacteriociins synergistically; bioengineering for increased efficacy; refine coating distribution	Pursue
Pediocin	Listeria	S. aureus and B. cereus	Processed meat (ham, bologna, smoked fish)	WPI coated PP, Cellulose	GRAS	Not approved		Minimal	Concern with resistance promotoes use of other bacteriocins in tandem	Increased resistance possible; considered natural	Limited studies	Use bacteriociins synergistically; bioengineering for increased efficacy; refine coating distribution	
Lacticin	Clostridia and Listeria	S. aureus, Bacillus, Lactococcus, Lactobacillus	Cottage cheese, cheese, milk, orange juice, egg, water, ham, turkey breast, smoked salmon	Zein, WPI, Paper board with AP; PE, Pectin/PLA composite Cellophane	GRAS	Not approved	Approved by 50+ countries	Laboratories	Concern with resistance promotoes use of other bacteriocins in tandem	Increased resistance possible; considered natural	Limited understanding beyond use as additive	Use bacteriociins synergistically; bioengineering for increased efficacy; refine coating distribution	Pursue
Chitosan	E. coli	S. Aureus, P. fragi, B. subtilis	Seafood	PVA, PE, carrier of other antimicrobials	GRAS	Not approved		Multiple	Innovations and use in water quality and fuel cells may lower prices or increase demand to increase prices	Non-toxic, biodegradable, and biocompatible	Abundance of research; variability of results due to natural origin	Combining with other antimicrobials to increase spectrum; identify optimum molecular weight and polymerization	
Lysozyme	Listeria; E.coli (with lactoferrin or EDTA)	S. Aureus, P. fragi, B. subtilis, L. plastarum	Tuna; sushi, raw and processed meat	Cellulose, paper, zein, SPI, PVOH, surface immobilization	GRAS	E1105; approved for cheese and beer		Numerous chemical companies	Need to combine with lactorferrin or EDTA to inhibit E.coli	Considered natural	Abundance of research; variability of results due to natural origin	To attain both Listeria and E. coli inactivity, determine optimum EDTA or lactoferrin concentration	Pursue
Lactoperoxidase	Listeria; E. coli	Yeasts, Molds	Salmon and roasted turkey, milk, cheese, vegetables	•WPI, alginate	GRAS	No approved	Recommended when adequate cooling unavailable in dairy	Numerous chemical companies	Whey derivation lowers cost	Advocacy by FAO has increased awareness	Efficacy a function of LPS, thiocyanate, and H_2O_2	Activation by H_2O_2	Pursue
Plant Extracts	E. coli (Oregano); Listeria (Neem)	S. aureus (Grapefruit seed, green teat)		SPI, WPI, chitosan, casein	GRAS	Approved	Approved	Numerous	Costly due to extraction	Taste preferences inhibit use; no labeling issues	Not applied beyond laboratory stages	Natural/organic platform; improving efficacy	Pursue as natural/organic platform
Metal ions	E.coli , Listeria (Titanium), Ziinc, Silver, Copper); Salmonella (Zinc and nisin)	S. aureus	Meat, sliced fruit, eggs, orange juice	Glass, metal, polymers, chitosan, zein, cellulose	Defined amounts	Defined amounts	Defined amounts	Numerous	Silver most costly	Consumer familiarity; Environmental and increased resistance; Limit migration into food is paramount	Nanoparticles most effectives due to shigh surface area	Medical research applicable to food packaging	
Surface Treatments	E. coli	Antifungal	Meat, produce	Paperboard, polymers	by-products would need approval	by-products would need approval	by-products would need approval	Internal	Variable	resultant additives require acceptance	Skill set within converters	Adapt processes from medical packaging; plasma activation; GRAS by-products	Pursue to expand core competency
Acids, Salts, Anhydrides	Listeria and E.coli (Sorbic Acid); Listeria (Lauric acid and EDTA)	Yeasts, Molds	Meat, produce	Coatings on various substrates	Most are GRAS	Defined amounts allowed	Defined amounts allowed	Numerous	Variable	Consumer familiarity	Processes of inactivation are well known	Refined efficacy	Pursue
Chlorine Dioxide	Listeria, Salmonella	Not Evaluated	Produce	Known permeability to ClO_2	Considered a treatment	E926 under consideration		Numerous	Systems in place lowers cost	Color issues; Connected to household disinfectant	Technology well known	Explore ability to recharge system	

Intelligence: New and emerging technologies in processing

- HPP
- MATS
- Ohmic
- PL
- ?

Intelligent Packaging

- Branding & communication
- Temperature/etc. monitoring
- Track and trace-fraud

Intelligent Packaging: Branding & communication

- Intelligent packaging expands brand image potential
- Canadian brand with pulses

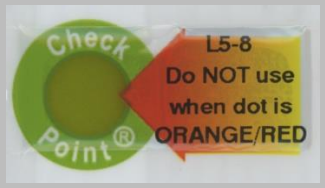
Intelligent Packaging: TTIs

- *FreshCode*, Varcode and*Tempix*, Tempix
  - fading barcodes

- *CoolVu*
  - aluminum layer thins causing a reaction

- *FreshMeter*
  - turns from blue to gray via benzopyridine photoactivation

- *L5-8 Smart Seafood*
  - irreversible color change from the hydrolysis of triglycerides



Intelligent Packaging: Degradation sensors

- High surface to volume ratio of nanofibrous membranes and
  electrospun sensors
- Based on surface enhanced Raman spectroscopy (SERS)
  - Measures total volatile basic nitrogen (TVBN)
  - Monitors cysteine loss via hydrogen sulfide
  - Color change indicator that activates as microbial growth increases
- Advances in wireless nanosensor networks (WNSNs)
  - Graphene printing and conductive polymers
    - enables wireless communication between nanosystems
- Incorporate antibodies (for detection) within polymer films

Intelligent Packaging: Responsive sensors

- Responsive sensors that detect then act to reduce deteriorative reactions
  - Through the release of CO_2, antioxidants or pH change agents
- Tremendous amount of IP in this area

<u>Current solutions</u>

- Measures total volatile basic nitrogen (TVBN)
- Monitors cysteine loss via hydrogen sulfide
- CO_2 sensors indicate freshness loss as produce respires
- Color change indicator that activates with microbial growth

Intelligent Packaging: Reduce fraud

Need to reduce fraud is high:

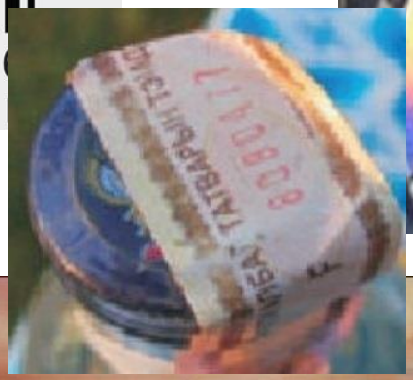
$62.5

billion industry by 2020

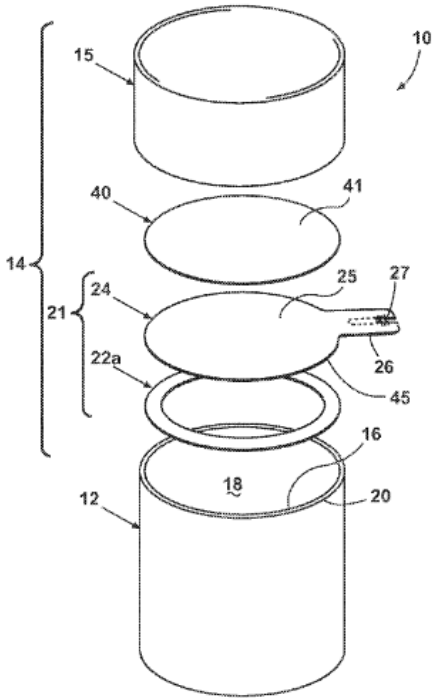
Food and packaging fraud are intertwined from ingredients to finished goods

Intelligent Packaging: Deter fraud (overt)

Overt authenticity is refined and solutions exist



Intelligent Packaging: Detect fraud (covert)



Intelligent Packaging: Status

- TTIs continue to be the standard
- For optimum safety, focus on degradation sensors in 3-5 years
- Assess branding and authenticity link to balance costs
- For nutritional waste reduction and safety, focus on responsive sensors in 3-5 years

How to Leverage Intelligence in FaB

- Identify new partnerships as a group that address shared value in intelligence:
  - Marketing
    - Branding and communication
  - Barriers & Shelf life
    - Common technology access
  - Retailers & Distributors
    - Track and trace
    - Fraud (FIDES)
    - Branding
  - Packaging suppliers and food suppliers
    - New materials with common packaging structures

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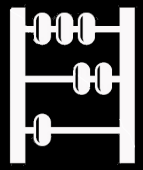
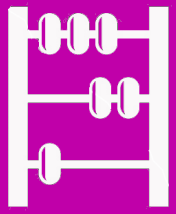


Innovate with agility



Innovate with agility

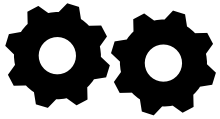
Innovate with agility

- Innovation requires the agility to meet changing value chain needs

- Need shared value in relationships
  - Consumer–fickle
  - Distributor/Retailer-real or virtual
  - Manufacturing - copacker or you
  - Packaging supplier

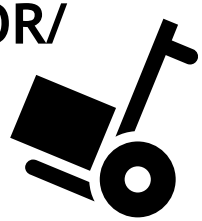
Packaging Challenges that Need Innovation/agility

MANUFACTURER



- Reduce contamination during product fill
- Assess initial microbial load
- Reduce initial microbial load
- Enable HACCP, etc.
- Address chilled worker conditions

DISTRIBUTOR/ RETAILER



- Enable stock rotation
- Time &Temp monitoring system
- Oxygen level monitoring system
- Control temperature
- Control microbial load at POS

CONSUMER/SOCIETY

- Enable safe package reuse
- Reduce consumer contamination from repeat use
- Expand time for safe product use
- Enable storage
- Portions
- Sustainability

Innovation/agility: Connect beyond immediate

- Gain tactical knowledge
- Expand value chain focused on needs at each point
- Use less internal resources to address problems
- Build structure for continual innovation

Innovation/agility: Economic reshuffling

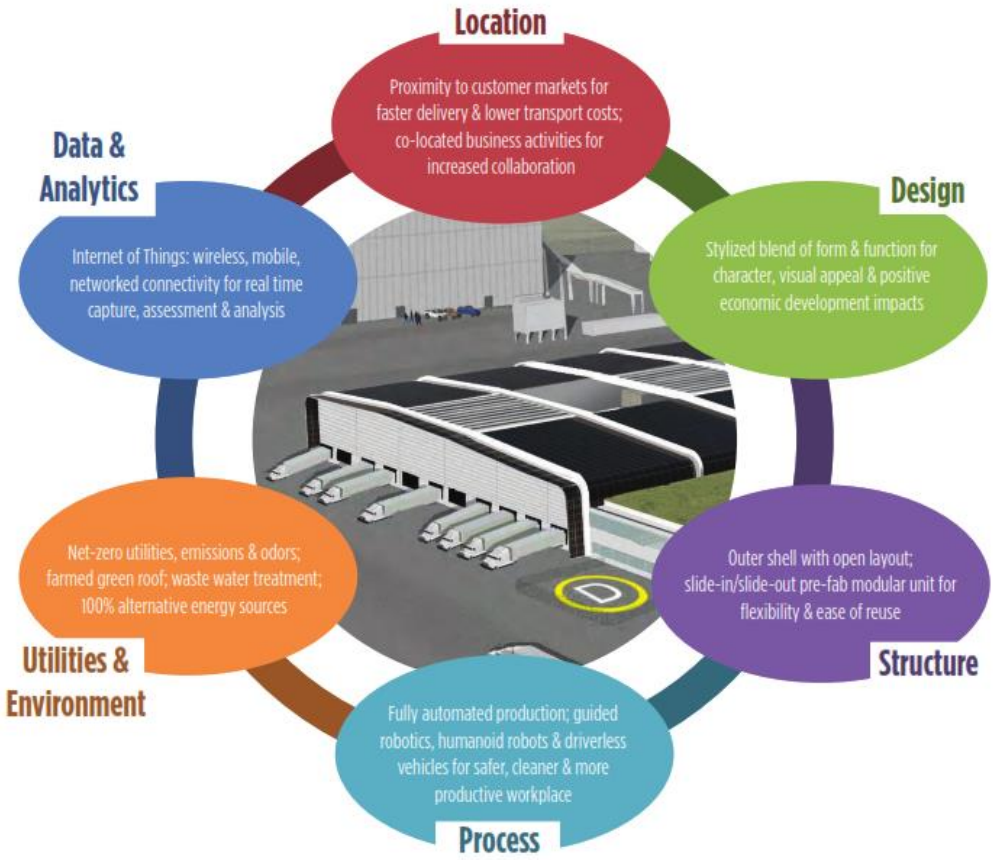
- Packaging can **enable** affordable choices the 4 billion+ consumers at pyramid's base
- Packaging needs to technically **leapfrog** to provide product protection and a market
- Packaging can **facilitate** manufacturing value added goods versus raw material exports
  - Reveals opportunity to use **historically** indigenous materials (jute)
- Research **potential** in facilitating leapfrogging in technology is high

Innovation/agility: Refine/flex distribution

- Packaging can **facilitate** the distribution via alternative channels (versus traditional models) to meet urban needs
  - A future value chain defined by consumer led value will optimize packaging based on global urban and rural consumers
    - Example-Medical contract packaging & Anderson's window walls & UHP
  - Optimal packaging technology focuses on post consumer **disposal** in urban areas (DSD)
  - Consumer specific packaging is growing
  - Packaging research on **predictive** restocking (beyond RFID) to make consumer and post consumer packaging seamless

Innovation/agility: Provides inherent opp.

- 6 weeks from idea to nationwide launch to *immediate* launch
- Data tracking



Yogurt Example

- Changing retail
- Product on market 2 years
- Disconnect to health for many ages
- Experience Solutions
  - Retail
  - In home
- Product (aging men, teens now)
- Packaging
  - Why?

Yogurt: everyone gets a golden ticket

Innovation/agility: Manufacturing

Innovation/agility: Manufacturing

THE FLEXIBLE FOOD PROCESSING PLANT OF THE FUTURE

- Architecturally significant, energy efficient building envelope with sleek design features and attractive landscaping
- Single level, open plan to facilitate modular conversion within production areas and interaction and collaboration among user groups
- Minimal use of hard-to-remove concrete
- Light-weight materials like polyurethane core-filled stainless steel
- Self-contained modular buildings-within-buildings for efficient conversion to future uses
- Modular floor drain system installed over base level floor with sub-floor in between to enable draining
- Retractable and expandable walls and roof system for module transfer and higher ceiling heights for future uses
- Maximized roof span and minimized roof-top equipment; farmed green roof
- Robotic transportation routes for material flow; 3-D printers for parts replacement
- Air filtration system for reduced risk of air-borne contaminants and elimination of biological odors
- Segregated spaces to minimize risk of cross-contamination, contain noise, and reduce downtime during a conversion process
- Sustainable on-site renewable energy, with wind, solar, battery-enabled energy storage, and maximized use of natural light
- On-site water generation and waste water treatment
- LED lighting and lighting control systems
- Centralized distribution of utilities and flexible connections
- Environmentally-benign refrigerants
- Perimeter employee amenities such as outdoor break and activity areas
- Co-located research and development, packaging for grocery shelves, marketing, offices, cold storage
- On-site rendering plant to prepare animal by-products for sale in secondary markets
- Net-zero utilities, waste, and emissions
- Internet of Things: fully networked facility connecting food safety, environment, quality, operations, inventory, process, packaging, facility monitoring and management

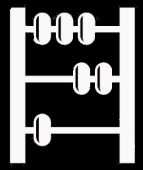
How to leverage agility links in FaB

- Identify new partnerships as a group that address shared value in agility (for example):
  - Manufacturing
    - Common resources needed to fast launches
  - Retailers & Distributors
    - Leverage location to meet needs better
    - LED lights
    - Packaging can help Retailers drive fast launches
    - Enable co-distribution, shelf in and outs
    - E-commerce-link launches
  - Packaging suppliers
    - Beyond price and into shared agility in response
    - Build in agility in machinery, materials, plans
    - Fused Deposition Modeling
      - Molded pulp mold cost from $30,000 and 2 weeks to $500 and 2 days

Outline

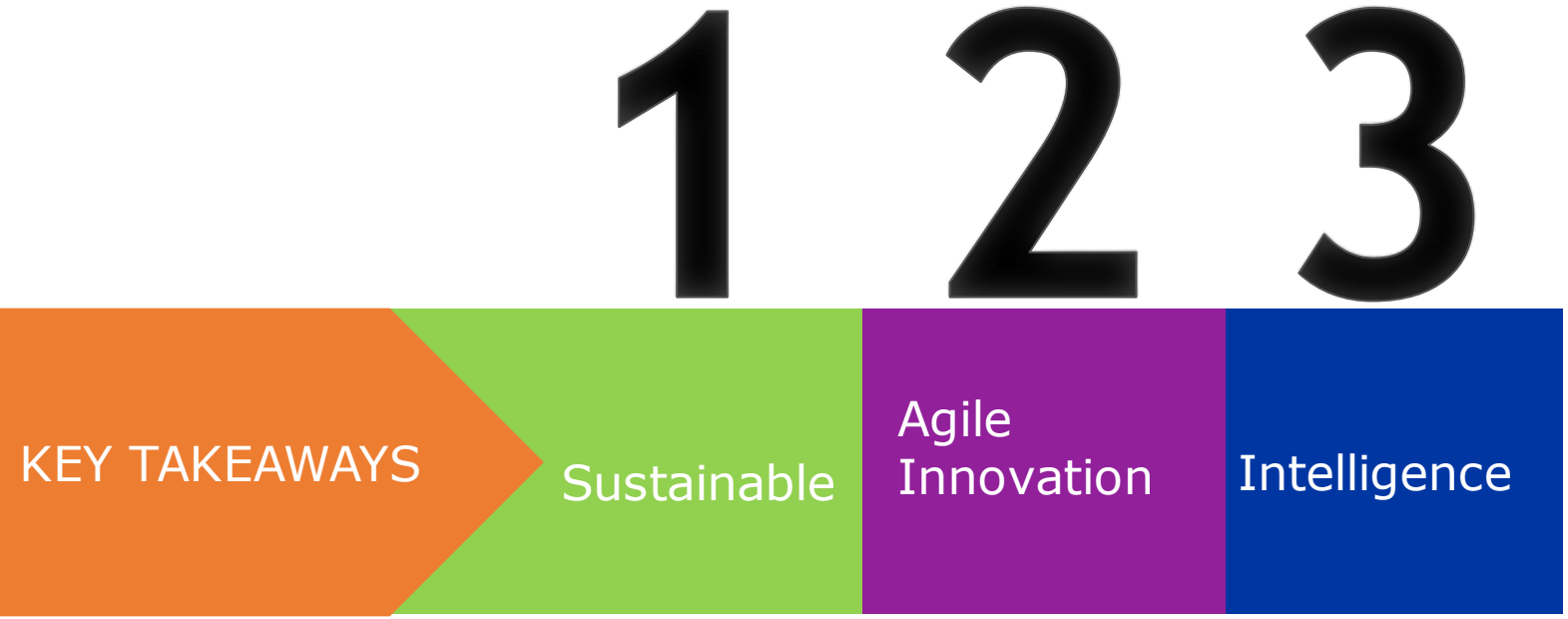
Create Sustainable links

Build Intelligent links



Innovate with agility

Key Takeaways: Recap



Recap-How to leverage packaging with links in FaB

- **Resources**
  - Common resources and sustainability goals
- **Manufacturing**
  - Common resources needed to fast launches
  - Common resources and learning curves in lowering energy costs
- **Packaging suppliers-machinery, barriers, etc.**
  - Beyond price and into shared agility in response
  - Build in agility in machinery, materials, plans
  - Materials with common packaging structures
  - Common technology access
- **Retailers & Distributors**
  - Leverage location to meet needs better
  - LED lights
  - Help Retailers drive fast launches
  - Enable co-distribution, shelf in and outs
  - Brick-retailers to help solve joint issues with packaging and product solutions-mutual benefit to address e-commerce
  - E-commerce-link with to meet packaging and product needs
  - Track and trace
  - Fraud
  - Branding
- **Marketing**
  - Branding and communication

Leveraging Packaging within a cluster

FaB
FOOD and BEVERAGE WISCONSIN

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