Alternatives Uses of Food Waste - Animal Feed

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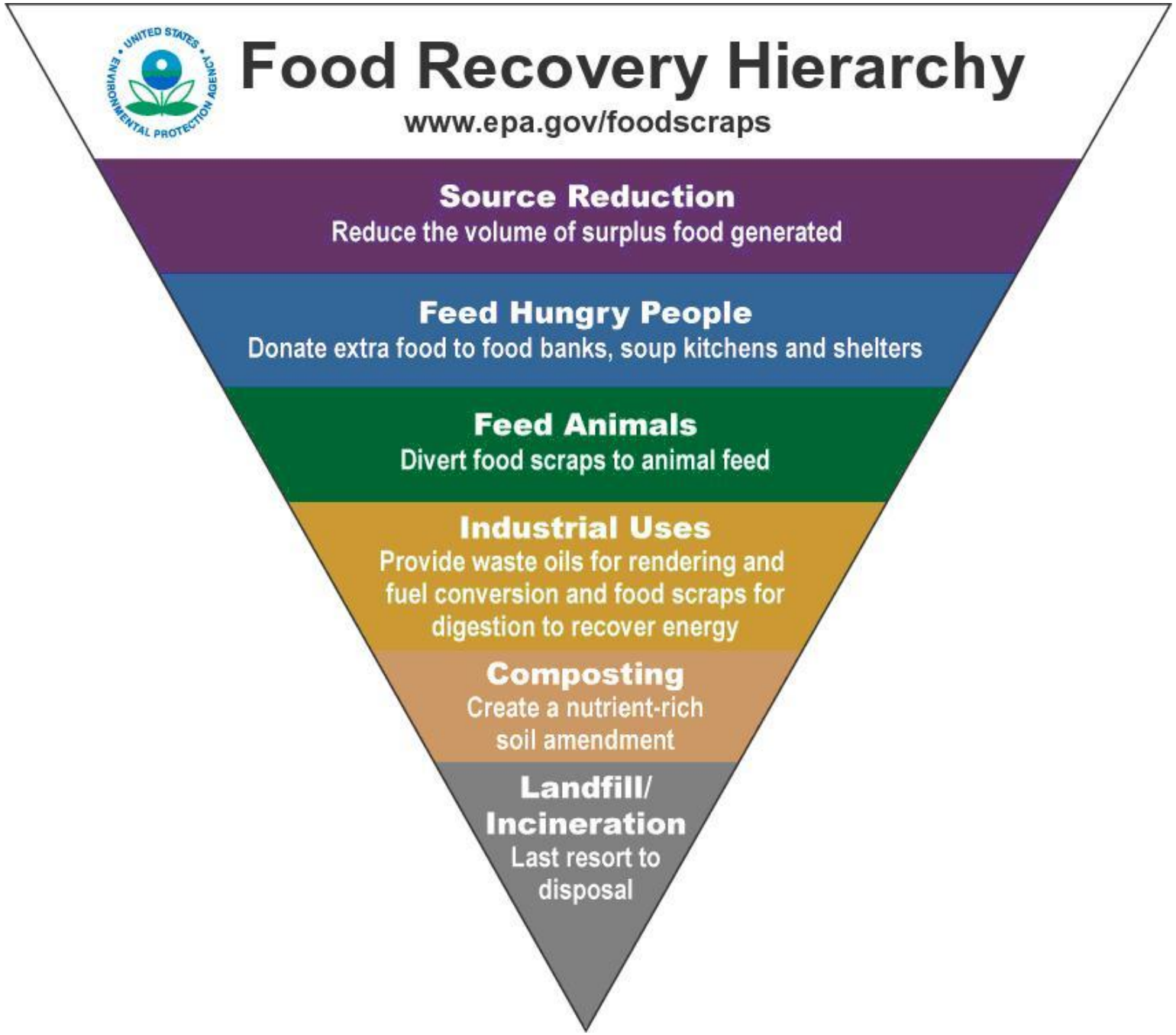
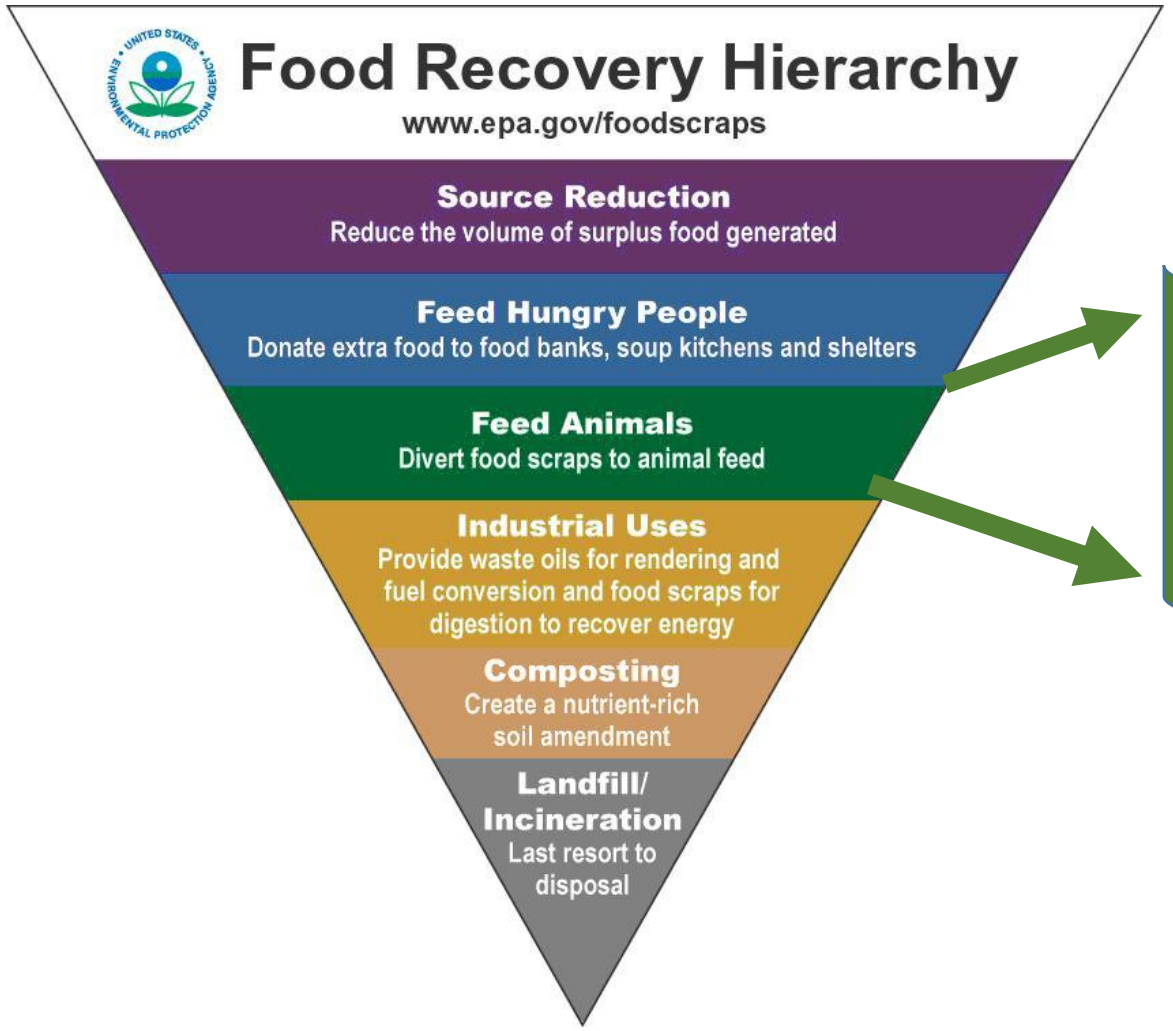
USDA and FAO focus on Food Recovery



Landfill Food Waste

- In 2012 US Landfills received 250,890,000 tons of waste
- Food waste was 36,430,000 tons: 14.5% of waste
- 4.8% of food waste was recovered compared to 34.5% of all waste
  - After recovery and compost food waste was still 34,690,000 tons: 21.1% of waste
  - Total waste into land fill was 164,270,000 tons
- Residential composting of food waste served 2,478,002 households
  - Out of 114,991,725 total households, only 2% of households in 11 states have composting programs

USDA and FAO focus on Food Recovery



FEED ANIMALS

Feed Industry – 2013 World Feed Production

	Million Tonnes (metric)	Mills
World	963	26,240
China	189	9,500
US	169	5,236 (373 billion lbs)
Brazil	67	1,237

- Feed Allocation

Poultry #1	444.0 million tonnes
Swine #2	243.0 million tonnes
Ruminant #3	196.0 million tonnes
Aquaculture #4	34.4 million tonnes
Pet #5	20.7 million tonnes
Equine #6	12.4 million tonnes

- Alltech Survey reported in AllAboutFeed 2014

Distinguish by-products of processing versus food waste (edible by humans)

- Manufacturing and rendering processes → by-products
  - Generate by-products inedible or only partly suitable for food such as
    - Meals - oil industry
    - Residues – flour, distilling, juice, canning, nut industries
      - middlings, germ meals, hulls, distillers/brewers grains, pulp and pomace,
    - Renderings – slaughter industry
- Food loss and waste → waste
  - Residues of edible human foods which are unsold or unacceptable for various reasons that potentially are discarded to landfills
  - Manufacturing sector, retail sector, household sector

Table 1. Examples of feeds commonly used within U.S. livestock production systems

COUNCIL FOR AGRICULTURAL SCIENCE AND TECHNOLOGY Number 53; September 2013

Feed Source	Examples	Human Edible?
Forage crops	Pasture grasses, alfalfa, clovers, hays, silages (grass or crop based)	No
Cereals	**Corn, wheat, barley, millet, sorghum, triticale, oats**	**Yes**
Plant proteins	Soybean (meal and hulls), cottonseed (whole & meal) safflower meal, canola meal, peanut meal	Partially
Grain by-products	***Distillers grains* (wet and dry), corn gluten, wheat bran, straw, crop residues**	**No**
Vegetable by-products	Apple pomace, citrus pulp, almond hulls, pea silages Waste fruit/vegetables	No Partially
Food industry by-products	**Bakery waste, cannery waste, restaurant waste, candy, potato chips**	**Partially**
Sugar industry by-products	Molasses (cane, beet, and citrus), beet pulp	Partially
Animal by-products	**Meat and bone meal, tallow, feather meal, bloodmeal, poultry litter**	**Partially**
Dairy by-products	Milk, whey products, *casein*	Partially
Marine by-products	**Fish and seafood meal and oils, algae**	Partially

USDA 2012 Agriculture Statistics Production of By-products & Cereals in Animal Feeds

Oilseed meals	tons (US)	**Cereals**	
Soy bean meal	30,300,000	Corn	128,800,000
Cottonseed meal	2,525,000	Sorghum	1,500,000
Linseed meal	197,000	Oats & Barley	2,900,000
Peanut meal	95,000	Wheat	5,900,000
Sunflower meal	360,000	Rye	100,000
Animal Proteins			
Tankage and Meat Meal	2,350,000		
Fish Meal	200,000		
Dried Milk	250,000		
Mill Products			
Wheat Mill Feeds	6,400,000		
Gluten feeds and meal	5,075,000		
Rice Mill Feeds	575,000		
Alfalfa Meal	NA		
Total Commercial Feeds By-products	**48,327,000**	**Total**	**139,200,000**
	25.8% of		**375 billion lbs**

USDA Agriculture Inventory of Animal Feeds

- By-products of food processing are included and cereals
- Food waste is not a category in Ag Stats
- What is magnitude of Food Waste
  - Potential as animal feed
  - Actual use as animal feed

Estimates from WRAP in UK

- Available food supply – 4.15% is diverted from industrial stream to animal feed
- FAO food supply estimates for US – 317.7 million tons
- 13,187,555 tons of food diverted to animal feed (26.4 billion US lbs)
  - Poor quality or damage
  - Shelf life outdated
  - Change in consumer preferences leading to over inventory
  - Packaging mislabeling
  - Overstocking
- Would not include residues of distilling, milling, oil, rendering

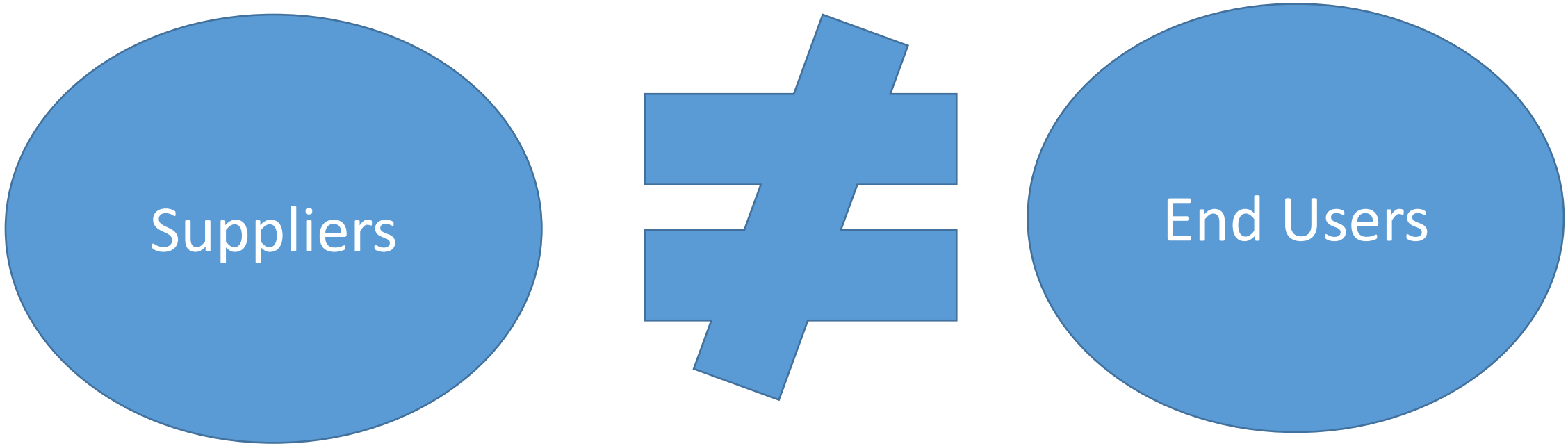
Animal Feed Estimates from BSR Tier I and II Surveys

	Manufacturing Sector	**Retail/Wholesale sector**	
Food Waste	44.3 billion US lbs	3.8 billion US lbs	
Disposal MSW	2.4 billion US lbs	1.7 billion US lbs	
Diversion to other uses	94.6%	55.6%	
Animal feed	30.6 billion US lbs	0.53 billion US lbs	31.13 billion lbs
Food donation	0.7 billion US lbs	0.68 billion US lbs	
Compost	0.8 billion US lbs	0.91 billion US lbs	
Land application	8.4 billion US lbs		
Other	1.7 billion US lbs		
WRAP estimate			26.4 billion lbs

Tier III BSR Estimates 2013 - Survey

	Manufacturing	*Retail/Wholesale*	*Restaurant*
Waste/$1000 sales			
	53 lbs	**10 lbs**	**33 lbs**
Donated (1)	1.5%	13.2%	1.4%
Recycled (2)	93.4%	29.2%	14.3%
MSW (3)	5.1%	57.6%	84.3%
Diverted (1+2)	**94.9%**	**42.4%**	**15.7%**
Donated	1.6%	23.3%	8.8%
Anaerobic	0.1%	8.3%	.
Rendering	1.7%	10.3%	.
Land applied	3.5%	7.0%	.
Compost	2.0%	24.6%	19.4%
An. Feed	86.8%	26.2%	0.1%
Other	4.4%	0.3%	.

Barriers to feeding food waste



Exist for Suppliers and End Users

Barriers to feeding food waste

- Suppliers and End Users (Nutritionists and Producers)
- Logistics – handling
  - Collecting, storage, transporting, mixing **WATER**
- Storage
  - Stability versus spoilage
- Regulation and Residues
  - Food safety, mold and bacterial contamination, biocide contamination, metals
- Variability
  - Nutrient content and supply

Food Waste as Animal Feed - Regulations

- Concerns with spread of disease
  - Viruses and Prions (Hog Cholera, ASF, FMD, SVD, BSE)
  - Bacteria – particularly Salmonella, Campylobacter
  - Nematodes – Trichinella
- Swine Health Protection Act
  - Garbage – all waste material derived in whole or in part from the **meat** of any animal…and other refuse…resulting from handling and cooking
  - Must be treated **100 ^{o}C (212 ^{o}F) for 30 minutes** throughout the product
  - Licensed facilities – 2,722 feeding 293,330 tons (US) of waste **(0.6% of swine feed)**
    - 160,000 market swine of total 137,758,900 marketed **(0.12% of total)**
  - Products not requiring heating: bakery waste, candy waste, eggs, dairy products, fish from Atlantic or Eastern US waters, processed products if heated >167 ^{o}F for 30 minutes, and rendered products

Cattle Materials Prohibited in Animal Feed

- 1. The entire carcass of **BSE-positive cattle**.
  - Prohibited use of the highest risk cattle tissues in ALL ANIMAL FEEDS
- 2. The **brains and spinal cords of cattle 30 months of age** and older.
- 3. The **entire carcass** of cattle that are **30 months of age or older** from which **brains and spinal cords were not effectively removed** or excluded from animal feed.
- 4. **Entire carcasses of cattle not inspected** and passed for human consumption, **unless** carcasses are **less than 30 months of age**
- 5. **Mechanically separated beef** derived from materials described in 2 and 3 above.
- 6. **Tallow that exceeds 0.15% insoluble impurities** derived from materials described in 2 and 3 above.

Rule(s) Overview:

- Title 21 CFR 589.2000 BSE - Feed Rule prohibits feeding most mammalian protein to all ruminants. (1997)
- Title 21 CFR 589.2001 - Enhanced BSE Feed Rule prohibits feeding certain materials from cattle (CMPAF) to all animals. (2008)

Banned substances from ruminant diets

Animal By-Product Meal
Animal Digest
Animal Liver
Bone Meal, Cooked
Bone Meal, Steamed
Cooked Bone Marrow
Dehydrated Food Waste
Dehydrated Garbage
Distressed Pet Food
Dried Meat Solubles
Fleshings Hydrolysate
Food Processing Waste
Glandular Meal and Extracted Glandular Meal
Hydrolyzed Hair
Hydrolyzed Leather Meal
Leather Hydrolysate
Meat
Meat and Bone Meal
Meat and Bone Meal Tankage
Meat Meal
Meat Meal Tankage
Meat By-Prodcuts
Meat Protein Isolate
Mechanically Separated Bone Marrow
Restaurant Food Waste
Salvage Pet Food
Stock / Broth
Tallow exceeding 0.15% Insoluble Impurities
Unborn calf Carcasses

Approved substances for ruminant diets

Blood and Blood Products
Pure Porcine Protein
Gelatin
Marine Protein
Tallow
Amino Acids

Milk Products and Milk Proteins
Pure Equine Protein
Poultry Protein
Vegetable Proteins
Oil
Dicalcium Phosphate

Problem with food waste – *variation in nutrients*

Food Plate Waste Nutrient Content – 63 samples (Westendorf, 1999)

Item	Mean	SD	CV	Range
DM	27.0	5.2	19.3	13.0 to 39.6
CP	20.8	5.7	27.5	13.6 to 37.7
Fat	26.3	8.0	30.4	9.1 to 46.9
ADF	6.3	2.6	41.2	2.4 to 15.3
ASH	6.2	2.2	35.3	3.0 to 16.4
Ca	0.92	1.02	111.1	0.06 to 6.33
P	0.64	0.46	72.1	0.12 to 2.18

Example variation

Item	**DISDG**		**Wet Brewers**		**Potato Waste**		**Bakery Waste**		**Candy Waste**		
%DM	*mean*	*sd*	*mean*	*sd*	*mean*	*sd*	*mean*	*sd*	*mean*	*sd*	
DM	89.4	1.2	**22.2**	**2.8**	16.5	2.3	89.1	1.6	90.7	5.2	
CP	29.9	1.2	32.0	2.1	10.4	0.9	12.4	1.3	**13.5**	**3.0**	
Starch	**7.0**	**1.4**	**3.1**	**2.2**	49.6	2.5	**41.7**	**19.6**	**11.6**	**9.3**	
NDF	37.1	4.8	54.8	5.4	**21.8**	**4.0**	**5.4**	**3.9**	**22.7**	**22.8**	
Fat	**12.1**	**2.5**	**10.6**	**2.0**	**1.5**	**1.5**	**8.9**	**3.8**	**12.6**	**8.3**	
Ash	5.0	0.4	**4.3**	**0.8**	**11.8**	**6.5**	**4.1**	**1.9**	**5.6**	**3.4**	
Ca	**0.07**	**0.05**	**0.27**	**0.08**	0.15	0.01	**0.27**	**0.18**	**0.28**	**0.14**	
P	0.83	0.06	**0.58**	**0.12**	0.15	0.01	**0.35**	**0.12**	**0.31**	**0.11**	
NEL, mcal/lb		0.94	0.06	0.83	0.04	0.68	0.06	0.96	0.04	0.89	0.40

Limited number of samples 3 to 8 total from 63 dairy farms in PA

Bold: CV>15%

Variation in nutrient content

- Need to develop a feed library based on multiple samples for an average value to start with by animal species (ruminant versus monogastric very different)
- Need rapid real time analysis by load if variation of content is significant
  - NIR analysis can be rapid but requires extensive chemical data base for calibration
  - DM can be done on farm
- Requires a reduction in particle size for incorporation in ration – grinding or chopping
- High water content limits amount which can be fed due to limitation on feed intake of very wet material (>=60% moisture)

Variation in performance in swine with food waste (Westendorf and Meyer AS143, UofFl

Diet	Grower, ADG	Finishing, ADG
	lb/day	
Corn/SBM	1.80	2.18
FW + 50% Corn Mix	1.45	1.98
FW + 25% Corn Mix	1.34	1.69
FW only	1.01	1.36

Feed Waste – limits intake due to high water content
limits performance due to variable nutrient content

Variation in Supply

- Inconsistent supply
  - Vegetable and fruit waste from retail outlets
  - Salad bar waste from restaurants
  - Brewers grains from breweries – seasonality
- Need consistent supply and proportions within supply to use consistently in animal diets to maintain acceptable growth and milk production

Storage on farm

- High moisture content makes material susceptible to mold and bacterial growth and deterioration – rapid feed out
- Feed sufficient amount to maintain quality, but limited by moisture content as to total amount which can be fed
- Ensiling material is possible, but requires time for anaerobic fermentation and rapid storage of significant amount – requires a lot of product at one time
- Acid treatment with propionic acid can stabilize but mixing with product and cost of treatment can be prohibitive

Conclusion

- Food waste can be used as animal feed
  - Tend to high in non-structural carbohydrates and digestible fiber
  - Reasonable energy source
- Logistics limit use
  - Collection, storage, transportation
  - Farms close to source
- Handling on farm limits use
  - Mixing into rations – chop or grind for uniformity
  - High moisture content
- Nutrient variation and variation of ingredients limit use
- Regulations and food safety must be complied with