FOOD WASTE RECYCLING IN UPSTATE NEW YORK: A QUALITATIVE STUDY EXPLORING THE FEASIBILITY OF FEEDING FOOD SCRAPS TO ANIMALS

A Thesis

Presented to the Faculty of the Graduate School

of Cornell University

in Partial Fulfillment of the Requirements for the Degree of

Master of Professional Studies in Global Development

by
Alexandria Castaneda and John E. Kennedy III

August 2021

ABSTRACT

Food waste is an inevitable consequence of the current structure of our food system. Recycling food scraps and using them as an energy source is a strategy that can reduce food waste disposal in US landfills and promote a circular economy. This can be done through feeding food scraps to animals, industrial uses such as anaerobic digestion, or composting. In this assessment of food scrap recycling habits, in-depth interviews were conducted with organic waste generators and receivers in Upstate New York. This study was conducted in response to the Food Donation and Food Scrap Recycling Act, which will go into effect in January of 2022**.** New York's organics ban is a piece of legislation that will redirect waste streams from food scrap generators who produce over 2 tons of organic matter per week and will require these generators to use their scraps in energy efficient ways. Interviews focused specifically on feeding food scraps to animals, as it is the recycling strategy that yields the most benefit for society, the economy, and the environment (EPA, n.d.). Interview responses were used to identify the benefits and challenges of using food scraps as animal feed in Upstate New York. We identified that food scrap use as animal feed provides a significant economic benefit to farmers and generators alike, proving to be an integral strategy to agricultural production in Upstate New York. We also found that investments in infrastructure and policy education and outreach are critical to increasing recycling capacity in NYS to promote or mandate the recycling of food scraps.

Key Words: Food Scraps, Food Waste, Circular Economy, Waste Management, Recycling

BIOGRAPHICAL SKETCH

Alexandria “Ria” Castaneda hails from the San Francisco Bay Area. From an early age, Ria devoted many school breaks and summer holidays to volunteer projects and service opportunities. After graduating from California Polytechnic State University in San Luis Obispo, California with a BS in Plant Science, Ria committed herself to the Peace Corps, serving in Paraguay for over two years on a myriad of agricultural initiatives. Her greatest achievement during that time was the establishment of green manure seed banks in her community and the surrounding areas, leading to more sustainable methods of farming. In her pursuit of a MPS in Global Development from Cornell University, Ria hopes to empower underserved communities around the world so that small rural communities may have autonomy and voice in the context of the larger global economy. Her current research focuses on the lifecycle of food waste in New York State and the opportunity and obstacles of incorporating alternative uses of food waste.

John Eugene Kennedy, known by his friends as Jake, is originally from the Piedmont region of North Carolina. He received his Bachelor of Arts from Appalachian State University with a degree in Sustainable Development in 2016. After receiving his Bachelors, Jake went on to serve in the United States Peace Corps in Zambia as an Agroforestry Extension Volunteer, and as Zambia’s Northern Province Peace Corps Volunteer Leader. He spent 27 months in Zambia between the two roles, partnering with his host community in projects surrounding conservation agriculture, communal agroforestry implementation, aquaculture production, animal husbandry, community development programs, and appropriate technology. After his time in the Peace Corps, Jake went on to teach at the Mongolian University of Life Sciences on a Fulbright Grant before beginning his studies in Cornell’s Masters of Global Development Program, where he worked as a Graduate Teaching Assistant. After completion of the program, Jake hopes to enter into a work sphere to help promote more equitable, accessible, and sustainable agricultural extension and education practices, all in an effort to lift up food sovereignty and community agency within structures supporting underserved populations.

Ria dedicates this work to her family, future children, and friends all over.

Jake dedicates this work to his loving family, friends, mentors, and the people who believed in him through his graduate course of study.

ACKNOWLEDGMENTS

A series of thanks to all the farmers, generators, Cornell Cooperative Extension agents, and state and private workers who provided their kindness, time, knowledge, information, and assistance.

A great thanks to Lori Leonard, 1.) Chair of the Global Development Department, and 2.) research lead for this primary project, for her generosity, dedication, assistance, and leadership throughout this project development process. You made this whole project possible.

A great thanks to Cyprian Kaziba and Lynn Bliven for all their assistance, efforts, and time.

Lastly, a special thanks for our families for their support and persistent love.

TABLE OF CONTENTS

Preface

With New York State implementing their 2022 organic ban legislation, organic waste streams will need to find opportune and sustainable outlets in which to move. While the existence of organics recycling facilities can be gleaned from New York State and private records, the existence of formal and informal exchange of food scraps that go towards on-farm recycling opportunities (particularly for use as animal feed) is not well documented. As these organic waste streams will begin to be diverted from landfills in January 2022, the opportunity to assess the existing habits, structures, and opportunities for growth in utilizing food scraps for animal feed has become an increasingly important management strategy.

The research documented within this paper aims to highlight the similarities and differences between two counties in New York State: Essex and Onondaga. Interviews and research within these two countries were conducted to assess the structures, habits, demographics, and organic waste source availability for farmers and generators within the entirety of New York State. The nature of this document is to serve as a case study in the analysis of existing systems in place for obtaining food scraps for recycling, (namely for animal feed), and to highlight recommendations for implementing the policy at a state-wide level.

Introduction

Most food scraps in the US are sent to landfill; in fact, currently only 5% of food scraps are diverted from landfills, although this percentage varies dramatically by source (Gunders, 2017). Food scraps are defined as food not suitable for human consumption or donation, which includes pre- and post-consumer food waste (trimmings, peels, byproducts of manufacturing, leftovers, etc.). Feeding food scraps to animals has the potential to reduce land needed to produce grain (Truong et al., 2019) and offset methane emissions (Chen et al., 2020). Landfilling scraps is increasingly becoming recognized as a poor disposal strategy in the United States. As a result, local and state governments are pushing innovative policies that encourage food scraps recycling.

Throughout the United States, there are only six states that have taken initiative at some level to create policies to ban organic waste and redirect the stream towards recycling opportunities. These six states are: California, New York (effective 2022), New Jersey (effective in 2022) Rhode Island, Vermont, Connecticut, and Massachusetts. Each state, however, integrates unique mechanisms for implementing organic waste bans, usually mandating organic recycling laws that require specific action to be taken for sending, collecting, and utilizing organic waste (Sandson et al., 2019).

New York State's ban requires that food scrap generators producing more than two tons of organic waste weekly must donate edible food or recycle food scraps if they are within 25 miles of a recycling facility. This law requires all large producers and generators to donate and recycle if they meet the requirements, with the exception of hospitals, nursing homes, K-12 schools, adult care facilities, and New York city, which has an existing food scrap diversion law

(*New York State Food Donation and Food Scraps Recycling Law*, 2019). This law reflects the collective efforts of state governments to reduce the total amount of scraps that are being sent to landfills, aiming to reduce global methane emissions, and to thwart the need for additional landfills to be built. Policies like New York State's Food Donation and Food Scraps Recycling Act pave the way for positive action in the US that will lead to more food scrap recycling through feeding food scraps to animals, industrial uses such as anaerobic digestion and composting.

This study focused on one recycling strategy: feeding food scraps to animals. Food scraps are used to supplement feed in domesticated animals such as chickens, pigs, and cattle; however, the policies surrounding this topic are varied and complex. Within New York State, there are numerous Federal and State laws impacting the treatment and utilization of feed given to farm animals. Such policies include the Federal Swine Health Protection Act (SHPA), the Ruminant Feed Ban Rule, the Preventive Controls Rule for Animal Food in the Food Safety Modernization Act (FSMA), the Food, Drug, & Cosmetic Act (FDCA), and the New York Law on Feeding Food Scraps to Animals. In the context of New York State, these enacted policies, when summarized, aim to ensure that any meat products and "garbage" (described as post-processed animal waste from handling, processing, preparation, cooking, and consumption) cannot be served to swine or poultry unless heat treated at a regulated facility to make the product commercially sterile (New York State Agriculture and Markets. *Garbage Feeding: Why it is Prohibited*). This treatment consists of heating byproducts to 212 Fahrenheit for a minimum of 30 minutes at a licensed facility. It must be noted that ruminants cannot be fed meat (*New York Food Donation: Feeding Food Scraps to Animals*, 2018). These policy initiatives aim to halt the spread of disease from animal products to humans but can create barriers to access if the

infrastructure to properly treat the food scraps is not in place. In the wake of the new law, it is important to understand the opportunities and challenges of using scraps to supplement animal feed. In response, this study aims to unpack the factors that foster feed supplementation with scraps to provide recommendations for upscaling such efforts in New York and elsewhere.

Literature Review/Background

One third of the global food supply, or 1.3 billion tons of food, are lost or wasted each year (Gustavsson et al., 2011). This amount of food represents enormous economic losses, estimated at $1 trillion USD annually, and significant contributions to greenhouse gas emissions (Ziolkowska, 2017; Chen et al., 2020). There is no universal definition for food waste; however, this term generally encompasses all edible and inedible food fragments that end up in the waste stream. As such, food scraps, which are defined as unsuitable for human consumption, are included in what the EPA would refer to as "wasted food" (EPA, n.d.). The poor disposal of food scraps is a global issue that is being tackled through the implementation of alternative food scrap recycling strategies.

Current food scrap disposal strategies in the US are damaging to the environment. Food is the largest category, by weight, of material in landfills; it is said that only five percent of food waste in the US gets diverted from landfills by composting or anaerobic digestion (AD) (EPA; Gunders, 2017). Food waste contributes to 2.6 percent of all US GHG emissions (Gunders, 2017). Furthermore, food waste is responsible for 11% of US based methane emissions from landfills (EPA, 2016). When food waste is left to sit in landfills, which are oxygen depleted, the process of methanogenesis occurs, which yields CH4 emissions into the environment as a result

of using CO2 as an electron acceptor (Lyu et al., 2018). This is of serious concern because methane is more reactive than CO2 in the environment (EPA), which means it intensifies the greenhouse effect and global warming (Brodny & Tutak, 2016).

The negative effects of landfilling food scraps have stirred organizations and stakeholders to implement campaigns to better utilize food waste. This began after 2012, when the National Resource Defense Council published their *Wasted* report unveiling the issues with current food waste management practices. This catalyzed a global and national response, which led the EPA, USDA, and United Nations to adopt food waste reduction targets in 2015 and begin to prioritize the issue (Gunders, 2017). The increased awareness of the prevailing issue of wasted food also influenced the introduction of the Food Recovery Act into Congress and the EPA's publication of a Food Recovery Hierarchy to give all stakeholders along the food supply chain information on how to best reduce, reuse, and recycle food waste (Figure 1).

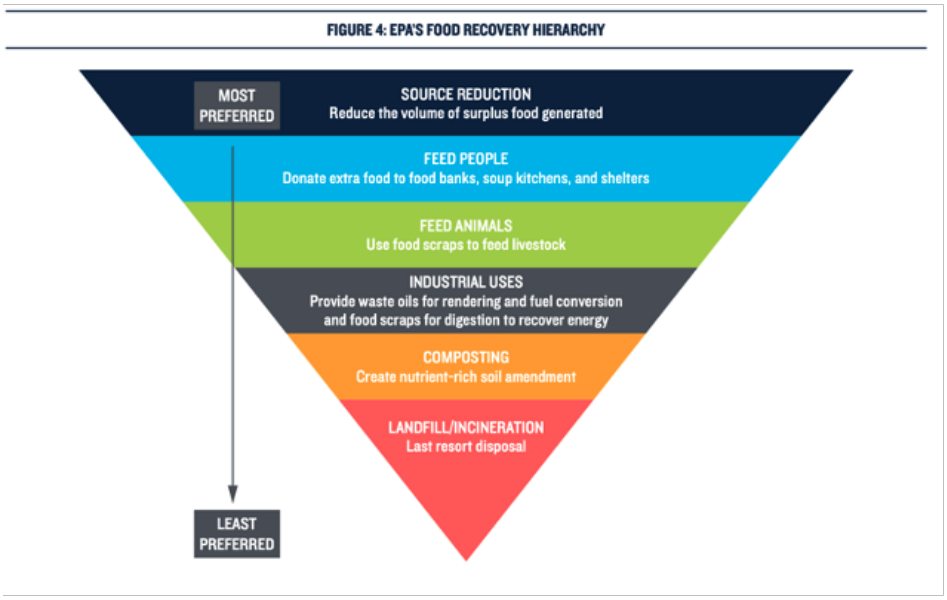

Figure 1. Food Recovery Hierarchy. EPA (2015).

This graphic provides a guide for how to best use food scraps and encompasses principles of a circular economy. The concept of a circular economy is at the core of reducing food scrap wastage, which highlights an intentionality to be restorative and regenerative, while aiming to eliminate waste through reuse (Kirchherr et al., 2017). These values are reflected in efforts to reduce food scraps being lost to landfills. In 2016, the EPA and the USDA launched the US Food Loss and Waste Champions, which was a program used to incentivize organizations toward reducing food waste by 50% by 2030 (Muth et al., 2019). Initiatives of this type are prevalent in the US on both local and national levels. Both public and private alike are attempting to address the problem of waste food in the US (Muth et al., 2019).

While there is action on the part of interested parties and an understanding that food wastage is important, policies in the US have not been the primary tool used to curb food waste along the food supply chain. Currently, only five states in the US have state-wide policies that enforce organics recycling - California, Massachusetts, Rhode Island, Connecticut, and Vermont (NCSL, 2021). However, as described above, New York will be the sixth state to implement a policy that aims to promote recycling of food scraps. Other states use economic incentives to combat this issue. In fact, ten states offer a tax incentive to organizations and individuals who donate edible food to food banks. Despite these efforts, only 10% of all edible food waste is reclaimed in the US (Gunders, 2017). Current management strategies, initiatives, and policy surrounding food scrap disposal in the US results in most food scraps ending up in landfills. For this reason, alternate methods of disposal and usage may be the answer to making big changes in the way food waste is handled in the US in the future.

Feeding Animals Food Scraps

Feeding food scraps to animals is one example of a recycling method that has the potential to divert food scraps from landfills. In some areas of the world, using food scraps for animal feed is commonplace (Joshi & Visvanathan, 2019). This practice has gone on for centuries, and provides many benefits to animals, society, and the food supply chain (Divina, 2016). Not only does feeding food scraps to animals contribute to waste reduction, but also promotes the efficient usage of resources. For example, using food scraps in feed diversifies the diet of animals, providing them the resources they need to develop (Wadhwa et al., 2013). Such contributions to an animal's diet also have the potential to reduce feed costs and global cropland associated with production for animal feed (zu Ermgassen et al., 2016). Substituting feed grain for treated food scraps has significant environmental and health advantages over comparative strategies (anaerobic digestion and composting) (Salemdeeb et al., 2017). A significant amount of food waste is used to feed animals in South Korea, Vietnam, Japan, China, and other nations in Southeast Asia (Joshi & Visvanathan, 2019). For example, in South Korea, 42 percent of recycled food waste is used for animal feed (Ju et al., 2016). However, while widely utilized as a food waste management strategy in some parts of the world, feeding food scraps to animals (especially post-consumer waste) is a controversial topic that is banned in some regions.

There are many reasons why feeding food scraps to animals has lost popularity. One cause is the changing landscape of animal production. Intensive animal feeding operations utilize precision feeding of a total mixed ration to maximize production and ensure uniformity of the end product (Dou et al., 2018). The incentives for such practices are influenced by a combination of economic feasibility and consumer preferences. Another reason why feeding food scraps to animals has been avoided is linked to the associated health risks for animals of eating untreated

post-consumer waste, even though it continues to be legal in many states to feed animals household plate scraps. For example, feeding untreated post-consumer food waste to animals poses the risk of promoting various diseases in swine, livestock, and other hoofed animals. Animal diseases of concern include hog cholera, foot and mouth disease, African swine fever, and swine vesicular disease (Westendorf, 2000). These concerns have influenced policy surrounding feeding food waste to animals; in fact, feeding post-consumer waste to animals is banned in the EU because of the outbreak of foot and mouth disease that happened in the UK in 2001 (Joshi & Visvanathan, 2019). While such events have dire effects including animal and economic losses, it is important that attention be drawn to the fact that proper management of food waste can significantly reduce the risk of disease outbreaks in animals. For example, feeding post-consumer waste that is heat treated to animals is permitted in many places around the world including Vietnam, the US, and Japan (Joshi & Visvanathan, 2019). Even in places where post-consumer waste is not permitted, there still exists a use for feeding pre-consumer waste to animals, which often happens on the retail~~er~~ and manufacturing levels in the UK and Australia (Truong et al., 2019).

In the US, feeding food scraps to animals has declined steadily since the 1980s due to disease outbreaks (Truong et al., 2019). Currently, there is a nation-wide ban on feeding animal tissues to ruminants, which include cattle, sheep, goats, deer, elk and antelopes (NCRS). The reason for this is the elevated risk for Bovine Spongiform Encephalopathy (BSE), or Mad Cow Disease in ruminants. As a result, the majority of what is currently fed to ruminants includes non-mammalian derived pre-consumer products; spent grains for example are commonly used to supplement livestock diets in some areas (Kavalopoulos et al., 2021). Unsurprisingly, the segments of the food supply chain that convert the most food scraps to animal feed are at the

retailer/wholesale level and the processing/manufacturing level, with 1.6 million metric tons or 0.15 – 13.9 million metric tons used respectively for animal feed (Truong et al., 2019). The benefit to using such products is that they run less of a risk for contamination as products are homogeneous and their component parts are not ambiguous much like the remnants of post-consumer waste. Additionally, they can be distributed in bulk, which makes their usage by a farmer potentially more feasible and economically justified.

Comparatively, at the consumer level only 149 metric tons are diverted to animal feed; most post-consumer waste is used in diets of non-ruminants, or pigs, as that is what US policies allow in most states (Truong et al., 2019). While permitted to feed post-consumer and animal tissues to pigs, the Swine Protection Act states that such usage is contingent on the correct processing of such materials to prevent the harboring and transmission of diseases such as African swine fever, foot and mouth disease, classical swine fever, and swine vesicular disease (USDA, 2009). It is estimated that in 2007, only 3% of US swine farms fed food waste to their pigs (Truong et al., 2019). The liability and risks associated with feeding food scraps to animals is high, which may be the reason why this is not a widely used practice. If this management option is to be scaled up, the government should invest in adequate post-consumer waste processing facilities.

Research Design and Methods

This paper explores and assesses the factors that influence feeding food scraps to animals in Upstate New York. Researchers focused on two counties with different recycling resources: Onondaga and Essex. Onondaga County covers 806 square miles, has a population of 460,000

and encompasses one of the largest metropolitan areas in Upstate New York, Syracuse. Comparatively, Essex County covers 1,916 square miles, has a population of 38,000, and is characterized as rural; in fact, Essex has the second largest land area of all counties in New York. While the study focused on generators and receivers within these areas, it became clear that counties are arbitrary units, and that food scrap recycling transcended these strict areas. Therefore, we followed interview leads outside the borders of these two counties, which resulted in interviews in an additional five counties. Some counties neighbored Onondaga and Essex, while others were non-contiguous. The interviews conducted provided insights about the opportunities and constraints to using food scraps as animal feed.

Interviewees were initially identified using the Organics Resource Locator, a tool developed by the Rochester Institute of Technology to inventory all organics generators and potential receivers in New York in preparation for the implementation of the Food Donation and Food Scraps Recycling Act. Subsequent participants were recruited through word of mouth and snowball sampling; each interviewee was asked to provide contact information for additional organics generators or farmers who were or had been involved in recycling food scraps. We conducted a total of 21 in-depth interviews: 11 with organics generators and 10 with farmers. The interviews took place between December 2020 and August 2021.

Interviews with the organics generators and farmers were guided by similar, yet distinct sets of questions to reflect the position of the interviewee within the food supply chain. The in-depth interviews with generators focused on three main topics: food scrap quantity and quality, food scrap recycling strategies and challenges, and preparedness for and awareness of the Food Donation and Food Scraps Recycling Law, which will be implemented in January 2022. Interviews with farmers focused on: the use of food scraps for animal feed, relations with food

scrap suppliers, and the process of incorporating food scraps into animal diets as well as the benefits and challenges associated with this practice. Conversations with both the organics generators and farmers ranged from 20 minutes to one hour. Due to the covid pandemic, on-site or in-person interviews were challenging, so most interviews were conducted over the telephone or via Zoom. Interviews were recorded with the consent of the interviewee, and they were later transcribed.

Regular assessment of the interview data allowed researchers to be intentional about seeking a broad set of key informants and information. Bi-monthly meetings during the data collection process allowed researchers to discuss and identify common themes that were used to inform subsequent interviews. Group discussion also allowed for verification of evidence to support emerging themes. Interview text transcriptions and notes were uploaded to a qualitative data tool, Taguette, and organized into two groups: farmers and organic waste generators. Interesting, relevant, and recurring information shared in interviews was assigned a tag or code that grouped themes together to be better visualized. Examples of codes include type of food scraps used, challenges, decision making, benefits, recycling strategies, and food systems issues. The following section outlines the common themes found in the interview data across 21 interviews.

Results

This section begins by highlighting study participant demographics and other relevant information to understand how interviewees fit into the broader context of their counties and food supply chain in relation to the law.

Characterization of Study Participants

Our study included a wide range of organics generators, including brewers, grocers, food processors, food pantries, and college institutions. Given the stipulations of the food waste ban, five out of 11 generators who were interviewed will be subject to the law in January 2022. The Department of Environmental Conservation has inventoried all generators in New York who are subject to the law and notified 14 within Onondaga County and only one within Essex County who will be required to recycle food scraps. The amount of organic waste generated by the research participants ranged from less than two tons per month to 32 tons per month, which provided researchers with information on how the volume of scraps generated influenced food scrap recycling decision making, which is linked to local agricultural dynamics. Table 2 shows a comparison of generators, agricultural land, and production within Onondaga and Essex counties.

Table 2. Comparison of Onondaga and Essex counties. Census of Agriculture (2017), U.S. Census Bureau (2019), Department of Environmental Conservation (2021).

	Onondaga	**Essex**
County Population	460,528	36,885
Market Value from Farm Inputs	$178,409,000	$13,178,000
Number of Farms	623	285
County Total Farm Acreage	160,717	57,622
Average Size of Farm in Acres	258	202
Number of Food Scrap Generators Subject to NY State Law	14	1

Most of the farmers we interviewed managed small farms, or farms that were not designated as Concentrated Animal Feeding Operations (CAFOs). According to the USDA, CAFOs are defined as a farm having "more than 1000 animal units (an animal unit is defined as an animal equivalent of 1000 pounds live weight and equates to 1000 head of beef cattle, 700 dairy cows, 2500 swine weighing more than 55 lbs, 125 thousand broiler chickens, or 82 thousand laying hens or pullets) confined on site for more than 45 days during the year" (*Animal Feeding Operations,* NRCS). In New York State, there are approximately 500 CAFOs, most of which house cows being utilized for dairy production (*Concentrated Animal Feeding Operations—NYS Dept. Of Environmental Conservation*). However, we also interviewed large-scale farming operations involving over 3500 cattle; the farms in our study ranged from 2.5 acres to 8,500 acres, which encompassed many agricultural products and farm types. Most animals being fed food scraps included poultry, swine and livestock; the law designates what is appropriate for each animal based upon their physiology and disease susceptibility. Within New York, poultry and cattle operations greatly outweigh swine - from the 2012 - 2017 census, the number of cattle and layer hens increased while the number of hogs declined. Most (60 percent) of the farmers who were interviewed were male, and their families had been involved in farming for at least a decade. The most common animals held by research participants included cattle, chickens, and hogs. Numerous farmers who were interviewed had expressed that their current operations had been smaller than in the past due to market consolidation, which is validated through census data. While the number of cattle and hens had increased from 2012-2017, the number of farms decreased.

New York State is generally a productive state in terms of agricultural output, leading the nation in some areas of output. Across New York State as a whole, agriculture brings in an annual gross income of $5.7 billion, working with approximately 33,000 farms across New York State (which make up roughly 23% of the total land area) (Dinapoli, 2019). The largest agricultural output for New York is based on dairy production, which makes up 47.1% of the total profit share from agricultural production (Ibid). With around 58,000 farmers in the state, the average age of farmers is around 57 years old, highlighting an aging population within the field of work (Ibid). Most farmers in New York are white; however, the state has seen a 14 percent increase in non-white farmers since 2012, and while most farmers are men, women now comprise around 37 percent of the total population of farmers in the state (Ibid).

Generator Donation of Food Scraps to Farmers

All the organics generators we interviewed used at least one method and sometimes several to recycle food scraps. Six out of 11 generators currently donate food scraps to farmers for animal feed and two had donated food scraps in the past, but since stopped due to contamination issues or system changes within their operations. Generators who donate food scraps to animal feed reported generating between 600 and 25,000 pounds of food scraps per week; therefore, many of them will not be subject to the new recycling law, at least in its current formulation. Most of the generators indicated that the agreement they had with farmers was informal. Without the generators, many farmers we spoke to would need to spend more on feed; similarly, generators would need to spend more on sending scraps to a landfill or organics site to be disposed of or recycled. Generators said their decision to donate food scraps for animal feed

was influenced by many factors, including the farmer's capacity to accept scraps, the costs of donation compared to dumping, staff time required, the ease of the transaction, environmental motivations, and utilitarian concerns, or the consequences of one's actions. The following excerpt from an interview with a brewery illustrates some of the factors that influence generators' decisions about donating scraps:

> *"...really when we first opened, we were approached probably by about 10 farmers. I just remember that we had farmers looking to grab it. This one was just the most convenient for him and for us just because this is only a mile down the road. And like, he has been good, you know, because you don't want to get to a situation where you're waiting for them to pick it up. And he knows that we have to get it picked up or else we need to have more tubs for it or we need to wait to brew, which is not good, right?"*

As this interview illustrates, there are complex dynamics at play and many considerations that generators weigh when deciding if and how to recycle their food scraps. In the interviews, most generators expressed that when it becomes too difficult, costly, or complicated to donate food scraps, they no longer do so.

Generators who did not donate food scraps for animal feed currently or in the past either sent scraps to be composted or digested at a nearby facility. Proximity to an organics recycling site, the cost of hauling, staffing costs, and relationships with farmers were indicated to be integral to the decision-making process surrounding recycling food scraps.

Farmer Utilization of Food Scraps for Animal Feed

In this study, we sought out interviewees who used food scraps to supplement their animal feed currently or in the past. The amount of food scraps utilized by farmers for feed ranged from about 160 pounds of material to 4 tons of material per day. The variation in quantity used reflects the diversity of farming operations and land held by study participants. The percent of feed supplemented by food scraps ranged from 1.5 percent to 100 percent depending on the season and scrap availability. Seasonality, number of animals, land, and types of animals raised all influenced capacity and willingness to use food scraps.

It is important to note how COVID-19 has influenced the use of food scraps by farmers. Some study participants expressed that limited operation of restaurants during the pandemic reduced the overall amount of food scraps available, which decreased the amount of feed a farmer would be able to supplement. Farmers shared that their decision to accept food scraps was generally influenced by the following factors: capacity to receive food scraps, the types of animals they were keeping, ease of transaction, moral concerns, or consequences of one's actions, types of food scraps available, food scrap generators' capacity to provide scraps, cost savings, and ease of utilization.

Benefits of Using Food Scraps for Animal Feed

The main benefit derived from using food scraps to supplement animal feed is economic. Both the farmer and the generator have lower operating costs when donating or utilizing scraps. For generators, when a farmer retrieves scraps using their own capital (gas, vehicle, tractor tailor, etc.), which was generally the case, it is free. As such, donating food scraps to farmers is always

cheaper (if not free) than paying a hauler to send scraps to a landfill or organics site. Even in situations where generators hauled the scraps directly to farmers using their own resources, they made this decision because it was the most economical solution to dealing with the scraps than through other means. In fact, one generator shared that they had transported scraps to a farmer outside of New York because the cost savings were so significant. They explain their motivations clearly in the following quote:

> *"It's mutually beneficial - we don't have to pay to put it in the dump and she doesn't have to buy food for the animals, or as much food for animals."*

The sentiment raised in this quote was common amongst generators and farmers - the exchange of scraps was more than a cost savings; it was an agreement of mutual support. In fact, many generators genuinely wanted to help local farmers and expressed this explicitly. Many interviewees were cognizant of the trying farming situation in New York and understood that cost savings on feed was integral for many farmers, both large- and small-scale producers. With an aging farmer population, decreased acreage for total farmland, and the COVID-19 pandemic, producers have faced many challenges over the past years. From before the pandemic, between the years 2012 to 2017, New York State producers have seen a total loss of 317,405 total acres being farmed (*New York Agriculture: New York Farm Bureau*). Between those same years, New York State saw another substantial decrease in the number of farms raising cattle and pigs, and a decrease in the number of overall pigs, goats, sheep, and broiler chickens (*USDA - National Agricultural Statistics Service—2017 Census of Agriculture*). On the other hand, in contrast with a reduction of the number of farms in total, heads of cattle and layer hen numbers have increased, signaling a shift towards a more concentrated operating market. For example, some farmers interviewed mentioned that while their herds and operations may have decreased, there

had been an uptick in the total numbers across the state. This may indicate that large-scale farmers are growing while small farmers are struggling to maintain their operations. Additionally, from the onset of the pandemic, many of the farmers expressed how the closure of restaurants and limited operating capacity of grocers affected the amount of food scraps that farmers had access to, which limited their use of food scraps for feed. This would put farmers in a financial pinch as scraps had been depended on for operations. In response, many generators sought to donate scraps to farmers as often as possible. The following quote illustrates the views of generators who would consider donating scraps an act of public utility:

> *"And again, we may have a few local farmers that will come in and pick up just a truck full or whatever and whatever they can take and that tends to be our preferred channel. Only because the smaller farmers in upstate New York, they need every kind of advantage they can get. So if they're willing to utilize it for animal food, we will call them first."*

The economic benefits on both sides of the transaction motivated recycling of food scraps for animal feed; however, as alluded to in this quote, many generators had more than one channel to donate food scraps. While farmers may be given priority, large generators generally used several recycling methods. Interviewees commonly mentioned the benefits of having access to a composting site or digester - both recycling methods are cheaper than landfilling, which further motivates generators to donate as much as possible. One generator expressed that what could not be donated for feed was sent to a digester, which ended up being 50% less expensive than sending scraps to a landfill. They explained that digesters near them charge around $55 per ton of scraps they receive compared to landfilling which charges $100 per ton of material. The finding here is clear: recycling scraps, whether by supplementing feed or other means, has a significant cost advantage over alternative food scrap disposal methods.

As to be expected, we find similar economic benefits from the farmer's perspective. The amount of scraps that farmers use to supplement feed directly contributes to a savings in feed costs. In fact, one interviewee expressed that they were able to save $200 a day through using scraps for feed, or $73,000 per year. Other interviewees expressed that they could not get by without the supplementation of food scraps and were engaged with five generators who they made trips out to twice a week. The fact that several farmers made multiple trips to retrieve scraps each week speaks to the importance of scraps in not only supplementing the diets of animals, but also supporting the livelihoods of farmers in upstate New York. The interview data shows that scrap supplementation in feed is integral to operations for both small-scale and large-scale producers in upstate New York. The economic benefits to generators and farmers who engage in these mutualistic transactions are irrefutable and should be supported by local and state leaders.

In addition to cost savings, environmental protection was an expressed advantage and motivation for using food scraps for feed. This benefit was described by generators and farmers in numerous ways including reducing methane emissions, closing the community loop, and putting food back into the system, which all encompass benefits to the environment. Many generators and farmers felt a responsibility to keep food in the system, or out of landfills. When asked about the main benefits to recycling food scraps one generator stated:

> *"Well, number one is cost. I think that it is very important to show that by recycling, we're saving half the cost, as if we went through our waste hauler. The other is knowing that we're going to get a credit out of greenhouse gas inventory."*

As shown in this quote, environmental benefits were noted by many interviewees, but ranked as less important to overall cost advantages. The quoted interviewee expressed that for

every ton of greenhouse gas they keep out of the atmosphere through food scrap recycling, they will receive a payment in return. It is clear that economic motivations to protect the environment are integral to upscaling food scrap recycling. However, this does not undermine the fact that many generators and farmers expressed a moral motivation to be stewards of their communities. Donating or recycling food scraps for feed was not necessarily easier for all generators, as the following interviewee alludes to:

> *"I don't know if there's a main benefit because I think all of the benefits kind of add up into a significant benefit in terms of the partnership. So, it's a bit more work for us to accept all of this kind of post matter. But I also think, like the benefit of having students on the farm, having students visualize, you know, that the food scraps from their cafeteria are coming here and then going right back into the food."*

This quote highlights the fact that despite the extra work food scrap recycling may be in some cases, modeling a circular economy is a significant motivator for generators and farmers. In this particular case, there was a teaching and modeling function that was carried out by the farmer and the university they partnered with. As the food scraps from the university's kitchen came to the farm, the students (who were enrolled in the culinary school) helped collect, separate, and deliver them. They then were able to go to the farm to collect farm goods and produce to utilize in the university kitchen. This is a prime example of how partnerships can close the gap to create circular models. Throughout the interviews, many generators and farmers talked about how they avoided landfilling or throwing food away, which was viewed as a waste of sustenance and resources. In many cases, generators and farmers desired to use food scraps in an environmentally friendly way, and when this wasn't possible it was generally due to lack of knowledge, resources, or infrastructure, which will be further examined in the next section.

While environmental protection is a major benefit of food scrap recycling, it can only be made possible through increased infrastructure and knowledge dissemination.

Less notable, but still an important benefit of using food scraps for feed is the potential for diet diversification. Many of the interviewed farmers noted this as a benefit for utilizing food scraps in their animal feed, especially among the feeding of hogs and poultry. Conventional dry matter often made up a significant portion of the animal's feed, but some farmers interviewed mentioned that the introduction of wet matter (food scraps, brewers' grain, etc.) proved to be beneficial towards their animals' overall health. However, it must be noted that food scraps can routinely contain around 50-86% of their moisture content, which has the potential to be problematic if certain animals consume too much wet matter (Georganas et al., 2020). It was found that some farmers integrated food scraps in a highly strategic manner, learning what ratio of dry matter to food scraps presented the best health benefits for their animals.

Challenges of Using Food Scraps for Animal Feed

Although there are many benefits to recycling food scraps, many farmers and generators mentioned prominent challenges to donating food scraps for animal feed. One of the main deterrents to recycling food scraps for feed are the legalities surrounding feeding food scraps to animals. As previously explained, there are many regulations associated with using food scraps for feed and few of the generators and farmers seemed to feel confident in their knowledge surrounding the laws in New York State. The law is clear in stating that any meat-derived products need be heat treated before being fed to swine, while in no case is it fit for livestock consumption, yet none of the generators or farmers donating or using post-consumer waste

mentioned heat treating food scraps. On the other hand, some generators evaded this complication completely by choosing not to donate their scraps for feed because of worries about the laws and animal health issues. In fact, some farmers expressed that they had been turned down by generators who they speculated did not have adequate capacity to separate meat products from scraps. This is common in situations where pre- and post- consumer waste were generated in the same facility; rather than separate these items, some generators would much rather send them all to one location to evade the complexities of the law. The lack of separation and categorization of pre- and post- consumer waste, in addition to the absence of processing facilities that treat post-consumer waste is a significant barrier to recycling more food waste as animal feed.

Another significant barrier to recycling food scraps for feed was the farmer's capacity and willingness to use scraps. These ideas are distinct, as capacity refers to the ability to use a specific volume of scraps, while willingness relates to the desire to incorporate scraps in the diet of a farmer's animals. The capacity is dependent upon the number of animals a farmer has, while their willingness to use the scraps is intertwined with the quality of their marketed product. Generally, the variability in quality of food scraps generated was not an issue for small-scale farmers whose product was not targeting a commercial market, but their capacity to use the scraps was much less than a larger scale producer. Conversely, the large-scale producer may have a higher capacity to use the scraps, but less of a willingness because the variability in scrap quality may influence their product in a negative way. Choe et al. (2017) showed that a diet of only scraps for swine may influence the texture of the meat in an undesirable way. However, if the large-scale producer uses a significant, but proportionally low percentage of food scraps in the diets of their animals, variability is unlikely to influence their product. Interview data showed

that adequate infrastructure and consistent coordination between generators and farmers was integral to maximizing the volume of food scraps used for feed.

An issue related to a farmer's capacity and willingness to use scraps is food packaging, which is a huge barrier for generators and farmers. This is especially a problem with certain commodities. Generators mentioned that some products are nearly impossible to recycle, including some dairy products that not only have a short shelf-life, but are also packaged in such a way that makes them difficult to utilize. For example, yogurts or products packed in a single serving container are not desirable from a farmer's perspective. It would cost the farmer a significant amount of time to de-package every item to incorporate into animal feed. While it may seem beneficial from a generator's perspective to donate as much as possible, this strategy may have negative consequences. One interviewee shared that they had burnt entire pallets of food that they were given by generators because they simply could not process it efficiently. When asked about these dynamics, one generator expressed:

> *"A lot of farmers, they're not going to stand there and de-package a few thousand pounds of food. Some will. Some definitely will. So that becomes the disconnect. And, you know, the same with compost operations is the packaging. So, these packages have been a boon to capturing some of these organics for sure."*

This quote solidifies the following finding: donating what can only be easily processed limits what can be used for feed. Inadequate staffing and tools to de-package food items created issues for both generators and farmers when donating or receiving food scraps. The current infrastructure and capacity of generators and farmers was the second largest barrier found to limit the utilization of food scraps for feed.

Less important, but still notable were the problems caused by the inconsistency in retrieving food scraps on part of the farmers. When farmers could not pick up materials from generators on an agreed upon basis, the generators were left to deal with full bins or containers of rotting food - this was especially a problem in the summer months. In these cases, the generator often had no choice but to dispose of scraps as quickly as possible, which could prove to be complicated. Some generators mentioned that landfilling was the only option because of a lack of local organics infrastructure. In Upstate New York, where certain counties are rural and have limited access to organics sites or farmers who have the capacity to receive a high volume of food scraps, recycling food scraps is less plausible. This further emphasizes the need to invest in organics infrastructure to support the recycling of food scraps.

Discussion

The goal of this study was to first, identify the constraints and opportunities in Upstate New York to use food scraps as animal feed, and second, offer recommendations for scaling-up this practice in Upstate New York and elsewhere. Through the interviews with key generators and farmers, we were able to identify several important themes and use them to make recommendations for local leaders. While the data allowed us to answer and address our research inquiries, it is important that we mention critical study components that influenced our results.

First, while we were able to connect with 21 individuals, a larger sample size may have provided us with more themes and relevant information to be able to provide a wider array of recommendations for scaling-up food scraps recycling. Second, it was clear that the timing of the study influenced the results, as many study participants expressed that the COVID-19 pandemic

had produced uncharacteristic circumstances that influenced food scrap donation and use. As these circumstances change over time, and it would be useful to know how local leaders could best support food scraps exchanges between generators and farmers in a post-pandemic scenario. In order to do this, it would be prudent to conduct similar studies in the future. Lastly, in our study sample, we included generators who are not subject to the law. This means that we share the motivations and situations of both large and small generators, where the law only applies to larger generators. It would be interesting to exclusively interview generators within Upstate New York who are subject to the law to provide a more in-depth look into how they may be supported during this policy change. This may give local authorities a better picture of how to prioritize their efforts in scaling-up food scrap recycling.

Conclusion and Recommendations

Recycling food scraps by feeding them to animals provided significant economic and environmental benefits to the farmers and generators interviewed for this study. However, within the framework of existing networks and relationships that are operating today, there are many challenges that arise that can limit the exchange, use, and continuation of feeding food scraps to animals. Such factors for farmers include the size and type of farm, the types of animals being raised on site, the scale of operation, availability of food scrap networks, localized infrastructure for processing and depackaging, and continuity of food scraps available to them. In this study, the farmer's proximity to generators and ease of access played a crucial role in their decision to receive scraps. For generators, such factors include willingness of farmers to receive food scraps, opportunity (or lack thereof) for donation/recycling, insufficient storage opportunities, and lack

of infrastructure supporting the movement of food scraps. The size and location of generators heavily influenced their decision to recycle food scraps in various ways including via composting, anaerobic digestion, and for animal feed. Within the complexity of challenges facing both farmers and generators in the recycling and usage of food scraps, key themes for infrastructure recommendations were taken from those interviewed, as seen in Table 4.

Table 4. Recommendations for Scaling-up Food Scrap Recycling in Upstate New York

Recommendations for Scaling-up Feeding Food Scraps to Animals	
Infrastructure Recommendations	***Result***
Investment in organics sites in areas where there are few	Encourage more food scrap recycling over landfilling
Investments in facilities to treat post-consumer waste	Discourage illegal feeding and support post-consumer scrap feeding
Investments in depackaging tools for large-scale generators	Increase capacity of farmers to use highly packaged materials, avoid wastage
Outreach and Education Recommendations	***Result***
Clear outreach to farmers and generators about feeding food scraps to animals	Resolve ambiguities about feeding scraps to animals, promote health of animals
Increase outreach and education regarding benefits of using food scraps as feed	Incentivize more farmers and generators to reycle food scraps for feed

The above recommendations are seen as realistic opportunities for New York State to improve upon the existing infrastructure supporting food scraps recycling and use. Given the challenges faced, the largest issues found in the system, with both farmers and generators, were lack of organic recycling sites, lack of food scrap treatment facilities, and lack of de-packaging opportunities, all of which played significant roles in individuals' decisions to receive food scraps or recycle them. During the interview process, there also seemed to be a lack of continuity on education surrounding such recycling opportunities and policies in place, leading to the recommendation for prominent action to be taken towards increasing the accessibility of education opportunities, intersectoral communication, and outreach to both farmers and generators. By maintaining outreach and education, future policy iterations could be adjusted in real time, and existing structures could be assessed and incorporated into New York State's mechanisms for structural improvement. In order for relationships between farmers and food

scrap generators to flourish, definitive improvements need to be made in order to decrease the barriers to access and ensure the sanitation, availability, and accessibility for food scraps to move from one place to another.

References

Animal Feeding Operations | NRCS. (n.d.). Retrieved July 26, 2021, from https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/livestock/afo/

Brodny, J., & Tutak, M. (2016). Analysis of Methane Emission into the Atmosphere as a Result of Mining Activity. *International Multidisciplinary Scientific GeoConference : SGEM*, *3*, 83–90. https://search.proquest.com/docview/2014425789/abstract/A3C4C47A6461407APQ/1

Census of Agriculture—2017 Census Publications—State and County Profiles—New York. (n.d.). Retrieved from https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/New_York/

Chen, C., Chaudhary, A., & Mathys, A. (2020). Nutritional and environmental losses embedded in global food waste. *Resources, Conservation and Recycling*, *160*, 104912. https://doi.org/10.1016/j.resconrec.2020.104912

Choe, J., Moyo, K. M., Park, K., Jeong, J., Kim, H., Ryu, Y., Kim, J., Kim, J. M., Lee, S., & Go, G. W. (2017). Meat Quality Traits of Pigs Finished on Food Waste. *Korean journal for food science of animal resources*, *37*(5), 690–697. https://doi.org/10.5851/kosfa.2017.37.5.690*Concentrated Animal Feeding Operations—NYS Dept. Of Environmental Conservation*. (n.d.). Retrieved July 25, 2021, from https://www.dec.ny.gov/permits/6285.html

Dinapoli, T. P. (2019). *A Profile of Agriculture in New York State*. 12. Retrieved from: https://www.osc.state.ny.us/files/reports/special-topics/pdf/agriculture-report-2019.pdf

Divina, C. C. (2016). *Scraps No More: Fruit Wastes for Benefits of Plants and Animals*. *12*, 11.

Dou, Z., Toth, J. D., & Westendorf, M. L. (2018). Food waste for livestock feeding: Feasibility, safety, and sustainability implications. *Global Food Security*, *17*, 154–161. https://doi.org/10.1016/j.gfs.2017.12.003

Georganas, A., Giamouri, E., Pappas, A. C., Papadomichelakis, G., Galliou, F., Manios, T., Tsiplakou, E., Fegeros, K., & Zervas, G. (2020). Bioactive Compounds in Food Waste: A Review on the Transformation of Food Waste to Animal Feed. *Foods (Basel, Switzerland)*, *9*(3), E291. https://doi.org/10.3390/foods9030291

Gunders, D. (2017, July). Wasted: how America is losing up to 40 percent of its food from farm to fork to landfill. NRDC Issue Paper 17-05-A.

Gustavsson, J., Cederberg, C., & Sonesson, U. (2011). *Global food losses and food waste: Extent, causes and prevention ; study conducted for the International Congress Save Food! at Interpack 2011, [16 - 17 May], Düsseldorf, Germany*. Food and Agriculture Organization of the United Nations.

Joshi, P., & Visvanathan, C. (2019). Sustainable management practices of food waste in Asia: Technological and policy drivers. *Journal of Environmental Management*, *247*, 538–550. https://doi.org/10.1016/j.jenvman.2019.06.079

Ju, M., Bae, S.-J., Kim, J. Y., & Lee, D.-H. (2016). Solid recovery rate of food waste recycling in South Korea. *Journal of Material Cycles and Waste Management*, *18*(3), 419–426. https://doi.org/10.1007/s10163-015-0464-x

Kavalopoulos, M., Stoumpou, V., Christofi, A., Mai, S., Barampouti, E. M., Moustakas, K., Malamis, D., & Loizidou, M. (2021). Sustainable valorisation pathways mitigating environmental pollution from brewers' spent grains. *Environmental Pollution*, *270*, 116069. https://doi.org/10.1016/j.envpol.2020.116069

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, *127*, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005

Lyu, Z., Shao, N., Akinyemi, T., & Whitman, W. B. (2018). Methanogenesis. *Current Biology*, *28*(13), R727–R732. https://doi.org/10.1016/j.cub.2018.05.021

Muth, M. K., Birney, C., Cuéllar, A., Finn, S. M., Freeman, M., Galloway, J. N., Gee, I., Gephart, J., Jones, K., Low, L., Meyer, E., Read, Q., Smith, T., Weitz, K., &

Zoubek, S. (2019). A systems approach to assessing environmental and economic effects of food loss and waste interventions in the United States. *Science of The Total Environment*, *685*, 1240–1254. https://doi.org/10.1016/j.scitotenv.2019.06.230

New York Agriculture: New York Farm Bureau. (n.d.). Retrieved July 25, 2021, from https://www.nyfb.org/about/about-ny-ag

New York Food Donation: Feeding Food Scraps to Animals. (2018). 3. Retrieved from: https://www.dec.ny.gov/docs/materials_minerals_pdf/feedanimalhlfs.pdf

New York State Food Donation and Food Scraps Recycling Law. (2019). New York Department of Environmental Conservation. https://www.dec.ny.gov/chemical/114499.html

New York State Agriculture and Markets. *Garbage Feeding: Why it is Prohibited.* Retrieved from: https://www.cortland-co.org/DocumentCenter/View/1722/Garbage-Feeding-PDF#:~:text=The%20Law%3A,to%20swine%2C%20cattle%20or%20poultry.&text=Plate%20waste%20is%20a%20very,foods%20are%20NOT%20considered%20garbage

Salemdeeb, R., zu Ermgassen, E. K. H. J., Kim, M. H., Balmford, A., & Al-Tabbaa, A. (2017). Environmental and health impacts of using food waste as animal feed: A comparative analysis of food waste management options. *Journal of Cleaner Production*, *140*, 871–880. https://doi.org/10.1016/j.jclepro.2016.05.049

Sandson, K., Leib, E., Harvard Law School, Center for EcoTechnology . (2019, July). *Bans and Beyond: Designing and Implementing Organic Waste Bans and Mandatory Organics Recycling Laws.* Retrieved from https://www.chlpi.org/wp-content/uploads/2013/12/Organic-Waste-Bans_FINAL-compressed.pdf

Truong, L., Morash, D., Liu, Y., & King, A. (2019). Food waste in animal feed with a focus on use for broilers. *International Journal of Recycling of Organic Waste in Agriculture*, *8*(4), 417–429. https://doi.org/10.1007/s40093-019-0276-4

U.S. Census Bureau QuickFacts: Essex County, Onondaga County New York. (2019). Retrieved from https://www.census.gov/quickfacts/fact/table/onondagacountynewyork,essexcountynewyork/PST045219

USDA - National Agricultural Statistics Service—2017 Census of Agriculture—Volume 1, Chapter 1: State Level Data. (n.d.). Retrieved from: https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_1_State_Level/New_York/

United States Environmental Protection Agency (n. d.) *Sustainable Management of Food.* Retrieved from: https://www.epa.gov/sustainable-management-food/food-recovery-hierarchy

United States Environmental Protection Agency. (n.d) *Sustainable Management of Food.* Retrieved from: https://www.epa.gov/sustainable-management-food/sustainable-management-food-basics

Wadhwa, M., Bakshi, M., & Makkar, H. (2013). *Utilization of fruit and vegetable wastes as livestock feed and as substrates for generation of other value-added products*.

Westendorf, M. L. (Ed.). (2000). *Food waste to animal feed* (1. ed). Iowa State Univ. Press.

Ziolkowska, J. R. (2017). Economic and Environmental Costs of Agricultural Food Losses and Waste in the US. *International Journal of Food Engineering*, *3*(2), 6.

zu Ermgassen, E. K. H. J., Phalan, B., Green, R. E., & Balmford, A. (2016). Reducing the land use of EU pork production: Where there's swill, there's a way. *Food Policy*, *58*, 35–48. https://doi.org/10.1016/j.foodpol.2015.11.001