Viability of Utilizing Pre-consumer Food Waste for Livestock Feed and Composting

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Prepared by:

BRINK, INC.
Environmental Solutions

Erie, CO
www.brinkinc.biz
720-887-9944

I. Project Description and Background

A. Project description

This project examines the conditions in which pre-consumer food, brewers, and distillers waste can be cost-effectively collected, transported, and utilized as feed stock or composting material at livestock production facilities.

Pre-consumer food waste is generated as a result of commercial, institutional and retail food processing and preparation for consumption. It may include produce and meat trimmings, bakery products, distilling and brewing by-products, and expired and damaged products removed from shelves or dispenser machines. It may also include unusable produce at the farm level.

A USDA Economic Research Service report published in 2010 indicated that 31 percent of the U.S. food supply at the retail and consumer level went uneaten. This does not include pre- consumer waste at the processor / distributor level.

B. Background

This project included discussions with food industry professionals representing growers, distributors, processors, supermarkets, breweries, distilleries, bakeries, and food banks, as well as agricultural producers, waste haulers, and recyclers.

Pre-consumer food waste

Pre-consumer food waste is a valuable product. The production of food requires a significant input of energy, nutrients, water, land and capital. A review of practices indicates the fate of pre-consumer food waste varies widely, and includes the following practices: donation to food banks, re-processing for juice production, landfilling, composting, and utilization as livestock or wildlife feed. One or more of these practices may be utilized by a given facility depending on the time of year, and the volume and type of food waste materials generated.

Utilizing pre-consumer food waste as livestock feed represents the highest use of the product when food bank donation is not appropriate. Food bank donation is not appropriate when food is inedible.

The broad variation in how food is handled, processed, and prepared in conjunction with the perishable nature of non-processed foods and the low value associated with food waste creates challenges that can be best addressed on a local and sub-regional level.

Food waste being composted

Non-meat pre-consumer food waste such as fruits and vegetables, bakery, brewers and distillers by-products can be used as a feed source for ruminant animals such as cattle and sheep, as well as mono-gastric livestock (swine). Food scraps that are spoiled, moldy or otherwise unsuitable for livestock consumption are best utilized as compostable material.

Livestock production facilities are uniquely suited to provide a one-stop solution for the problem of underutilized pre-consumer food waste. Livestock producers have both the expertise and equipment needed to feed balanced rations to livestock, and handle and land apply the resulting waste products, either as manure or compost. Additionally, the use of pre-consumer food waste products as composting material can increase the nutrient value of compost.

This study identifies the current methods being used to dispose of pre-consumer food waste, the perceived challenges related to connecting food-waste generators with livestock producers, and the conditions in which utilization of pre-consumer food waste can be viable. Note: Unless otherwise specified, the term "food waste" means "pre-consumer" food waste only. "Post-consumer" food waste utilization options were not part of this study.

II. Pre-consumer Food Waste Disposal Methods

Most pre-consumer food waste disposal methods fall within three broad categories: 1) landfilling, 2) composting and 3) animal feed utilization or land application. Additionally, edible food that is no longer marketable (past expiration, physically damaged) is typically donated to food banks, which provides food for the needy and provides a tax deduction to the donor.

Approximately fifty (50) entities were contacted as part of this project to gather information about pre-consumer food waste disposal methods. These included small and large companies, non-profits and government agencies. Following are some of the comments received from respondents regarding how they manage food waste:

Front range supercenter: Meat trimmings are removed for use at a wild animal sanctuary near Keenesburg, produce going for composting, dairy products are going into dumpster.

National grocery store chain: Food that is still edible is donated to food banks. Remaining waste food products are currently going into dumpster(s) but they are interested in more sustainable solutions, including livestock utilization.

Rural independent grocery store (eastern plains): Local hog producer(s) usually pick up waste food regularly. If no one shows up, waste food is put in dumpster for landfilling.

Grocery store (Grand Junction): Dairy products that are near or past "sell by" date are donated to a local food bank. Meat trimmings are picked up by a dog owner. All other waste products go into dumpster, but sustainable alternatives, including livestock utilization, would be considered.

Large Ft. Collins Brewery: Brewing by-products, including spent grain, hops, yeast and liquid beer are removed by a local dairy for feeding or land application on fields.

National Organic Food Distributor: In Colorado, non-sellable food is sent to the landfill. Not interested in utilizing waste food for livestock feed or compost due to liability concerns. The fear is that food could be collected and resold.

Longmont-area Organic Farmer: Vegetables that are not suitable for retail sale are donated to a local food bank. All other vegetable waste is sold to a nearby dairy for use as livestock feed. Perishable foods such as zucchini, squash, tomatoes and cucumbers are the most common products that go for dairy feed.

Distiller's grain

Denver Whiskey Distillery: Grain by-product is given or sold to livestock producers.

Multi-National Food Distributor: All information is considered proprietary.

Kombucha Producer: Waste by-product is currently being composted, but interested in finding better uses, such as a poultry feed amendment. Some research suggests kombucha by-products unlock beneficial enzymes in compost and grains.

National Supermarket Chain: Non-sellable but still edible food is donated to food banks. In Colorado, waste food is currently being landfilled. A few stores in Wyoming are having waste food products removed by livestock producers. In California, food waste is being composted as it is less expensive than landfilling. Looking at ways to reduce landfilling of food waste. They are interested in livestock utilization concept but logistics and costs would have to work. They would need regular pickup to accommodate increased fresh cut fruit.

Front Range Waste Haulers: Have commercial and residential composting service; fees are higher than sending equivalent waste volume to the landfill due to economics of landfill tipping fees versus composting. Compost customers are serviced once per week. Consumer composting programs are much more labor intensive because containers must manually dumped into trucks and the composting container must be cleaned and sanitized either at each residence or at the waste hauler's facility. Increased customer density within a given area would help lower hauling costs and make composting more price competitive with landfilling. The concept of hauling pre-consumer food waste to livestock is of interest if the economics and logistics work.

Small Brewery in Lafayette: Brewing once per week; local livestock producer picks it up at no cost. Very pleased with arrangement.

Brighton-area Non-Organic Grower: No response.

Farmers Market Supermarket Chain: Non-sellable but still edible food is donated to food banks. Currently sending all food waste to landfill but looking into composting. They are probably only generating a barrel or two of food waste per day; not sure it would be worthwhile for a livestock producer.

Pigs eating vegetable waste

Regional Brewery in Longmont: Producing about 19 tons of spent brewers grain and 5,000 gallons of liquid waste per day. The grain by-product is sold and the liquid by-product is given to the same livestock producer.

Broomfield Brewery and Restaurant: A livestock producer takes all their brewers waste, hops and spent yeast.

Brewery in Breckenridge: Two area beef producers take brewing waste products.

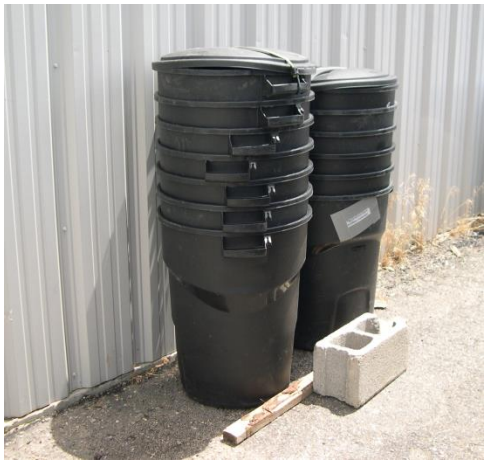
National Bakery (two contacted): No response.

Small Grocery Store in Sterling, CO: Minimal waste food is generated; all of it goes into the dumpster. Most of the waste is trimmings from cabbage, lettuce, and other produce.

Regional Supermarket Chain (division of Kroger): Started a composting pilot project two years ago by bringing in an additional container for compostable material. They currently have 43 stores doing composting; most using 8 cubic yard bins. Each bin has 3 compartments for separating food waste. They are composting produce, dairy products and meat trimmings. A Denver-based waste

hauler is removing and composting the waste food. The participating stores will collectively produce more than 15 million pounds of compost this year. Their goal is to have 100 Front Range stores composting by 2016. They also have three (3) mountain stores that are donating waste produce to farmers (2 pig farmers, 1 chicken grower). Mountain stores are not involved in composting due to distance and cost, and would be open to having a livestock producer take their food waste products.

Organic Food Market: Composting is being done at stores where they can manage it. A consistent supply of fruit waste is generated from their juicing and fresh cut fruit programs. Leafy greens, berries and other non-sellable produce trimmings are also generated throughout the day. Bones and fat are rendered as much as possible. Their goal is to recycle as much of their food and cardboard waste as possible. They would be interested in working with livestock producers; cost and timely pickup would be key to making it work.



Plastic containers waiting to be filled with waste trimmings at an organic vegetable processing facility in Lafayette

Food Bank: Pre-consumer food is picked up from vendors, caterers, and restaurants. A portion of the product received is no longer of sufficient quality to serve to humans and is placed in a dumpster for composting.

Small Organic Farm: Food scraps are routinely collected from an organic food processer, an organic supermarket, and an upscale restaurant. Food scraps are mixed with wood chips and composted. No animals are being raised at this time.

III. Valuing pre-consumer food waste

A. Food waste value

Today's plethora of consumer food and beverage choices equates to a wide variety of pre-consumer food waste being generated. The composition of brewers / distillers waste products is the most consistent, while food waste generated by processors and grocery stores can vary widely, even within a single day. The corresponding nutrient value of food waste varies with the food waste composition.

Food Waste Sample

A waste food sample was collected from a natural foods grocery store in Longmont in late July. The test results of the sample, which included ear corn tops, husks, tassels, and fruit trimmings, such as strawberry and kiwi ends, are displayed in the following table.

Table 1: Laboratory test results of food waste

Name: GROCERY STORE
Sample ID: FRUIT AND EAR CORN TRIMMINGS
Lab Number: 233580

Constituent Analyzed	As Received	Oven Dry
Moisture, %	88.1	0.0
Dry Matter, %	11.9	100.0
Crude Protein, %	1.3	10.7
Crude Fiber, %	2.3	19.5
Acid Detergent Fiber %	2.9	24.7
Crude Fat, %	0.3	2.2
Ash, %	0.7	5.8
Nitrogen Free Extract, %	7.3	61.7

The tested sample contained approximately 88 percent water, which is typical of fresh fruit and ripe field corn. The average moisture content of strawberries, for example, is 92 percent (Source: http://www2.ca.uky.edu/enri/pubs/enri129.pdf.) In Colorado, pre-consumer food waste combinations that contain high moisture levels are beneficial for composting, providing water to speed microbial degradation. For livestock, high moisture feedstuffs can be mixed with dry feed products, such as hay and grain to improve palatability. The downsides to high moisture content food waste are that spoilage occurs more quickly and the nutrient content is relatively low on an "as received" basis (as shown in the table above).

A variety of methods are available for valuing food waste as livestock feed. The objective of each is to compare the cost or value of one feed source versus another based on a nutritional category of interest. For example, the table below estimates the feed value of a variety of common milling and processing products, as well as fruits and vegetables, compared with corn and soy. The nutritional categories being used to determine the relative feed value of each commodity is Total Digestible Nutrients (TDN) and Crude Protein (CP).

Table 2. Feed Value Table

Feed	% DM	% TDN (Total Dig. Nutrients) DM basis	% CP (crude protein) DM basis	% TDN (Total Dig. Nutrients) As-fed basis	% CP (crude protein) As-fed basis	A-SOY Ratio	B-CORN Ratio	Feed Value
Corn Grain	85	89	9.6	75.7	8.2	0	1	$140.00
Soybean Meal 48%	89	84	53.9	74.8	48	1	0	$320.00
Milling and Processing Products								
Apple Pomace	20	70	5	14	1	-0.0128	0.1977	$23.59
Bakery Waste	88	89	11.9	78.3	10.5	0.0507	0.9852	$154.15
Beet Pulp	91	78	8	71	7.3	-0.0094	0.9476	$129.64
Wet Brewers Grain	24	67	25	16.1	6	0.1069	0.1069	$49.17
Dry Brewers Grain	92	67	25	61.6	23	0.4097	0.4099	$188.50
Corn Cobs	90	47	2.8	42.3	2.5	-0.0512	0.6097	$68.98
Wet Corn Distillers	30	84	29.5	25.2	8.9	0.1537	0.1813	$74.55
Dry Corn Distillers	92	83.7	29.5	77	27.1	0.471	0.5524	$228.05
Corn Gluten Feed	40	82	27.5	32.8	11	0.187	0.2488	$94.67
40% Gluten Meal	91	86	43.9	78.3	39.9	0.7895	0.2543	$288.24
60% Gluten Meal	91	86	67.2	78.3	61.2	1.3208	-0.2708	$384.76
Oat Hulls	93	35	3.8	32.6	3.5	0.0006	0.4297	$60.34
Oats - Mixed Feed	90	60	14	54	12.6	0.1698	0.546	$130.77
Roasted Soybeans	92	93.5	41.3	86	38	0.7198	0.4255	$289.90
Rye Distillers - Wet	30	84	29	25.2	8.7	0.1499	0.185	$73.86
Whey	7	78	14	5.5	1	0.0098	0.0625	$11.88
Wheat Bran	89	70	18	62.3	16	0.233	0.5932	$157.63
Rice middlings	88	66.9	15.6	58.9	13.7	0.1849	0.5955	$142.53
Fruits and Vegetables								
Apples	17	70	2.8	11.9	0.5	-0.0202	0.1773	$18.35
Bananas	24.3	84.1	4.5	20.4	1.1	-0.0278	0.2977	$32.76
Beets	13	80.3	12.6	10.4	1.6	0.0128	0.1253	$21.65
Bread	63	89	13.3	56.1	8.4	0.0584	0.6835	$114.37
Broccoli	11	70	33	7.7	3.6	0.0701	0.0325	$26.99
Cabbage	9.5	85.3	25.3	8.1	2.4	0.0383	0.0692	$21.96
Carrots	12	84	9.9	10.1	1.2	0.0025	0.1308	$19.11
Celery	6	62	15.3	3.7	0.9	0.0129	0.0364	$9.24
Lettuce	5	51	22	2.6	1.1	0.0207	0.0133	$8.47
Onions	9	57.6	12.6	5.2	1.1	0.0144	0.0543	$12.21
Potatoes	23	81	9.5	18.6	2.2	0.0044	0.2419	$35.28
Tomatoes	6	69	16.4	4.1	1	0.0135	0.0414	$10.11

Source: Ontario Ministy of Agriculture, Food and Rural Affairs, Nutrient Testing, Order 03-007

Total Digestible Nutrients (TDN): The sum of the digestible fiber, protein, lipid, and carbohydrate components of a feedstuff or diet. TDN is directly related to digestible energy and is often calculated based on ADF.

Compared with grain milling and processing products, fruits and vegetables generally have lower feed values on a protein and digestible nutrients basis, but are may be higher in non-digestible fiber, which is valuable for providing roughage in a feed ration.

The table below estimates the feed value of bakery waste before and after de-bagging and transportation costs are included. A change in any one of the cost variables could significantly change the net delivered value of the bakery waste.

Table 3: Estimated net value of bakery waste delivered

Food waste	Feed Value / Ton (from Table 2)	Est. semi-truck load capacity (tons)*	Value of full load	Example Hauling Distance, one way (miles)	Hauling cost (per mile)	Feed Value of truckload after hauling cost	Feed Value per Ton after Hauling Cost	Less De-bagging cost (per ton)**	Net Feed Value per ton	Net Feed Value per Truck load
bakery waste	$114	15	$ 1,716	30	$ 5.00	$ 1,566	$104.37	$ 30.74	$73.63	$ 1,104
* based on a loaf of 1.5 lb bread, 0.08 c.f./ loaf, 15% void space in container trailer										
** Based on $8.30 / hr. labor rate, 1,333 loaves per ton, and estimated loaf debagging rate of 6 bags per minute										

B. Composting value

Fruit and vegetable waste products that are not viable as a feed source can be mixed with animal manure for composting. Colorado State University Extension data (see Table 4) indicate vegetable waste has a Carbon:Nitrogen (C:N) ratio ranging from 12 - 20:1, while fruit waste has a C:N ratio of about 35:1. Cow manure has a C:N ratio of around 20:1. A mixture of these three components in equal parts would yield a material with a C:N ratio of about 24:1, which is the ideal ratio for composting.

Table 4: Carbon/Nitrogen ratios of various compost feed stocks

Material	C:N Ratio
Vegetable waste	12-20:1
Alfalfa hay	13:1
Cow manure	20:1
Apple pomace	21:1
Fruit waste	35:1
Corn stalks	60:1
Horse manure	25:1
Coffee grounds	20:1
Poultry manure	10:1

CSU Extension; *Composting: Resource Conservation, Reduce, Reuse, Recycle*

IV. Regulations - feeding food waste to animals

A. Ruminants

In 1997, FDA published a final regulation that prohibits the use of most mammalian protein in the manufacture of animal feeds given to ruminant animals, such as cows, sheep, and goats. The rule does not prohibit the use of mammalian protein as an ingredient in feed for non-ruminants, such as swine, but requires process and control systems to ensure that such use does not cause contamination of ruminant feed during feed manufacture or transport.

FDA strengthened the 1997 rule in 2008 by prohibiting the use of the highest risk cattle tissues in ALL animal feed. These high risk cattle materials are the brains and spinal cords from cattle 30 months of age and older, and the entire carcass of cattle not inspected and passed for human consumption, unless the carcasses are shown to be from cattle less than 30 months of age, or the brains and spinal cords have been removed. Source: U.S. Food and Drug Administration (FDA) http://www.fda.gov/AnimalVeterinary/GuidanceComplianceEnforcement/ComplianceEnforcement/BovineSpongiformEncephalopathy/default.htm

Since meat products sold through supermarkets and other retail outlets in Colorado are required to be USDA inspected and approved, deli trimmings from these facilities should be acceptable for use as feed for hogs provided they are treated to kill disease in accordance with the Swine Health Protection Act (see below).

B. Swine

The Swine Health Protection Act (SHPA) (Public Law 96-468), passed by Congress on October 17, 1980, imposes restrictions on feeding food waste to swine. The SHPA does not distinguish between pre- and post-consumer food waste. Food waste, or "garbage" as defined in the SHPA, includes "all waste material derived in whole or in part from the meat of any animal (including fish and poultry) or other animal material, and other refuse of any character whatsoever that has been associated with any such material, resulting from the handling, preparation, cooking, or consumption of food.

The SHPA disallows feeding food waste that meets the definition of "garbage" to swine, unless the material has been treated to kill disease organisms. To satisfactorily treat the food waste, it must be heated throughout at boiling (212° F or 100° C at sea level) for 30 minutes before it is fed to swine. The final temperature of all pieces of meat in the mixture must be at least 167° F after cooking. The exception is food waste generated in a household and fed to swine on the same premises where the household is located. Under those conditions, waste food does not have to be treated.

Pre-consumer food waste that does not include animal material and has not been co-mingled in any way with animal material is not regulated under the SHPA. Some examples of pre-consumer food waste that would typically not be

regulated under the SHPA are vegetable and fruit discards and trimmings, bread, and brewing and distilling by-products. If any of these by-products came into contact with any animal material, the product would have to be cooked to kill disease organisms prior to being fed to swine.

The full text of the SHPA can be accessed at https://www.govtrack.us/congress/bills/96/hr6593/text.

Bottom Line:

- All meat products intended for swine feed must be properly cooked first.
- Non-meat products can be fed to swine without cooking if the products have never been associated (ie. contaminated) with animal material. Animal material includes poultry and fish.

C. Colorado feed distribution regulations

The distribution of commercial animal feed is regulated under Colorado Feed Law, Sections 35-60-101 through 115, C.R.S. 8 CCR 1202-6. The feed law rule Incorporates by reference the Official Definitions of Feed Ingredients as published in the 2015 Official Publication of the Association of American Feed Control Officials, Inc. ("AAFCO").

In Colorado, a facility that wants to sell or give away food waste meeting the definition of "garbage" described above must register with the Colorado Department of Agriculture Inspection and Consumer Services Division, obtain a permit, renew the permit annually, and pay a tonnage distribution fee for the amount distributed annually. Fees are listed below:

Table 5: Feed Tonnage Distribution Fees (Colorado):

Tonnage Distribution Fees	Fee	Unit
Base Fee	$50.00	per year
Annual Renewal Fee	$75.00	per year
Per Dry Ton	$0.05	dry ton
Per Wet Ton (> 60% moisture)	$0.025	wet ton

Any pre-consumer food waste that is sold or given away as feed is required to be labeled. The label must include guaranteed [lab] analysis of the product, an ingredient list, and other information.

The Colorado Feed Rule can be accessed at http://www.sos.state.co.us/CCR/GenerateRulePdf.do?ruleVersionId=6183&fileName=8%20CCR%201202-6.

AAFCO is currently considering a revision of the definition of food waste materials within its feed ingredient list. Approval of a revised definition will likely occur by mid-2016. It is possible that the revised definition(s) will provide greater clarity and appropriate flexibility while protecting human and animal health and the environment.

D. Environmental regulations

Commercial composting is regulated under Section 14 of the Colorado solid waste regulations. An agricultural composting operation is exempt from regulation if the operation "compost [s] yard waste, woody materials, agricultural residuals, or crop residues and/or food scraps provided all of the following conditions are met:

(1) The owner of the composting operation is the same as the owner of the animal or crop production operation where the yard waste, agricultural waste, animal waste, food waste is generated (primary feedstocks);

(2) The owner or operator only imports complementary and compatible Type 1 feedstocks, agricultural residuals or crop residues necessary for composting;

(3) The composting facility is located on property owned or leased by the animal or crop production operation;

(4) The composting facility is operated in such a manner that noise, dust, and odors do not constitute a nuisance or health hazard and does not cause or contribute to surface or ground water pollution; and

(5) All resulting compost, soil amendment or fertilizer produced is utilized exclusively at the animal or crop production operation or on the person's property.

The regulation defines Type 1 composting material as "yard waste, woody materials, agricultural crop residues, and other materials determined to pose a low level of risk to human health and the environment, from physical contaminants and human pathogens.

Section 14.1.2 of the state Compost Regulation references food waste as either a Type 2 or Type 3 compost feedstock. Type 2 compost feedstock includes "Department approved food processing residuals from vegetable food processing such as spent brewers grains and hops and vegetable scraps." The term "vegetable scraps" is not defined in the regulation. However, another term - "Food Processing Vegetative Waste" - is defined as material generated in trimming, reject sorting, cleaning, pressing, cooking, and filtering operations from the processing of fruits and vegetables and the like in food processing and packaging operations or similar industries that process food products. Vegetative wastes include, but are not limited to, tomato skins and seeds, pepper cores, potato peels, cabbage, onion skins, celery pieces, cranberry hulls, cranberry tailings, rice hulls, carrot stems, and coffee grounds.

Type 3 material includes "food processing residuals not covered in Type 2." This would include "compostable materials generated as a by-product of the industrial

food processing sector that are non-toxic, non-hazardous, and contain no sanitary wastewater."

Type 2 material is exempt from the permitting and reporting requirements set forth in Section 14 of the Compost Regulation in cases where the "composting facility [has] a throughput of less than 20 tons of Type 2 feedstock during any calendar year." Also, "any composting facility with a throughput of less than 40 tons of Type 2 feedstock in any calendar year using an in-vessel composting method" is exempt. Facilities must maintain records of feedstocks to qualify for exemption status.

The owner or operator of a Type 2 composting facility that does not qualify for an exemption must submit an Engineering Design and Operations (EDOP) and construction quality assurance plan to the Department and the local governing authority for review and approval. A Class 2 composting facility must be designed, constructed and operated in accordance with its approved EDOP, and annual record-keeping and reporting is required.

The cost associated with developing the documentation and construction quality assurance plan can start at a few thousand dollars and go substantially higher depending upon a site's attributes and location, types of composting material that will be involved, and the size of the operation. This range would not include costs related site testing and engineering and construction work related to developing the site for composting.

V. Perceived Barriers / Concerns:

A. Food waste generator concerns / needs

1. Cost: Among Front Range pre-consumer food waste generators, cost is cited most frequently as the reason food waste is landfilled rather than being composted. Waste hauling companies cite lower customer density and higher labor costs as the primary reasons why composting services are more expensive than landfilling. Additionally, landfill tipping fees are relatively low. Costs associated with composting would likely be similar to those related to sending pre-consumer food waste to livestock facilities. Below are examples of the comparative costs associated with having waste removed for landfilling versus composting.

Table 6: Landfilling versus composting costs

	Hauling Cost (3 yd bin, 1X per wk)	
	Trash	Compost
Denver Metro Area	$ 68	$ 103
Northern Front Range	$ 130	$ 160

On average, across the waste hauling industry, using a composting service is about 23% more expensive than disposing of waste via landfilling *(source: Alpine Waste and Recycling, 8/2015).*

2. Timely and Reliable Pickup: Limited storage capacity and storage bin sanitation are the primary reasons timely pickup is necessary. The storage container and area around it must be kept reasonably clean to minimize odors and pests, and the container must not leak. Composting service providers typically provide weekly pickup.

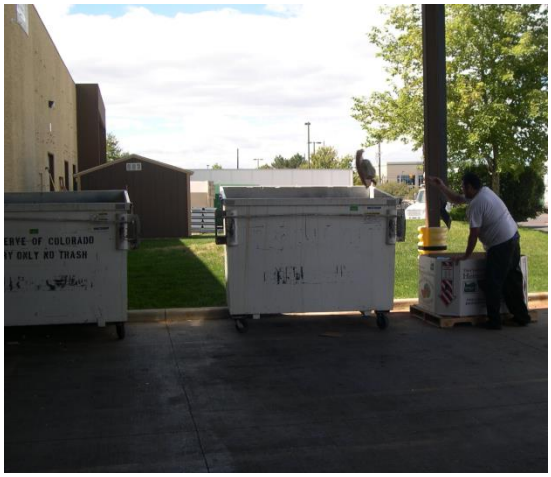
3. Liability: Pre-consumer food waste must be used only for the agreed-upon purpose (livestock feed or composting). No food waste can re-enter the human food system and the generator must be held harmless once the food waste has been removed from the generator's premises.

4. Convenience: Accommodating additional food waste storage for livestock feed or composting, and related activities such as requiring staff to separate waste streams prior to disposal must be reasonably efficient. In Tennessee, Walmart has partnered with two feedlots to send vegetable and fruit waste to two area cattle feedlots. Quality control is maintained by placing locked, placarded containers at each facility. Store employees must obtain a key from store managers to unlock the containers before dumping in the food waste.

B. Livestock producer concerns / needs

1. Cost. The food waste product must be free or the cost must be significantly lower than other feedstuffs to justify the related challenges associated with hauling, storing, handling, mixing and feeding a variable and often rapidly perishable product.

2. Quality and consistency of product. The food waste must be generally free of spoilage and foreign material such as plastic and cardboard must be removed prior to pick-up for livestock feeding. High moisture fruit, vegetables and bread can deteriorate rapidly in warm, poorly ventilated dumpsters and storage bins.



Past-sell and excess bread at food bank is sent to be processed into poultry feed

Ruminant livestock (cattle, sheep) are sensitive to abrupt dietary changes. Additionally, it is generally illegal to feed mammalian protein to ruminants, and meat products can only be fed to swine after treatment via cooking. Food waste products are typically discarded without sorting, and may be highly variable in consistency from day to day depending upon the season and store promotions and other factors.

3. Liability: Ruminant livestock cannot be fed most mammalian protein and any meat fed to swine must be property cooked first. Egregious or repeated violations of livestock feeding restrictions may warrant regulatory action such as seizure, injunction, or prosecution (U.S. Food and Drug Administration).

4. Volume. Supermarkets that were contacted estimated the amount of food waste generated daily to be within the range of 100 to 200 pounds; possibly more if they had special offerings such as a fresh cut fruit and juicing program. The average feeder steer consumes 20 to 30 pounds of feed per day, depending on the animal size and ration composition. Thus, a pen of 100 feeder steers can eat 3,000 pounds of feed per day. A significant volume of food waste is necessary to justify the cost of hauling and integration into rations.

Table 5 (following page) summarizes the perceived barriers identified by food waste generators and livestock producers regarding food waste utilization by livestock.

Table 7: Perceived Barriers and Potential Solutions

	Food waste generators		Livestock Producers		
	Concerns	**Notes**	**Concerns**	**Notes**	**Potential Solutions**
1	Cost	For Composting: higher tipping fee than landfill. For animal feed: fees and labor related to regulatory compliance.	Cost	Time spent keeping track of waste food fate (ie. what animal species received the food waste)	1. Generator pays livestock producer landfilling rates to remove. 2. Tax incentive for donating food waste to livestock producers.
2	Timely and reliable pickup	Regular pickup = better sanitation & food waste quality	Quality & Consistency	Free of spoilage, foreign material. Product consistency is especially important for ruminants.	Timely pickup helps ensure product quality. Manual separation may be needed by generator to improve consistency. Aerated and shaded storage bins help preserve product quality.
3	Liability	Regulatory compliance assurance (i.e. State animal feed distributor and FDA regulations)	Liability	For animal feed: ensuring waste food is fed to approved species	Contract between parties defines allowable uses and food waste constituents
4	Convenience	Needs to be reasonably convenient.	Volume	Volume must be adequate to be worthwhile	Staff training and well marked storage bins help improve appropriate disposal. Right-size volume with livestock numbers

VI. Findings and Recommendations

The three methods of waste food disposal being used by pre-consumer food waste generators are landfilling, composting and livestock feeding. A mixture of disposal methods may be used by food waste generators depending on available alternatives. For example, a supermarket may allow a local livestock producer to take as much waste food as desired, and then landfill the remainder. One large supermarket chain (King Soopers) is in the process of integrating food waste composting at all of its Front Range stores.

Virtually all brewers and distillers are already sending their by-products to livestock operations for use as feed (typical) or as a soil amendment for cropland. The majority of supermarkets, food processors, bakers, food distributors and produce growers are donating a portion of their products to food banks. Food banks are distributing a substantial volume of food throughout the state. The Denver Food Bank of the Rockies, for example, received and distributed over 50 million pounds of food last year. A relatively low percentage of food product received at food banks cannot be distributed and must be discarded. The product may not meet quality requirements or have damaged packaging.

There is broad interest among pre-consumer food waste generators in making better use of waste food, either as livestock waste and / or as compost. Following are take-away comments from discussions with individuals representing the spectrum of food waste generators regarding how more food waste can be used for livestock feed or compost.

A. Cost is key

Cost-effective removal, transport and delivery of food waste represents the crux of the pre-consumer food waste utilization challenge. From a logistical standpoint, commercial waste haulers already have a collection and disposal infrastructure in place that provides landfilling or composting of food waste. Delivery of pre-consumer food waste to livestock operations may also be feasible. For many generators, cost is the greatest determinant of whether food waste is landfilled or used for livestock feed or composting.

Factors that can help lower costs for waste haulers:

- Greater customer density (ie. greater hauling cost efficiency)
- Greater volume (ie. lowers processing costs)
- Shorter haul distances
- Lower tipping fee for composting

Livestock producers will substitute pre-consumer food waste for more conventional feedstuffs when there is an obvious cost savings. In this context, "cost" includes all aspects related to delivering feed to livestock, including hauling, handling and storage costs, spoilage loss, labor, and the feed value of the food waste. For example, a Front Range livestock feeder reduced his hay

purchases by utilizing barley hulls from a brewery. The barley hulls provide dietary fiber and carbohydrates and cost less than $100 per ton versus $130/ton for hay or $140/ton for soy hulls.

B. Cost / Benefit *

A cost / benefit analysis compares the costs of a project with the project's benefits and provides an indication of whether the project is worth doing. Quantifying the cost and benefits of using pre-consumer food waste as livestock feed depends on several variables, including the type and quality of the food waste, feed value, moisture content, storage time, and distance between the generator and user. Situation-specific information is necessary to prepare an accurate cost / benefit analysis.

The following table outlines the costs and benefits associated with feeding pre-consumer food waste to livestock.

Table 8: Costs and Benefits:

Food Waste Generator *	
Costs	**Benefits**
Typically higher removal cost than landfilling	Recycling of nutrients (environmental benefit)
Additional storage bin(s)	Saving landfill space (environmental benefit)
Labor cost (separating food waste)	Marketing and public relations enhancement
Regulatory compliance management	Support local meat / dairy production
Livestock Producer *	
Costs	**Benefits**
Transportation (hauling to the facility)	Reduced feed cost
Removing any contaminants, such as cardboard or plastics	Recycling of nutrients (environmental benefit)
Ration formulation and special storage considerations	Saving landfill space (environmental benefit)
Regulatory Compliance Management	Fresh fruits and vegetables in livestock diet

** see preceeding text in VI, B.*

C. Food connectors

Two food waste generators indicated it would be beneficial to have a "connector" entity or person to link them with livestock producers that are looking for food waste. Many breweries have found recipients for their spent brewer's grain by posting its availability on craigslist. This option is available to all food waste generators. An entity such as the Colorado Department of Agriculture or a state livestock association could also provide an online service for connecting food waste generators with interested recipients.

D. Certification program

Two pre-consumer food waste generators suggested that a certification program would be helpful as a marketing and employee motivational tool. The certification program would publically recognize companies for eliminating all land-filling of food waste and other related material, such as cardboard.

F. Pilot project potential

Between 2009 and 2014, a zero waste program with an emphasis on food waste diversion was conducted in Colorado Springs in concert with a local food bank. The effort involved unpackaging and feeding pre-consumer food waste to livestock and composting food waste with manure generated from the small livestock operation. The group that designed and coordinated the effort – Future Pointe (www.futurepointe.com) - provided the following data related to costs incurred and savings realized by the food bank with regard to food disposal.

- 19 millions lbs. of food distributed annually by the food bank
- 3% of inventory (530,000 lbs.) wasted in 2009, less than 1% wasted in 2015
- $3,000/yr. in waste disposal related expenses ($12,000/yr. savings over 2009)
- $12,000/year in byproduct revenue from packaging materials sold as commodity
- $10,000/year revenue from animal feed conversion service
- 2 jobs created since 2009 (1 full-time and 1 part-time)

Through the zero waste program, the food bank has been able to generate positive income from its food waste disposal activities through its collaboration with commercial enterprises that are in turn making use of the waste products. The revenue that is being generated has enabled the food bank to hire two staff members who in turn focus on expanding the "food to fodder" program, and work on reducing all types of waste generated by the food bank.

Additional pilot projects like the Colorado Springs food bank example are needed in other food waste generator sectors. A pilot project that connects one or more waste generators with livestock producers and tracks all of the costs, logistical challenges and solutions, and regulatory compliance requirements would be helpful as a roadmap for others to follow. Widespread distribution of the project results could help accelerate food waste to livestock and composting connections by answering many similar questions that food waste generators and livestock producers have, and provide real cost and revenue data.

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