Sustainability & Pet Food

Presenter:
Heather Acuff, Ph.D.
Director of Research & Development
Nulo Pet food

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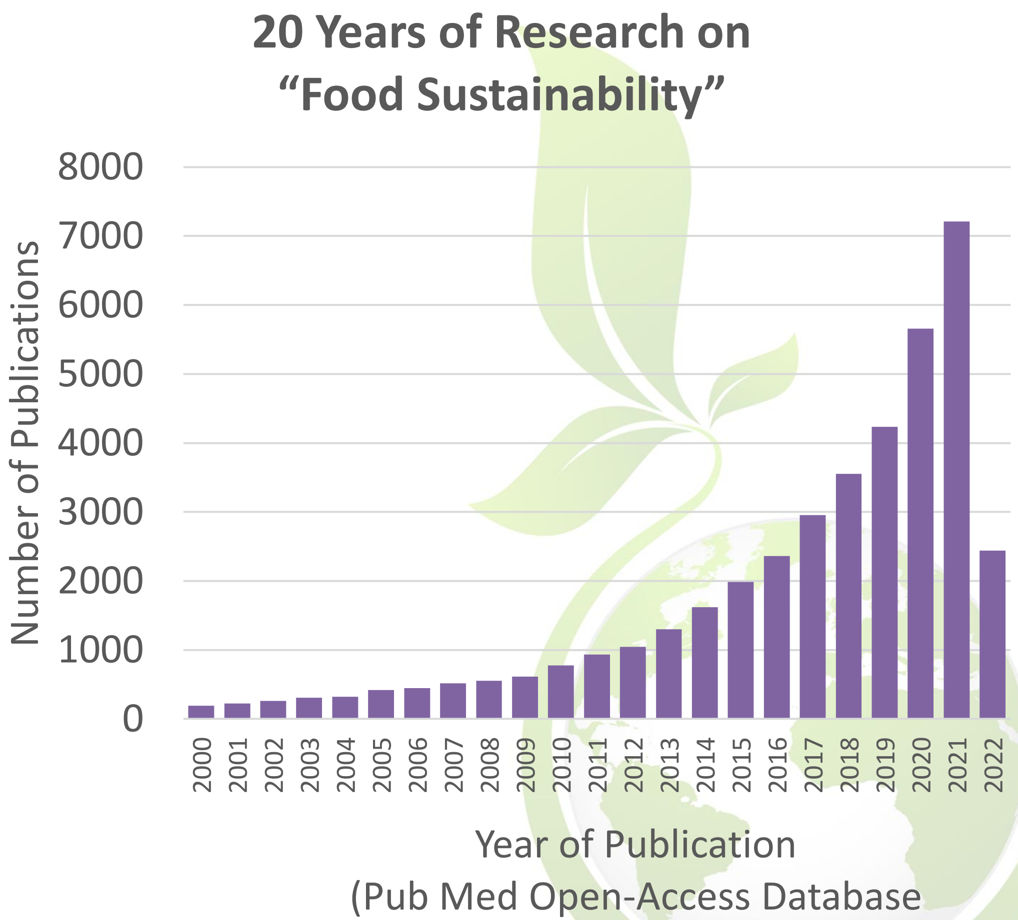
Introduction

Food Security & Management of Resources

- The overuse of resources has become a concern as world populations increase.
- The environmental footprint of pet ownership and provision of necessary supplies and food for pets on the use of natural resources, emissions, and waste is also growing.



Objectives

1. To define sustainability as it relates to dogs and cats, and its relevance to the pet food industry.

2. To describe life cycle analysis, and how it can be used to quantify environmental impacts of complex food systems.

3. To highlight published examples of life cycle analysis for animal, plant, and alternative pet food ingredients.

4. To identify opportunities to contribute to ongoing sustainability efforts of the pet food industry.

Population Data

U.S. Dog Ownership

Households: 45.0%

Population: 83.7M Dogs

U.S. Cat Ownership

Households: 26.0%

Population: 60.0M Cats

Pets outnumber our kids!

Brazil Dog Ownership

Households: 44.3%

Population: 52.2M Dogs

Brazil Cat Ownership

Households: 17.7%

Population: 22.1M Cats

References:
U.S. Pet Statistics: AVMA, 2021
Brazil Pet Statistics: IBGE, 2013
Human Population Statistics: www.data.worldbank.org

Global Pet Industry Market Size

$\$220^{+}$ Billion USD in 2021

53% Pet Food & Treats | 47% Vet Care, Products, & Services

(Reference: /www.fortunebusinessinsights.com/)

Environmental Impact of Dog & Cat Ownership

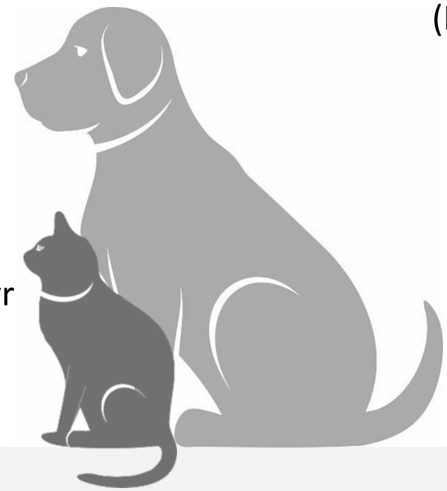
Pet Ownership

2/3 of U.S. Households Own Pets

- Dogs: 83.7M Dogs
- Cats: 60.0M Cats

Pet Food

9.8 million metric tons of dog and cat food produced annually in the U.S. (IFEEDER, 2020)



Carbon Footprint[1]

- Dogs: 27–1,444 kg CO_2 eq/yr
- Cats: 43–228 kg CO_2 eq/yr

Pet Waste

5.62 x 10^6 U.S. tons of feces (dog + cat) produced annually (Okin, 2017)

This is comparable to the amount of landfill waste generated annually by the state of Indiana (population 6.73 million in 2019).

[1]Estimates reported for pets in the E.U., Netherlands, Japan, and China

Current Knowledge

What is sustainability?

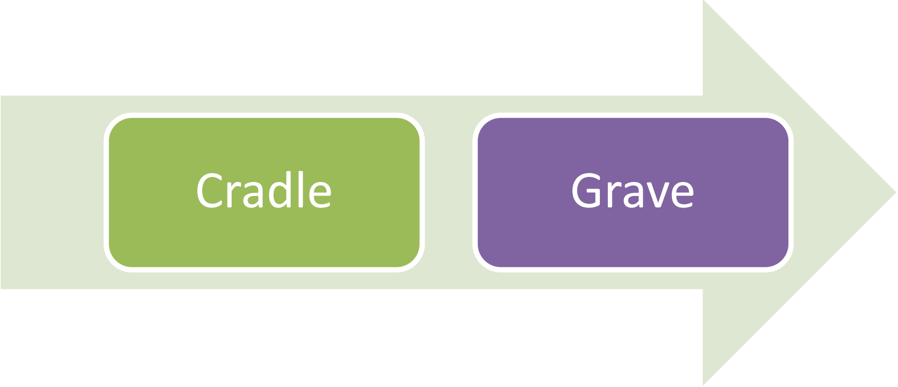
> "The conscientious management of resources and waste necessary to meet the physiological requirements of companion animals without compromising the ability of future generations to meet their environmental, social, or economic needs."

Quantifying Carbon Footprints

Life Cycle Analysis

ISO 14044:2006

A globally-recognized model framework to study the environmental impact categories associated with a product or process



Impact Categories

- climate change
- ozone depletion
- human toxicity risk
- particulate matter
- ionizing radiation
- photochemical ozone formation
- acidification
- eutrophication (terrestrial, freshwater, & marine)
- freshwater ecotoxicity
- natural resource use

Four Stages

01 Define Goal & Scope

What is being measured?
What are the system boundaries?
What impact categories are most relevant?

02 Life Cycle Inventory

What are the material inputs?
What are the energy inputs?
What are the waste streams?

03 Impact Assessment

Life Cycle Databases
Scientific Papers
Translate Inputs and Outputs to Net Impact

04 Interpretation

What is the magnitude of impact?
How does one system compare to others?
Can the system be improved?

Climate Change Terminology

Greenhouse Gases (GHG)

- any gas in the atmosphere which absorbs and re-emits heat, and thereby keeps the planet's atmosphere warmer than it otherwise would be.

	Greenhouse Gas	Global Warming Potential (GWP) (100 yr.)
1.	Carbon dioxide (CO_2)	1
2.	Methane (CH_4)	25
3.	Nitrous oxide(N_2O)	298
4.	Hydrofluorocarbons (HFCs)	124 – 14,800
5.	Perfluorocarbons (PFCs)	7,390 – 12,200
6.	Sulfur hexafluoride (SF_6)	22,800
7.	Nitrogen trifluoride (NF_3)[3]	17,200

Source: ecometrica.com

Carbon dioxide equivalent (CO_2e)

- signifies the amount of CO_2 which would have the equivalent global warming impact
- Equation A-1 in 40 CFR Part 98

Pet Food Life Cycle Analysis

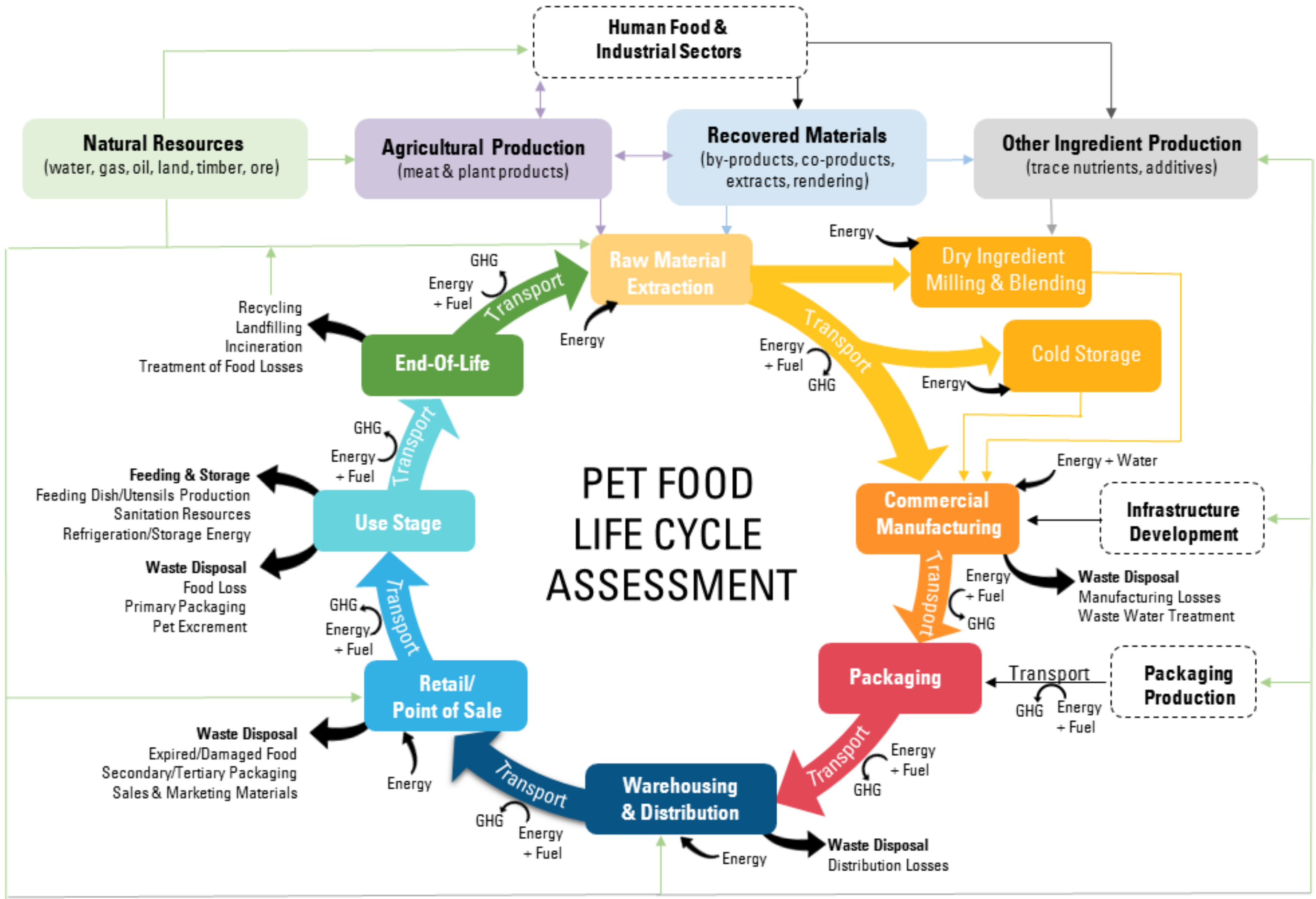


Fig. 1. Schematic diagram of a generic life cycle assessment (LCA) for commercially-prepared pet food beginning with raw material extraction and tracing through manufacturing, packaging, distribution, retail, usage, and end-of-life disposal. GHG = greenhouse gas emissions.

Pet Food Carbon Footprints

Product Environmental Footprint Category Rules (PEFCRs)

- In 2014 the European Commission approved the pilot project to develop PEFCRs for prepared pet food for cats and dogs.
- The Technical Secretariat (TS) charged with developing the PEFCR is composed of the following volunteering organizations:
  - FEDIAF
  - C&D Foods
  - FACCO
  - Mars PetCare Europe
  - Nestlé Purina PetCare Europe
  - saturn petcare gmbh
  - Quantis
- Standardized model for calculating environmental impacts for manufacturing prepared foods for dogs and cats.

Image source: https://ec.europa.eu

Pet Food Carbon Footprints

PEFCRs for Prepared Pet Food for Cats and Dogs in Europe

Key Findings

- Overall, the most relevant impact categories for pet food were determined to be climate change, eutrophication (freshwater, marine, terrestrial), land use, and natural resource depletion (water, mineral, and fossil).
- Dog food (wet and dry) collectively had a greater environmental impact than cat food due to higher consumption volume of dog food.
- The estimated impact of wet food also exceeded dry food due to the high use of natural resources for packaging production (tin plating)

kg CO_2e per daily ration[1]

	Dog	Cat	*Total*
Dry	0.38	0.12	*0.50*
Wet	1.27	0.39	*1.66*
Total	*1.65*	*0.50*	

[1] Characterized results for life cycle excl. use

Pet Food Carbon Footprints

5 Key Areas For Carbon Footprint Reduction

1. Diet Format & Nutritional Composition
2. Raw Material Selection
3. Commercial Manufacturing
4. Packaging
5. Distribution

Product Design

Both **diet format** and **nutritional composition** have a direct impact on the resources required to construct a product.

Protein is the most expensive and ecologically demanding macronutrient yet is a key factor for the selection of pet food products by pet owners.

- AAFCO minimums: 18% for adult dogs; 26% for adult cats (DM Basis)
    - >30% Crude Protein may help maintain lean body mass (i.e., older pets, working dogs)
- Protein levels in excess of an animal's requirement adds strain to the increasing global demand for protein for humans, agricultural animals, and companion animals.

➢ **Sustainable Approach:** Review formulas for protein excesses and determine if a lower protein level may be acceptable.

Raw Material Selection

Three Beef Production Strategies

Pelletier et al. (2010)

- Calves started and finished on Iowa feedlots
- Calves started in Iowa feedlots and finished on pasture and hay in Iowa.
- Calves started on out-of-State small-grain pastures, then finished in Iowa feedlots

Image source: https://www.iacattlemen.org/

Raw Material Selection

Inventory of Material and Energy inputs

Pelletier et al. (2010)

Cow-Calf System

- Herd size (cows, heifers, bulls)
- Herd feed, water, and land requirements
- Calving rate
- Weaning weight

Finishing System

- Days to finishing
- Weight at finishing
- Feed/forage, water, and land requirements
- Distance feed is transported (local or interstate)
- Manure production rates
- Nitrogen and phosphorus excretion rates
- Noxious emission rates (ammonia, nitrous oxide, methane, and nitic oxide)

Fodder Production

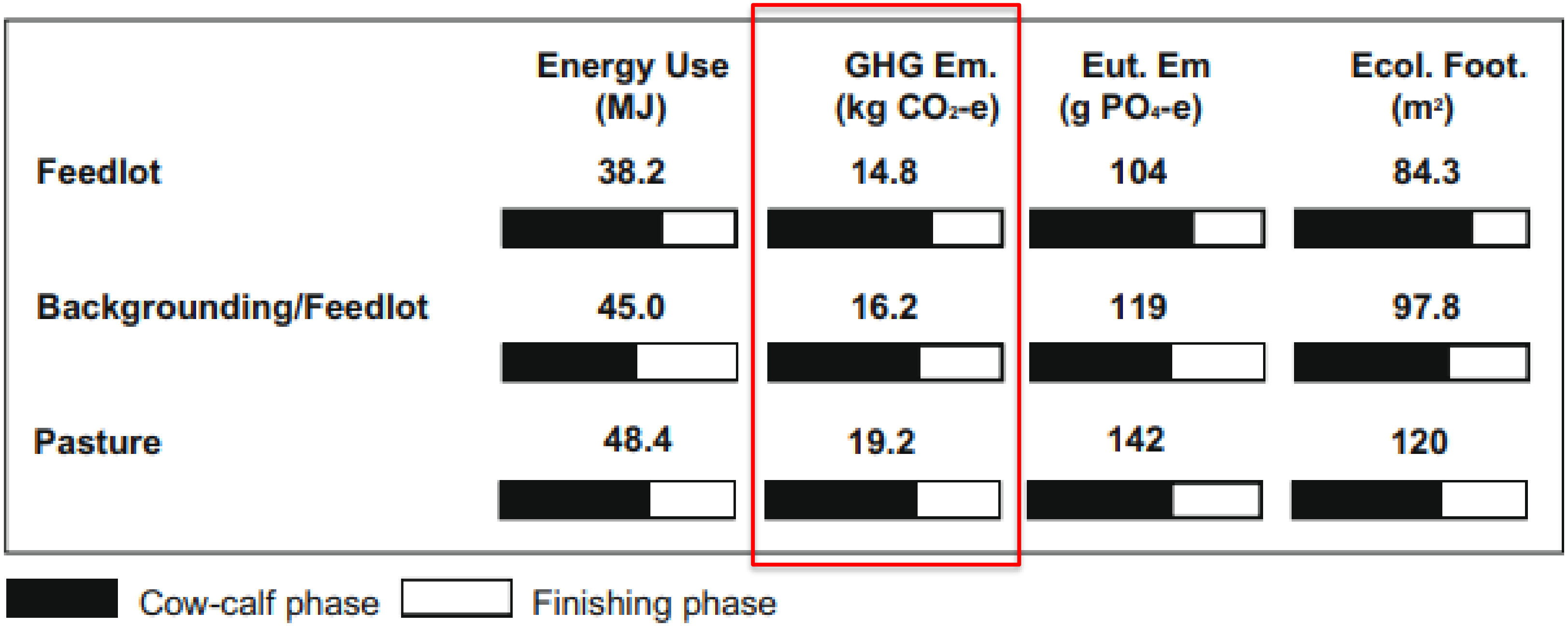
- Fertilizer and pesticide application rates for corn and soy
- Energy inputs for pasture and hay production
- Material transport distance
- Field-level emissions
- Co-product allocation

Raw Material Selection

LCA Results

Pelletier et al. (2010)

	Energy Use (MJ)	GHG Em. (kg CO_2-e)	Eut. Em (g PO_4-e)	Ecol. Foot. (m^2)
Feedlot	38.2	14.8	104	84.3
Backgrounding/Feedlot	45.0	16.2	119	97.8
Pasture	48.4	19.2	142	120

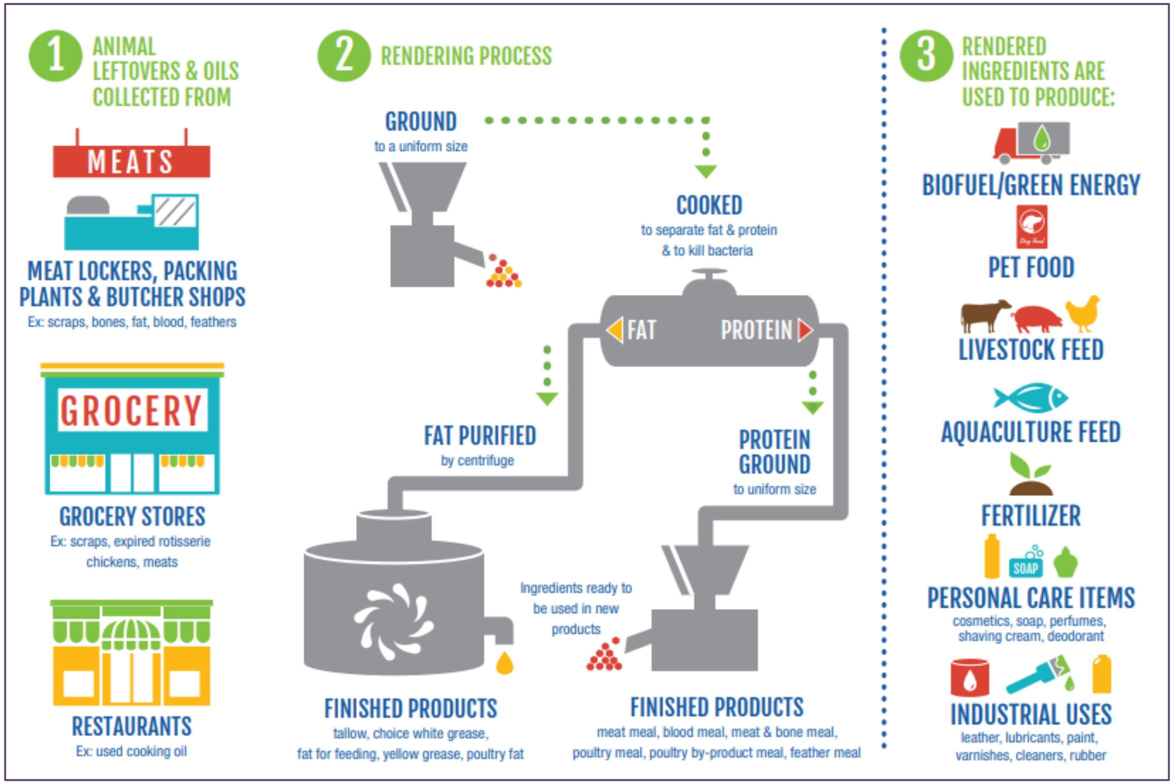


Cradle-to-farm gate life cycle cumulative energy use (MJ), ecological footprint (area of productive ecosystem), and greenhouse gas (CO_2 eq) and eutrophying (PO_4 eq) emissions per kg of live-weight beef produced in feedlot, backgrounding/feedlot, and pasture-finishing beef production systems in the Upper Midwestern United States.

Raw Material Selection

Overview of Rendered Animal Proteins

North American Renderers Association, Inc., www.nara.org, (2019)
Meeker and Hamilton (2006)



Rendering Statistics

- Approximately **50% of the live weight** of an animal is comprised of secondary products.
- **56 billion pounds** of raw materials are collected by renders in the U.S. and Canada annually.
- Rendering all of this material has the same effect on GHG emissions as removing **>12 million** cars from the road.

Raw Material Selection

Winter & Spring Wheat Varieties

Johnson et al. (2016)

- LCAs were performed for 11 U.S. wheat farms
- Input considerations:
  - Fuel
  - Electricity
  - Fertilizer
  - Feed
  - Herbicides
  - Insecticides
- Emission estimates were modeled with the aid of the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model, version 1.8c (Excel-based model).
- Results were normalized using a functional unit of CO_2 eq. emissions per planted hectare and per harvested kg of commodity.

Image source: world-grain.com

Raw Material Selection

Wheat LCA Results

Johnson et al. (2016)

Table 7. Greenhouse Gas Emissions (GHG) summary for wheat farms.

Farm Name	Farm Size (hectares)	Wheat Per-hectare CO_2 emission (T CO_2e/hectare)	Wheat (TCO_2e/T)
Winter Wheat			
Oregon Wheat 3600	1.457	1.372	0.45
Central Kansas Wheat 4500	1.821	1.816	0.60
Central Kansas Wheat 2000	0.809	1.883	0.62
Washington Wheat 1725	0.698	3.818	0.67
Adams County Washington Wheat 3500	1.416	1.798	0.67
Washington Wheat 5500	2.226	3.960	0.69
Montana Wheat 4500	1.821	2.100	0.73
Washington Colorado Wheat 5640	2.282	2.538	0.76
Washington Colorado Wheat 3000	1.214	1.998	0.99
Northwest Kansas Wheat 4000	1.619	4.380	1.18
Northwest Kansas Wheat 5500	2.226	4.873	1.32
Mean		*2.776*	*0.79*
Spring Wheat			
Montana Wheat 4500	1.821	2.038	1.01
Oregon Wheat 3600	1.457	2.132	1.06
Washington Wheat 5500	2.226	4.530	1.12
Washington Wheat 1725	0.698	4.842	1.20
Mean		*3.385*	1.10

Raw Material Selection

Black Soldier Fly Larvae

Smetana et al. (2016)

- A LCA of insect production and processing at industrial scale and compare the results with alternative scenarios of insect-based defatted formulation pro-duction (powder used as intermediate for feed and food purposes)
- Input considerations:
  - raw material production for insect diet (inputs),
  - insect breeding
  - Insect harvesting
  - processing to the intermediate product ("cradle to gate")
- Emissions-Related Categories Considered
  - Greenhouse Gas Emissions
- Impact estimates were modeled with the aid of SimaPro8software.
- Functional unit was considered as 1 kg of dried defatted insect powder

Image source: petfoodindustry.com

Raw Material Selection

Black Soldier Fly Larvae

Smetana et al. (2016)

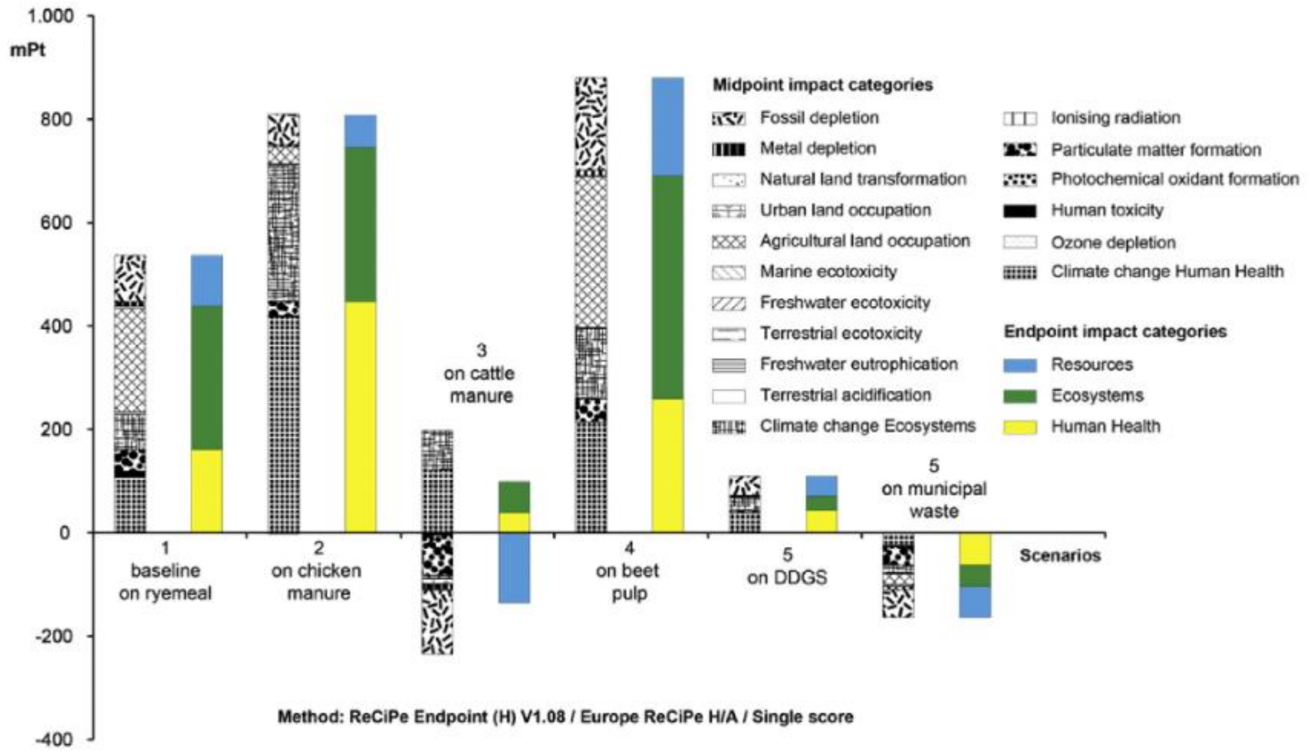


Fig. 3.Single-score comparison of insect production scenarios (FU: 1 kg of defatted protein powder, from cradle-to-gate; (milli) Pt = eco-points (a weighted normalized value of environmental impact).

LCA as a Comparative Tool

Life Cycle Analysis Insights

- Which ingredients are the most sustainable? It depends!
- Standardization of LCA across industry segments can help improve clarity in data reporting.
- Improvement in the environmental performance of one segment can help improve the whole system.
- Making LCA easier for suppliers to implement may help facilitate widespread adoption.

Average Global Warming Potential Estimates of Select Insect-, Animal-, and Plant-Origin Ingredients with Applications in U.S. Pet Foods

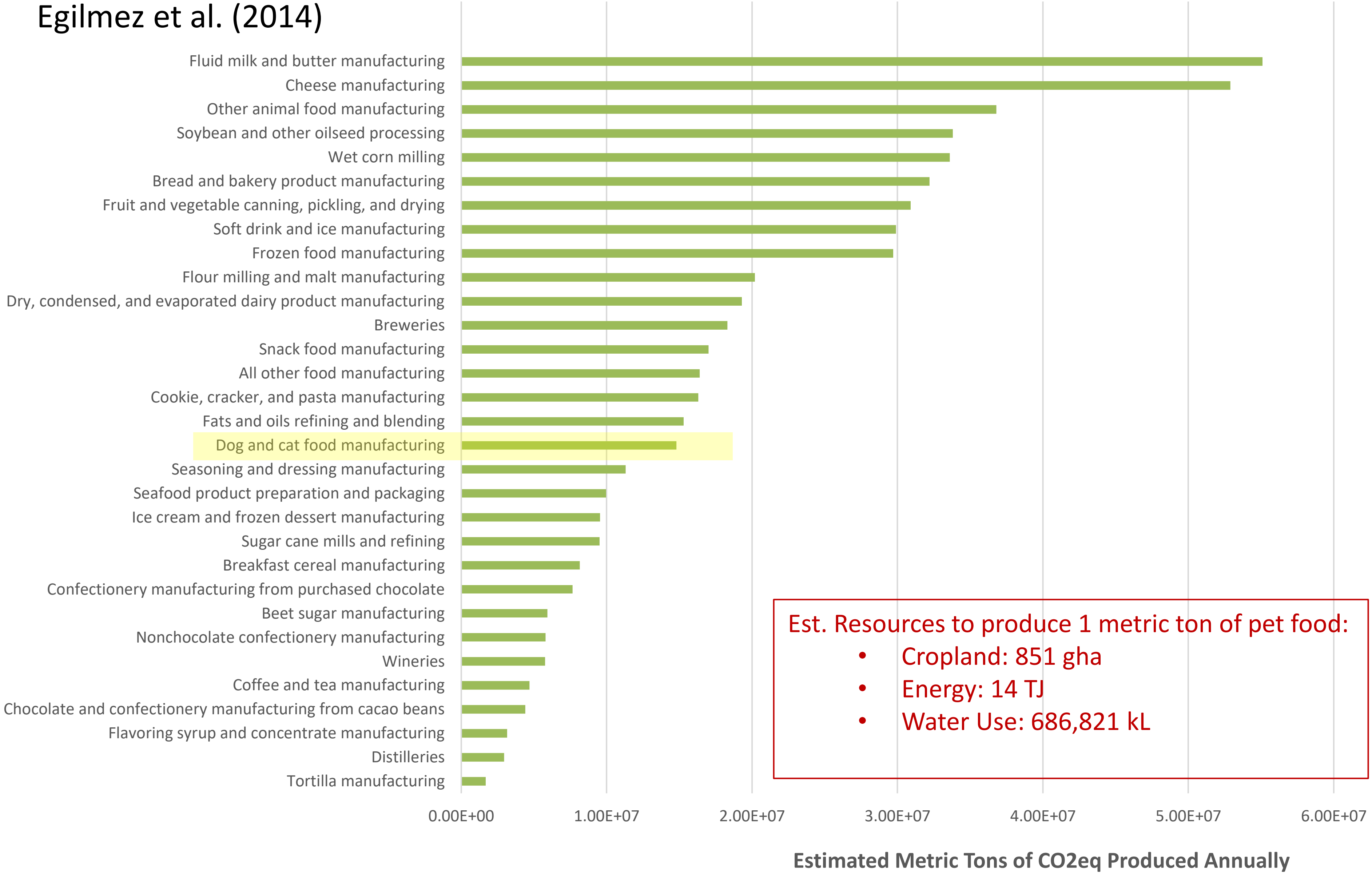
Ingredient	LCA Study Location	Carbon Footprint (kg CO_2 eq/kg Functional Unit)	Reference
Insect-Origin			
Black Soldier Fly Larvae[a]	DEU	1.36 – 15.1	Smetana et al. (2016)[78]
Animal-Origin			
Plains-Ranched Beef[b]	USA	20.4 – 23.2	Rotz et al. (2019)[79]
Pasture-Finished Beef[c]	USA	19.2	Pelletier et al. (2010)[80]
Feedlot Beef[c]	USA	14.8	Pelletier et al. (2010)[80]
Grassland-Grazed Lamb[b]	NZL	19	Ledgard et al. (2011)[81]
Hillside-Raised Lambs[c]	ENG	17.9	Jones et al. (2014)[82]
Lowland-Raised Lambs[c]	ENG	10.9	Jones et al. (2014)[82]
Organic Farmed Salmon[c]	CAN	2.7	Pelletier and Tyedmers (2007)[83]
Farmed Salmon[c]	CAN	2.1	Pelletier and Tyedmers (2007)[83]
Pork[c]	USA	2.01 - 3.02	Thoma et al. (2015)[84]
Chicken[c]	USA	1.99	Putman et al. (2017)[85]
Poultry By-Product Meal	PRT	0.73	Campos et al. (2020)[86]
Poultry Fat	PRT	0.67	Campos et al. (2020)[86]
Hydrolyzed Feather Meal	PRT	0.60	Campos et al. (2020)[86]
Rendered Animal Protein	GBR	0.15	Ramirez et al. (2012)[87]
Rendered Animal Fat	GBR	-0.77 - 0.15	Ramirez et al. (2012)[87]
Plant-Origin			
Rice	USA	1.41 - 1.88	Johnson et al. (2016)[88]
Potato	FRA	0.10 - 0.11	Godard et al. (2012)[89]
Sorghum	USA	0.60 - 1.24	Johnson et al. (2016)[88]
Wheat	USA	0.45 - 1.32	Johnson et al. (2016)[88]
Soybean	USA	0.34 - 0.70	Johnson et al. (2016)[88]
Oats	FRA	0.31	Wilfart et al. (2016)[90]
Corn	USA	0.30 - 1.68	Johnson et al. (2016)[88]
Spring Peas	FRA	0.29	Wilfart et al. (2016)[90]
Rainfed Legumes	ESP	0.23	Aguilera et al. (2015)[91]

[a] Functional Unit = 1 kg Insect Protein Meal
[b] Functional Unit = 1 kg Carcass Weight
[c] Functional Unit = 1 kg Live Weight

LCA as a Comparative Tool

LCA Modeling of U.S. Food Manufacturing Sectors

Egilmez et al. (2014)



Est. Resources to produce 1 metric ton of pet food:

- Cropland: 851 gha
- Energy: 14 TJ
- Water Use: 686,821 kL

Packaging Facts

Containers and packaging make up a major portion of municipal solid waste, amounting to **82.2 million tons** of generation in 2018 in the U.S. (**28.1 percent of total generation**).

Data on U.S. Containers & Packaging in Municipal Waste by Weight (2018)

Packaging material	Generated (million tons)	Recycled (million tons)	Recycled %
Plastic	14.5	1.9	14%
Paper & Paperboard	41.9	33.9	81%
Aluminum	1.9	0.67	35%
Steel	2.21	1.63	74%
Glass	9.79	3.06	31%
Overall Total	82.2	44.3	54%

Reference: EPA.gov (2018)

Packaging Considerations

Packaging Production

Packaging makers are challenged with exercising high social and environmental performance while ensuring the packaging material will meet both customer and consumer expectations.

Packaging Materials

Worldwide, it's estimated that as much of 40% percent of all plastic produced is single-use packaging. Pet food containers and are commonly constructed from polyethlyene and its derivatives, paper and paperboard, or metals (aluminum, tin, or steel).

Packaging Performance

Packaging carries out many important functions including protecting products from spoilage, nutritional degradation, and serving as a source of information for consumers.

Sustainable Approaches

Reduce

- Excess material during packaging design (i.e. size, weight, thickness)
- Ship in smaller secondary packaging
- Optimize pallet configurations and truck loading to increase units/load

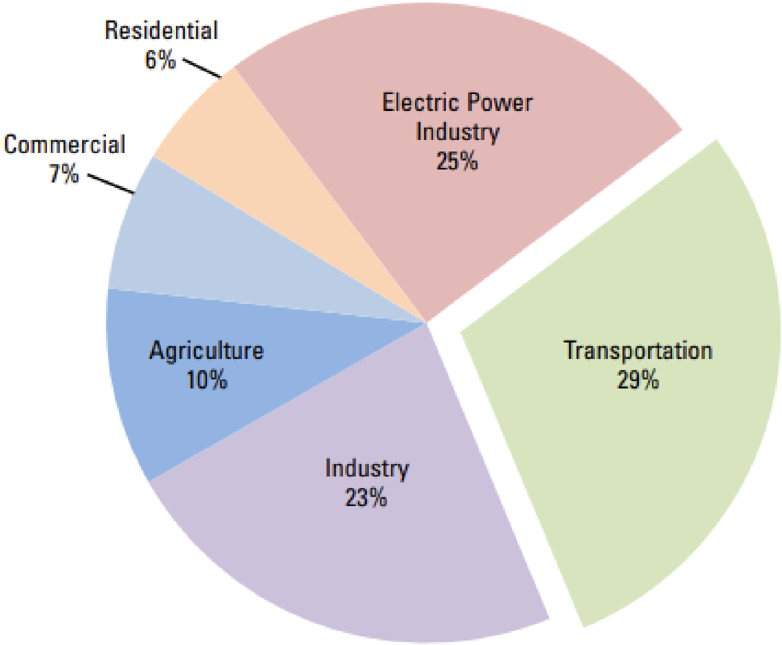
Reuse

- Source recycled materials where possible
- Look for renewable, compostable, and biodegradable materials with packaging innovation (i.e. corn starch, chitosan, cellulose)

Recycle

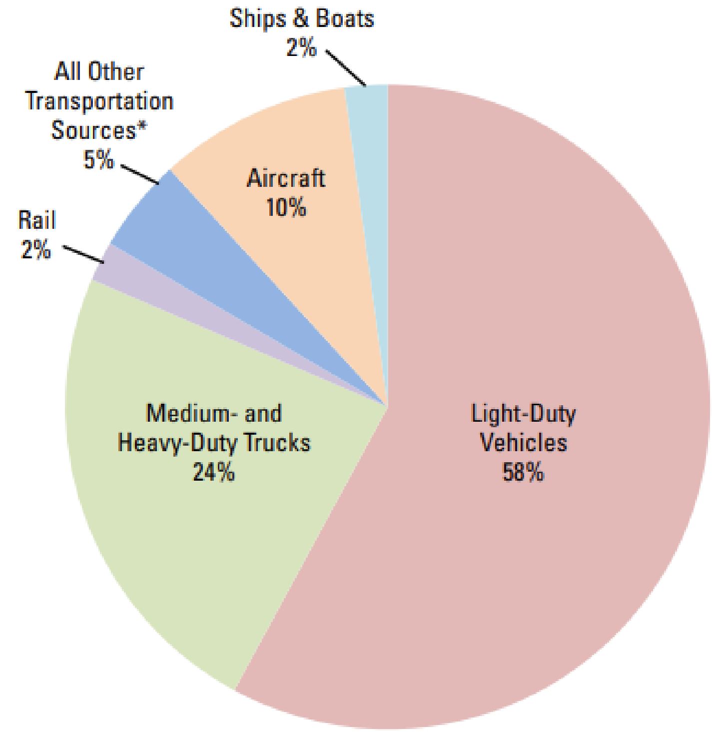
- Share disposal and recycling best practices with consumers.
- Look for recycling programs that make recycling more convenient for consumers.

Distribution Impact



Share of U.S. GHG Emissions by Sector, 2019[3,4]

Note: Totals may not add to 100% due to rounding.



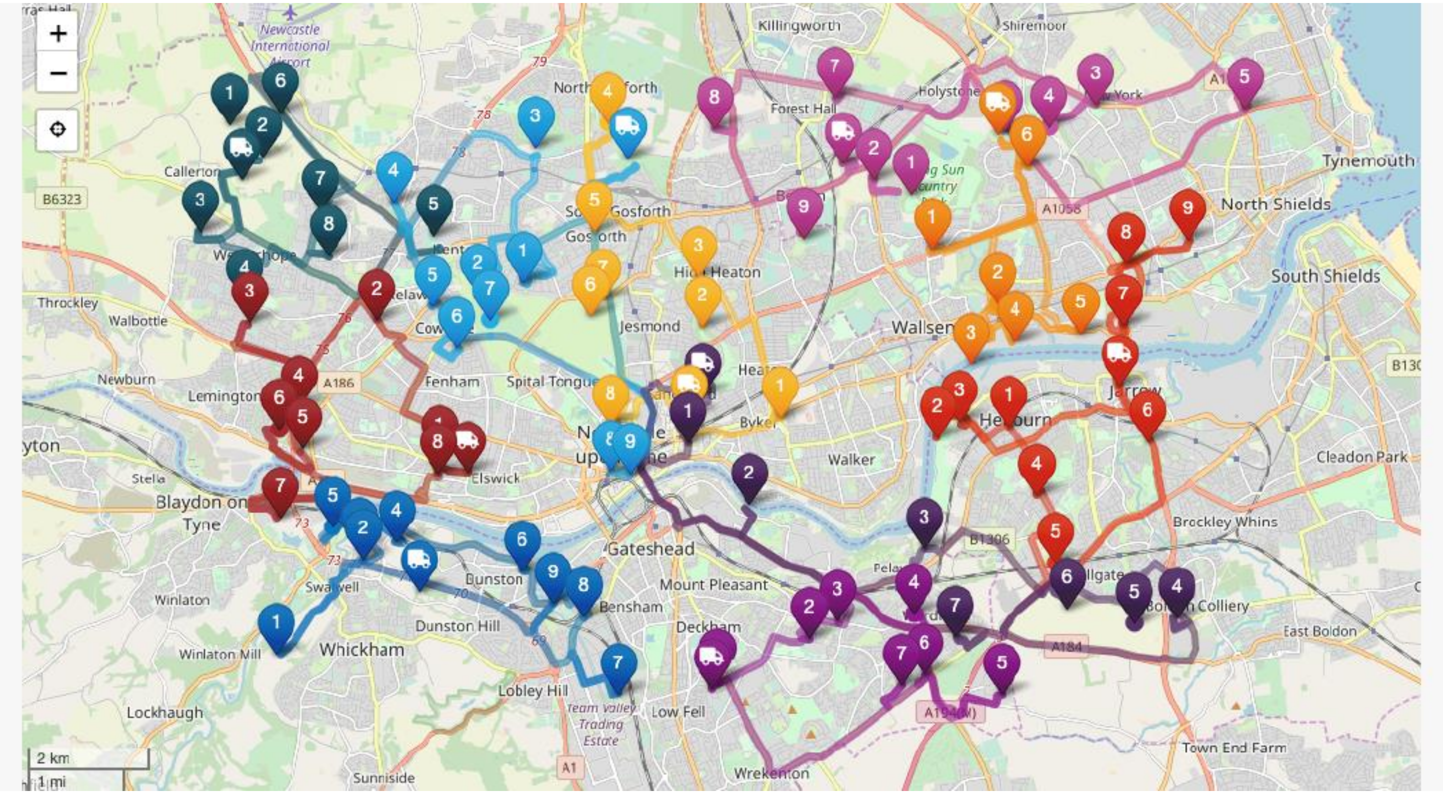
Share of U.S. Transportation Sector GHG Emissions by Source, 2019[4,5]

Note: Totals may not add to 100% due to rounding.

Reference: EPA.gov (2019)

Distribution Impact

The "Last Mile"



Distribution Impact

The "Last Mile" Challenges & Solutions

Transporting Raw/Frozen/Fresh Foods

Transporting perishable goods is even more environmentally harmful than transporting non-perishable items because perishable products must be stored at a particular temperature, which requires refrigeration. Refrigeration uses more energy, so a refrigerated delivery truck creates more emissions than a non-refrigerated one.

Rapid Delivery Timeframes

When the number of delivery vehicles increases, so do carbon dioxide emissions, which makes up the bulk of greenhouse gas emissions.

Failed Delivery Attempts

When a package makes the journey to the consumer's home and is not able to be delivered, the miles traveled and associated impacts are compounded by repeat delivery attempts.

Multi-Purchase Deliveries

- More items in one shipment results in fewer deliveries
- Bundling shipments by optimal route delivery days

Consolidating Returns

- Multiple returns in one shipment
- Limiting return windows
- Optimizing return locations for pick-up routs

Parcel Lockers

- Common area deliveries
- Reduces failed delivery attempts
- Shortened transportation routs

Consumer Education

- Reporting delivery metrics
- Providing convenient alternatives
- Incentivizing greener options

Conclusions

Quantify

Improve

Collaborate

Sustain

Select References

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Heather Acuff, Ph.D.
Director of Research & Development
Nulo Pet food
Heather.Acuff@nulo.com

Question & Answer Session