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Isaac Goldman April 7, 2019

A Recipe for Sustainability: Serving Plant-Based Food to Decrease Greenhouse Gas Emissions at U.S. Colleges and Universities

by

Isaac Goldman

Jonathan Crane, Ph.D.
Adviser

Department of Interdisciplinary Studies

Jonathan Crane, Ph.D.

Adviser

Wesley Longhofer, Ph.D.

Committee Member

Peter Wakefield, Ph.D.

Committee Member

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Abstract

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The livestock sector is a significant contributor to climate change, representing about 14.5% of human-induced greenhouse gas emissions (GHGE).[1] Production of beef and lamb create about 250 times more emissions per gram of protein than legumes.[2] But, converting millions of people from eating meat to legumes and other climate-friendly foods is not realistic in the immediate future because 92% of people in the United States currently consume a diet that includes animal protein.[3] However, younger generations in the US are more interested in plant-based eating: 60% of college students want to reduce their meat intake and 79% of Gen Z'ers would go meatless one to two times a week.[4] The time is right for universities to play a role in offering more foods with lower amounts of GHGE. This thesis compares food sustainability initiatives at universities across the country to identify best practices to provide and promote plant-based food with a low GHGE footprint. The second part of this thesis is a calculation of the greenhouse gas emissions required to produce the food currently served in Emory's main dining hall. This quantitative modeling demonstrates how serving plant-based options would be the most effective way to decrease food-related GHGE. I then propose a number of actionable steps to help Emory and other universities decrease their food-related GHGE.

[1] Pierre J. Gerber et al., *Tackling Climate Change through Livestock: A Global Assessment of Emissions and Mitigation Opportunities.* (Food and Agriculture Organization of the United Nations (FAO), 2013): 15.
[2] David Tilman and Michael Clark, "Global Diets Link Environmental Sustainability and Human Health," *Nature* 515, no. 7528 (2014): 518, https://doi.org/10.1038/nature13959.
[3] Jeff Jones and Lydia Saad, "Americans Who Are Vegetarians or Vegans (Trends)" (Washington, DC: Gallup, Inc., July 1, 2018): 2, https://news.gallup.com/poll/238346/americans-vegetarians-vegans-trends.aspx?g_source=link_newsv9&g_campaign=item_238328&g_medium=copy.
[4] Aramark, "Aramark Brings Gen Z Food Trends to Life with New Back-to-School Offerings on College Campuses Nationwide," August 9, 2018, https://www.aramark.com/about-us/news/aramark-general/back-to-school-2018. Aramark conducted this third party study in February 2018 of a random sample of 5,272 Americans, ages 18-60, to examine consumer attitudes toward plant-forward eating. "Gen Zers" or those in Generation Z are those born from the mid-1990s to the early 2000s.

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This thesis would not have been possible without my three advisors—Dr. Jonathan Crane, Dr. Wesley Longhofer, and Dr. Peter Wakefield. They were each the "yin" to my "yang" in many ways. All of them are calm, thoughtful, and constructive while I am much more upfront and tend to act a little more on impulse. This made them the best advisors I could ask for.

It was Dr. Crane's "Eating Ethics" class that first exposed me to the broad topic known as "food studies," and it was this course that first sparked my interest in food and sustainability. When brainstorming with Dr. Crane about thesis topics, he told me I should write a thesis that will be the most valuable to me once I graduate. I am so happy he gave me this guidance because I have truly enjoyed every moment I sat down to write this thesis.

It was my independent study with Dr. Longhofer, though he likes to be called "Wes," in Spring 2018 that jumpstarted this thesis, as I worked with Bon Appétit at Emory to try and implement plant-based food options on campus. I would come in to his office speaking a mile a minute about some of the challenges I was facing. He would process my thoughts, then figuratively unravel my jumbled ideas, and I would leave our meetings with a clear, straightforward approach. Wes introduced me to *Drawdown*, which plays a major role in this thesis. It was the first book that showed me how plant-based diets really can have a positive impact on the climate

Dr. Wakefield was so valuable at reminding me that my thoughts were insightful, but to make a strong argument in my thesis, I needed to ground my thoughts in "scholarship." It was Dr. Wakefield's office that I first walked into when I thought I wanted to study food through the Interdisciplinary Studies major. I have enjoyed having Dr. Wakefield as a mentor, professor, and friend to share biking stories with.

I am also thankful for the entire Bon Appétit at Emory team. Particular thanks to Jessica Perry, who was the first person willing to work with me to try and increase the amount of plant-based options on campus. Particular thanks also to Eric Foster. He was the person who allowed me to work with Bon Appétit's invoices to track the GHGE from the DUCling's food. Without being able to model the GHGE from the DUCling's food, this thesis would not exist. Last but not least, thanks to Kellie Piper who showed me past programs Bon Appétit had led to decrease food-related GHGE at other Bon Appétit locations

Additional thanks to the long list of faculty and staff who I met with about my thesis. In particular, thanks to Noah Scovronick who helped me strategize how to try and model the GHGE from the DUCling's food. Additional thanks to Cassandra Quave, Taylor Spicer, Arri Eisen, Linda Craighead, Daniel Rochberg, and past visiting professor Alice Reznickova.

Thank you to my friends. Special thanks to my good friend Shivam Jariwala, who always joins me in my food endeavors, and who saved my thesis by showing me how to convert paper invoices into excel files. Thank you also to my housemates. I loved coming home each night and being able to share laughs after long days of writing in the library.

Lastly, thank you to my family. Thank you to my two older brothers who were such valuable outlets to speak with, as two people who had already written theses, but more so as two older brothers who were so curious about my thesis topic and took the time to read my drafts.

To my parents, who supported me in different but such valuable ways. To my mom, who woke me up for morning bike rides the week before I turned in my thesis, so I could enjoy the outdoors and spend much needed time away from my thesis. To my dad, who woke me up for morning tennis the week before I turned in my thesis and used the time he was on planes to read over multiple drafts.

I never thought I would be writing an honors thesis because I always preferred to "do" something instead of write about it. But, this thesis has been my most fulfilling experience at Emory, and I could not have done it without so many different professors, mentors, family, friends, and of course the plant-based food I ate every day to fuel me through the end.

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Terminology:

- Vegan Diet: Does not include any animal or meat-based products.
- Vegetarian Diet: Does not include meat or fish, but does include animal-derived products, such as eggs, butter, and dairy milk.
- Plant-Based or Plant-Rich Diet: "an eating pattern dominated by fresh or minimally processed plant foods and decreased consumption of meat, eggs and dairy products. Compared to meat-centred diets, it involves increased consumption of a variety of grains (including whole grains), fruits, vegetables, legumes, nuts and seeds."[5]
- Flexitarian Diet: Mainly follows a "plant-based diet," but has less strict boundaries on the amount of meat consumed.
- Mediterranean Diet: A diet followed traditionally in the Mediterranean region—near Greece, Italy, and Spain—that includes high consumption of olive oil, fruits, vegetables, legumes, nuts, and unrefined cereals; moderate to high consumption of fish; moderate consumption of poultry, eggs, and dairy products; and low consumption of red meat[6]
- Omnivorous Diet: Includes all types of food, both plant-based and animal-based
- Carnivorous Diet: Includes only meat
- Plant-Based Food: Refers to food made of plants and can be interchangeably used with "Vegan" food
- Animal-Based or Animal-Derived Food: Food produced by an animal (e.g. milk, cheese, yogurt, eggs), but not animal meat itself
- Retail Location: A store where consumers pay a price that the store allocates for that specific item (e.g. a grocery store)
- Food Service Location: Any location that prepares food outside the house (e.g. restaurants, university dining halls, stadiums, hospitals)
- Dining Hall: An all-you-care-to-eat foodservice location on a college or university campus
- Food Court: A place with multiple restaurants in one common area, usually accompanied by a common seating area
- Life-Cycle Assessment: "A holistic method to evaluate the environmental impact during the entire life cycle of a product. Two types of environmental impact are considered during the life cycle of a product: use of resources such as land or fossil fuels, and emission of pollutants such as ammonia or methane."[7] The standard stages that are tracked for a product's LCA are raw ingredient production, processing, manufacturing, distribution (transportation), consumption, and disposal. For meat-based foods, emissions from the slaughterhouse are included. Emissions from environmental effects of food production, such as acidification and eutrophication are not included in a LCA.

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[5] E. J. Lea, D. Crawford, and A. Worsley, "Public Views of the Benefits and Barriers to the Consumption of a Plant-Based Diet," *European Journal of Clinical Nutrition* 60, no. 7 (July 2006): 829, https://doi.org/10.1038/sj.ejcn.1602387.

[6] Courtney Davis et al., "Definition of the Mediterranean Diet; A Literature Review," *Nutrients* 7, no. 11 (November 2015): 9141, https://doi.org/10.3390/nu7115459.

[7] M. de Vries and I. J. M. de Boer, "Comparing Environmental Impacts for Livestock Products: A Review of Life Cycle Assessments," *Livestock Science* 128, no. 1 (March 1, 2010): 2, https://doi.org/10.1016/j.livsci.2009.11.007.

- *Drawdown*: The book edited by Paul Hawken that compiles the 100 most impactful solutions, in terms of greenhouse gas emissions, to address climate change[8]
- Global Warming Potential: A standard unit of measurement to calculate the relative effectiveness of greenhouse gases in trapping the Earth's heat over a certain time horizon, relative to carbon dioxide.[9]
- The DUCling: Emory's temporary all-you-care-to-eat dining hall during the 2017-2018 and 2018-2019 school years, while the new Campus Life Center is being constructed, which will be the site of the new dining hall

Abbreviations:

- CH_4: Methane
- CO_2: Carbon Dioxide
- CO_2-eq: Carbon Dioxide equivalent
- DD: Drawdown
- GHG: Greenhouse Gas
- GHGE: Greenhouse Gas Emissions
- GWP: Global Warming Potential
- N_2O: Nitrous Oxide

Prologue

The idea for this thesis stemmed from the numerous sustainability classes I have taken at Emory University. With each course came the opportunity to learn from professors with expertise in environmental science, botany, food security, food sustainability, food ethics, business and society, and much more. These courses provided me a chance to hear from some of the most important stakeholders in sustainability at Emory University—everyone from Dr. Peggy Barlett on the Sustainable Food Committee to Taylor Spicer in the Office of Sustainability Initiatives to Jessica Perry from Bon Appétit at Emory. While the course material forced me to think critically about sustainability as discussed in literature, the conversations with Emory's sustainability stakeholders pushed me to think critically about how sustainability is practiced at

[8] Paul Hawken, ed., *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming* (New York, New York: Penguin Books, 2017).
[9] P. Forster et al., "Changes in Atmospheric Constituents and in Radiative Forcing. Chapter 2," *Climate Change 2007. The Physical Science Basis*, (2007): 212, http://inis.iaea.org/Search/search.aspx?orig_q=RN:39002468. Each food has a corresponding GWP, which is calculated based on the amount of greenhouse gases emitted throughout the food's life-cycle.

Emory. On the one hand, I found myself taking pride in Emory's sustainability achievements, such as the LEED certified buildings I walk into every day, and Emory's Waterhub, which recycles up to 400,000 gallons per day. On the other hand, I found myself questioning whether Emory's waste management program was actually effective in composting on-campus waste. I also wondered whether the food Emory serves in its dining halls and food courts was actually "sustainable" and who was defining "sustainability." It was this last issue about the "sustainability" of Emory's food that truly piqued my interest. This thesis examines how U.S. colleges and universities, and Emory in particular, can provide large quantities of food and still reduce their environmental footprint, measured in terms of greenhouse gas emissions.

Through examining climate solutions from *Drawdown*[10] and identifying the largest contributors to greenhouse gases in the food system, I identify serving plant-based food as an effective way to feed students on college campuses. Although "plant-based foods" may not be as glamorous a concept as "local" food, I argue that by offering and promoting diets higher in plant-rich foods, universities are able to decrease their greenhouse gas emissions. Using Emory University as a case study, I examine how Emory frames food sustainability and its goals to increase its percentage of "sustainable" food every year. I also analyze how Emory's definition of food sustainability compares to other definitions of this term. By quantifying Emory's amount of greenhouse gas emissions from the food it serves in its main dining hall, the DUCling, I am able to evaluate Emory's approach to "sustainability" and identify some opportunities for the university to improve the environmental footprint of its food sourcing. By examining some of the best practices, I suggest a number of actionable innovations for dining halls to create more plant-forward menus, where meat is shifted from the center of the plate to more of an accompaniment

[10] I will discuss *Drawdown* more in Chapter 3.

to plant-based dishes. While acknowledging that college students still use their past eating behaviors as the number one way to choose their food, I consider the challenges for shifting diets toward more plant-based food knowing that a consumer's values of health and sustainability are not always consistent with their food choice. But, through examining the effectiveness of marketing campaigns, citing case studies, and finding data on student perceptions of plant-based foods, I conclude there is demand among students for more plant-based foods. Universities have the opportunity to supply this demand, but they need to support the launch of plant-based products in university dining halls. By suggesting a number of low-cost, actionable options to serve and support more plant-based food options, this thesis lays out how a college or university can effectively engage students in more plant-based eating habits—so omnivores can transition to a more flexitarian diet and so universities can decrease their food-related greenhouse gas emissions, thus decreasing the university's total greenhouse gas emissions.

Introduction

Paul Hawken's *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming*, declares "plant-rich diet" as the fourth most important solution to "reverse climate change on a global scale" by 2050.[11] *Drawdown* claims that incorporating a "plant-rich diet," not necessarily a vegan or vegetarian diet, has the ability to reduce 66.11 gigatons of carbon dioxide (CO_2) globally by 2050.[12] This substantial reduction in CO_2 emissions cannot be achieved by any single country, institution, or company. But, colleges and universities who feed thousands of people every day can take the lead by making their campuses more environmentally sustainable by serving more plant-based foods in their dining halls. Universities can also play a

[11] Paul Hawken, ed., *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming* (New York, New York: Penguin Books, 2017).
[12] Hawken, *Drawdown*, 39.

role in guiding future generations toward more sustainable diets by helping shift their students' eating habits towards more plant-based foods during their formative college years.

Emory has made strong commitments to sustainability on campus. The university has an official goal to reduce greenhouse gas emissions 20% by 2020 and 35% by 2035, from a 2005 baseline. Emory has already implemented numerous sustainability solutions on campus, many of which are included in Project Drawdown's 80 solutions to stop global warming.[13] Emory has an Office of Sustainability Initiatives and a number of sustainability stakeholders, specifically food sustainability stakeholders.[14] Emory is thus poised to be a leading university in terms of serving sustainable food. However, there is a major misalignment between Emory's greenhouse gas reduction goals and Emory's food sustainability goals.

This misalignment exists because Emory does not calculate the amount of greenhouse gas emissions (GHGE) required to produce the food served on its campus.[15] This means that Emory

[13] Emory currently composts its food waste in the DUCling and provides compostable containers at all dining locations on campus, except the DUCling. "Food Waste" is Drawdown (DD) solution #3 and "Compositing" is Drawdown solution #60. Emory has a network of buses that transport students and the local community around Emory and Druid Hills, which theoretically decreases the number of cars on the road, and counts under the DD solution of "mass transit"—number 37. Emory also has recycling bins around campus and in dormitories, ensuring less waste goes to landfills, which falls under solution number 56, "Industrial Recycling." Emory's Waterhub, an on-campus water recycling system, utilizes eco-engineering processes to clean waste water for future non-potable uses. This system is capable of recycling up to 400,000 gallons of water per-day, almost 40% of Emory's total campus water needs ("The WaterHub at Emory University – Emory Office of Sustainability Initiatives," accessed January 29, 2019, https://sustainability.emory.edu/programs/the-waterhub-at-emory-university/.). The Waterhub is counted as solution number 46, "Water Saving." Emory's new Campus Life Center will have geothermal heating, which is number 18 on the Drawdown list. Almost all of Emory's buildings are LEED certified and use LED light bulbs, which reduce energy output and light pollution, and help Emory receive a high LEED certification. Commercial LED lighting is DD solution number 44.

[14] Emory's food-related stakeholders are Emory Dining; Bon Appétit Management Company; the Office of Sustainability Initiatives; the Sustainable Food Committee (comprised of students, faculty, and staff); Emory students who eat in dining halls every day; Bon Appétit employees who work in the dining facilities; and the suppliers of Emory's food.

[15] Emory counts GHG emissions from three scopes: "Scope 1 includes all direct GHG emissions from sources owned or maintained by Emory. For example, emissions from burning purchased fuel in Emory's boilers or fleet vehicles. Scope 2 includes indirect GHG emissions from purchased fuels consumed by the institution, or otherwise imported into Emory's organizational boundary. Scope 2 emissions physically occur at the facility where electricity is generated (in our case, Georgia Power's production plant) but are attributable to Emory as the end user of the product. Scope 3 is an optional reporting category that allows for the inclusion of all other indirect emissions. Scope 3 emissions are directly attributable to Emory's activities, but are from sources that do not fit into the Scope 1 or 2

does not count the GHGE produced from its food towards the university's total greenhouse gas emissions inventory.[16] So, while Emory's GHG reduction goal focuses on decreasing university-wide GHGE by a quantitative amount of GHGE, Emory's food sustainability goals do not commit to decreasing emissions by a specific quantitative amount. In fact, Emory's definition of food sustainability does not make an explicit reference to greenhouse gas emissions, which are widely considered a metric to track sustainability. Instead, Emory's definition of food sustainability is broad and tries to ensure economic, environmental, and social sustainability, which are ideals to strive for, but are nearly impossible to achieve just through the purchasing of "sustainable" food.[17] Emory is not alone in this lofty definition. Universities, such as University of California Berkeley[18] and University of Massachusetts Amherst[19] are just two of hundreds of colleges and universities that view sourcing "local" or "sustainable" food as a way to ensure

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definitions. Some examples of scope 3 activities are business travel; commute transportation emissions of students, staff, and faculty; and emissions from waste generated by the institution when the GHG emissions occur at a facility controlled by another company, e.g. methane emissions from landfilled waste" (Office of Sustainability Initiatives, 2). The GHG emissions produced from the food Emory serves on campus would fit into Scope 3 because the food the university serves and the emissions from those foods are directly attributable to the university just as methane emissions from landfill waste at an offsite facility are attributed to Emory.

[16] The inventory only takes into account the three scopes of GHGE, as mentioned in the note above. This is not unique to Emory. Throughout my research, I did not find any universities that counted food-related GHGE as part of their total GHGE inventory

[17] Emory Sustainable Food Committee, "Sustainability Guidelines for Food Service Purchasing" (Emory University, May 27, 2016), 1. This is Emory's definition of food sustainability from the "Sustainability Guidelines for Food Service Purchasing": "Sustainable food incorporates at least four dimensions and Emory seeks to move food purchases toward all four, though we realize some are easier than others in terms of availability and price. First, as a general rule, we recognize that shorter transport distances are more desirable than long distances and thus prioritize Georgia and the Southeast region over food from international sources. Second, we seek food grown using more sustainable growing practices, such as reduced chemical use, enhanced soil quality, and good working conditions and pay for workers. Third, the scale of production can contribute to a more vibrant and healthy farm economy and rural communities, and thus we prioritize small and medium farms over large farms. Finally, we recognize the community benefits to independent farms and cooperatives, and we have a general preference for them over corporate providers. Our commitment to sustainability includes rural economic health, civic vitality, open space preservation, reduced use of fossil fuels, environmental protection from harmful agricultural inputs and practices, preservation of biodiversity, safe and just working conditions in the agricultural sector, improved human health, optimal nutrition, and new systems of accountability. We continue to balance these purchasing criteria with cost and supply constraints."

[18] "Food | Sustainability," accessed March 2, 2019, https://sustainability.berkeley.edu/our-performance/food.

[19] "UMass: Local Food," UMass: Local Food, accessed March 2, 2019, https://www.LocalUMass.com/.

sustainability. However, these institutions do not have goals to source foods that require few greenhouse gas emissions. By including GHGE in their definition of food sustainability and purchasing food based more on food type (e.g. plant-based) and less on where the food is grown, universities will be able to set targets to decrease their amount of food-related GHGE. This can help universities increase their purchasing of foods with a low GHG-footprint, instead of increasing their purchasing of "local" or "sustainable" food, which can actually lead to an increase in GHGE.[20]

There are multiple strategies to reduce greenhouse gas emissions associated with the life-cycle of food. Three of the most impactful strategies, when thinking about specific actions that someone can implement, are eating more plant-based foods,[21] reducing food waste,[22] and reducing the volume of food consumed. This thesis will focus on plant-based foods as a strategy for institutions to reduce the GHG emissions produced from the food served in dining halls, using Emory as the main case study.

A reduction in food-related greenhouse gases can be reached at Emory University without drastic institutional change. There is already support for what Emory calls "local" and "sustainable" food initiatives. Some plant-based food options exist on dining hall menus, and multiple student groups and classes focus on sustainable food, which means many students are already exposed to the benefits of healthy, sustainable food. Such student awareness and institutional support make Emory a great environment to promote more plant-based foods.

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[20] Using GHGE as a metric for food sustainability will allow Emory's food sustainability goals to align with its 2020 and 2035 university-wide greenhouse gas reduction goal.
[21] Hawken*, Drawdown*, 39.
[22] Hawken*, Drawdown*, 43.

Emory can become a leading university in providing low-GHG food by reducing its food-related GHGE by 25% by 2035, as outlined by the Cool Food Pledge.[23]

The Environmental Footprint of Different Diets

There are a wide variety of diets followed in the United States and across the world. The graph below shows the GHGE per kilocalorie (kcal) of four of the most popular diets. It can be assumed that a Flexitarian diet has similar GHGE per kcal as the Mediterranean diet. Both diets are based mainly in the consumption of fruits, vegetables, and legumes, with small amounts of meat consumption. The main difference is the Mediterranean diet incorporates a much larger amount of fish consumption than the Flexitarian diet. Also, because a vegan diet does not allow the consumption of animal products, such as dairy and eggs, that particular diet would be the lowest on this graph because it has the smallest amount of GHGE per kilocalorie.

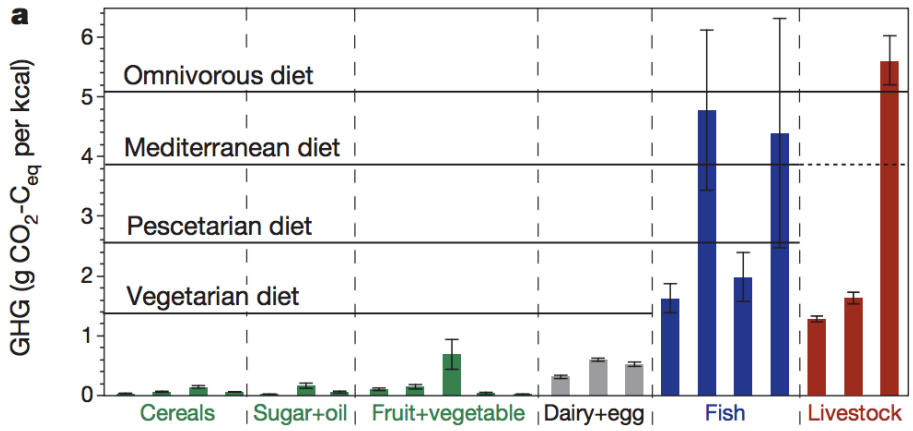

Figure 1. Lifecycle GHG emissions (CO2-Ceq) for 22 different food types per kilocalorie[24]

[23] "The Cool Food Pledge | World Resources Institute," accessed March 12, 2019, https://www.wri.org/our-work/project/cool-food-pledge. The Cool Food Pledge is a new initiative that was established at the Global Climate Action Summit in September 2018 by the World Resources Institute in partnership with the United Nations Environment Program, the Carbon Neutral Cities Alliance, and a number of other organizations. This target is in line with limiting global temperature rise to 1.5 to 2 degrees Celsius, as outlined by the Paris Agreement, and has been signed by institutions and companies, such as UCLA Health, WeWork, and Sodexo.

[24] Tilman and Clark, "Global Diets Link Environmental Sustainability and Human Health," 519. The 22 columns in the chart represent the 22 different food types that are measured in this study. From the far left column to the far right column, the 22 food types are maize, wheat, rice, other cereals, sugar, oils, oil crops, temperate fruits, tropical

Popularity of Various Diets in the United States

Recent research suggests that 3% of the US population is vegan, 5% of the US population is vegetarian, which leaves 92% of eaters as omnivores.[25] While 92% of US eaters consume animal-based foods, in a survey conducted by Johns Hopkins, 66% of survey participants declared they had reduced their consumption in at least one meat category compared with three years ago.[26] Within this group of "meat-reducers," the most common approach was buying less meat (64%), followed by smaller portion sizes (56%), meatless meals (42%), meatless days (32%), and avoiding meat altogether (9%).[27] This 66% of omnivores in the US actively reducing their meat intake is much higher than the percentage of vegans and vegetarians, who combined only make up 8% of the US population. Thus, a small reduction in the consumption of meat by omnivores, such as one less meat meal per week, can have a substantial impact on the United States' environmental footprint.

Flexitarians cite a variety of reasons for decreasing their meat consumption: cost (51%) and health (50%) are the main reasons, but also out of concern for the environment (12%) and animal welfare (12%).[28] In fact, concerns about environment and cost are directly correlated with reduced red and processed meat consumption, which makes sense because red meat tends to be the most expensive in grocery stores and restaurants.[29] Additionally, the flexitarian diet fills a

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fruits, vegetables, roots, legumes, butter, eggs, dairy, non-trawling fishery, trawling fishery, non-recirculating aquaculture, recirculating aquaculture, poultry, pork, ruminant meat. The lines extending past the tops of the bars represent the standard error of the mean (s.e.m.).

[25] Jeff Jones and Lydia Saad, "Americans Who Are Vegetarians or Vegans (Trends): 2."

[26] Roni A. Neff et al., "Reducing Meat Consumption in the USA: A Nationally Representative Survey of Attitudes and Behaviours," *Public Health Nutrition* 21, no. 10 (July 2018): 1837, https://doi.org/10.1017/S1368980017004190. Meat was classified into four mutually exclusive categories: red meat, processed meat, poultry, or seafood.

[27] Neff et al, 1841.

[28] Neff et al, 1840.

[29] Neff et al, 1840.

void between the extremes of the vegan and vegetarian diet on one end and the omnivorous diet on the other end. College students already claim to eat fresh fruits at least once a day, agree that fast food, and that "fresh salads are healthier than meat products."[30] Therefore, awareness among college students regarding healthy diets and plant-based foods is actually quite high. Flexitarianism could be an attractive diet to those students who may not be looking for a restrictive diet, such as vegetarianism or veganism, but may want to follow a healthier diet with a lower environmental footprint.[31]

Chapter 1: The Health Benefits of Consuming a Mainly Plant-Based Diet

1.1 Reducing Consumption of Meat and Animal-Based Foods

Eating food that requires fewer GHGE can not only create a positive impact on the environment, but can also provide benefits to human health. One study (Westhoek et al., 2014) tested the health effects of decreasing meat and dairy intake by 50%, while increasing plant-based foods consumption up to 50%.[32] This change in food consumption resulted in a reduced intake of saturated fat by up to 40%. High levels of saturated fat have been associated with a higher rate of coronary heart disease, but replacing saturated fats with foods high in polyunsaturated fats, such as walnuts, flax, sunflower seeds, and fish, has been shown to decrease risk of heart disease.[33] In addition, consumption of red meat has been linked to

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[30] Abraham, Noriega, and Shin, "College Students Eating Habits and Knowledge of Nutritional Requirements," 16.
[31] Abraham, Noriega, and Shin, 16.
[32] Henk Westhoek et al., "Food Choices, Health and Environment: Effects of Cutting Europe's Meat and Dairy Intake," *Global Environmental Change* 26 (May 1, 2014): 199, https://doi.org/10.1016/j.gloenvcha.2014.02.004. According to my definition of a "flexitarian diet" from the "Terminology" section, this type of reduction in meat and dairy with an increase in plant-based foods allows this diet to be classified as a "flexitarian diet."
[33] Renata Micha and Dariush Mozaffarian, "Saturated Fat and Cardiometabolic Risk Factors, Coronary Heart Disease, Stroke, and Diabetes: A Fresh Look at the Evidence," *Lipids* 45, no. 10 (October 2010): 901, https://doi.org/10.1007/s11745-010-3393-4.

increased risk of colorectal cancer and overall higher mortality risk, while consumptions of legumes, nuts, whole grains, low-fat dairy products, and fish can lower mortality risk.[34]

In terms of obesity and weight gain, Body Mass Index (BMI) has shown to be highest in what Derbyshire, 2017 calls "non-vegetarians" (known as "omnivores"), lower in "semi-vegetarians" (known as "flexitarians") and vegetarians, and lowest in vegans.[35] Research has also shown that vegetarian and "semi-vegetarian" diets were associated with a reduced likelihood of diabetes, compared to a "non-vegetarian" diet.[36] Clearly, there are health benefits to decreasing meat consumption. But, the research does not conclude it is necessary to follow a strictly vegan diet to avoid all risks of chronic diseases, such as obesity. Just as "shifting less than one day per weeks' worth of calories from red meat and dairy products to chicken, fish, eggs, or a vegetable-based diet" can achieve a larger "GHG reduction than buying all locally sourced food,"[37] following a flexitarian diet that shifts away from meat and dairy foods and towards vegetarian proteins can decrease the risk of developing chronic diseases, while increasing lifespan.

Chapter 2: The Environmental Sustainability of Meat-Based vs. Plant-Based Foods

2.1 Deforestation

Beyond human health, food choice carries powerful consequences for the environment, farmers, food companies, the economy, and much more. Adopting a diet lower in meat and animal-based foods can reduce land and water use needed to produce livestock and can lead to a

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[34] An Pan et al., "Red Meat Consumption and Mortality: Results from Two Prospective Cohort Studies," *Archives of Internal Medicine* 172, no. 7 (April 9, 2012): 561, https://doi.org/10.1001/archinternmed.2011.2287.
[35] Emma J. Derbyshire, "Flexitarian Diets and Health: A Review of the Evidence-Based Literature," *Frontiers in Nutrition* 3 (January 2017): 2, https://doi.org/10.3389/fnut.2016.00055.
[36] Derbyshire, 3.
[37] Christopher L. Weber and H. Scott Matthews, "Food-Miles and the Relative Climate Impacts of Food Choices in the United States," *Environmental Science & Technology* 42, no. 10 (May 15, 2008): 3508, https://doi.org/10.1021/es702969f.

reduction in greenhouse gas emissions. From the deforestation required to clear land for animal grazing to the methane emitted by livestock to the fossil fuels required to grow animal feed, livestock farms emit a large quantity of greenhouse gases.[38] Greenhouse gases are detrimental to the planet and contribute to climate change because they absorb infrared radiation and trap heat in the atmosphere, thus contributing to the "greenhouse effect" and warming the temperature of the Earth.[39]

Deforestation results from the livestock industry's desire to (1) expand pastures so more animals can graze on larger plots of land and to (2) clear flat land on which to grow feed for livestock. According to the Food and Agriculture Organization (FAO), over the past quarter century, forests around the world have been cleared from an area the size of India because of these desires to expand pastures and grow feed crops.[40] Deforestation contributes to global warming in many ways. First, the process of clearing and burning trees releases greenhouses gases into the air.[41] Second, clearing trees means the trees that once sequestered carbon in their leaves and trunks have to release the carbon into the air.[42] Third, without a tree cover, the soil in the forest becomes dried out and loses its nutrients, which is problematic because nutrient-deficient soil cannot store carbon in its roots.[43] Fourth, deforestation causes a loss of biodiversity for both the animals and plants who are displaced from their original forest.[44]

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[38] Troels Kristensen et al., "Effect of Production System and Farming Strategy on Greenhouse Gas Emissions from Commercial Dairy Farms in a Life Cycle Approach," *Livestock Science* 140, no. 1–3 (2011): 142.
[39] "Definition of GREENHOUSE GAS," accessed September 22, 2018, https://www.merriam-webster.com/dictionary/greenhouse+gas. India is 1.269 million square miles, making it the seventh largest country in the world by area.
[40] FAO, "Cattle Ranching and Deforestation," Policy Brief 03 (Rome, Italy, 2006): 1, http://www.fao.org/3/a-a0262e.pdf.
[41] FAO, 2.
[42] FAO, 2.
[43] FAO, 2.
[44] FAO, 2.

2.2 Quantifying the GHGE of Different Types of Food Using Life-Cycle Analysis

Drawdown calculates a reduction of 66.11 gigatons of CO_2 from switching to plant-rich diets.[45] In this calculation, and all of *Drawdown's* calculations, CO_2 is used as the unit of measurement to quantify total greenhouse gas emissions. This is because carbon dioxide is the most-emitted greenhouse gas.[46] However, with regard to food production and the byproducts of that process, for example the manure from livestock, CO_2 is not the most commonly emitted greenhouse gas. In fact, nitrous oxide contributes the largest amount of GHG emissions. Methane contributes the second most, and carbon dioxide contributes the third most from both conventional and organic farming systems.[47] This is especially problematic for the environment because nitrous oxide has a higher global warming potential (GWP) than methane and carbon dioxide.[48] Over a 100-year time horizon, nitrous oxide is 298 times stronger than carbon dioxide and methane is 25 times stronger than carbon dioxide, meaning nitrous oxide and methane warm the earth 298 times and 25 times more than carbon dioxide, respectively.[49]

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[45] Hawken, *Drawdown,* 39.

[46] EPA, "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017" (Environmental Protection Agency, April 12, 2019): ES-9 https://www.epa.gov/sites/production/files/2019-02/documents/us-ghg-inventory-2019-main-text.pdf. According to the last GHG inventory in 2017, CO_2 accounts for 81.6% of total U.S. GHGE, CH_4 accounts for 10.2%, and N_2O accounts for 5.6%.

[47] H Flessa et al., "Integrated Evaluation of Greenhouse Gas Emissions (CO2, CH4, N2O) from Two Farming Systems in Southern Germany," *Agriculture, Ecosystems & Environment* 91, no. 1 (September 1, 2002): 187, https://doi.org/10.1016/S0167-8809(01)00234-1.

[48] P. Forster et al., "Changes in Atmospheric Constituents and in Radiative Forcing. Chapter 2," *Climate Change 2007. The Physical Science Basis*, 2007: 212.Global Warming Potential (GWP) is a standard unit of measurement to calculate the relative effectiveness of GHGs in trapping the Earth's heat over a certain time horizon, relative to carbon dioxide. In this case, the time horizon is 100 years

[49] P. Forster et al., 212. This calculation means that releasing 1 kg of methane (CH_4) into the atmosphere is equivalent to releasing 25 kg of CO_2, while releasing 1 kg of nitrous oxide (N_2O) into the atmosphere is equivalent to releasing 298 kg of CO_2. However, methane only has an atmospheric lifetime of 12 years, which means that after 12 years, methane is removed from the atmosphere by natural processes. Carbon dioxide and nitrous oxide have 100 and 114 year atmospheric lifetimes, respectively.

In contrast, production of most plant-based foods emits far fewer greenhouse gases.[50] Below is a graph to illustrate the amount of GHGE from the life-cycle of 1 kg of meat, animal-based, and plant-based foods. The unit of measurement to calculate GHGE, also known as Global Warming Potential (GWP), is $kgCO_2$-eq/kg,[51] which includes emissions of methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2). Meat-based foods are denoted with red, animal-based foods are denoted with orange, and plant-based foods are denoted with green:

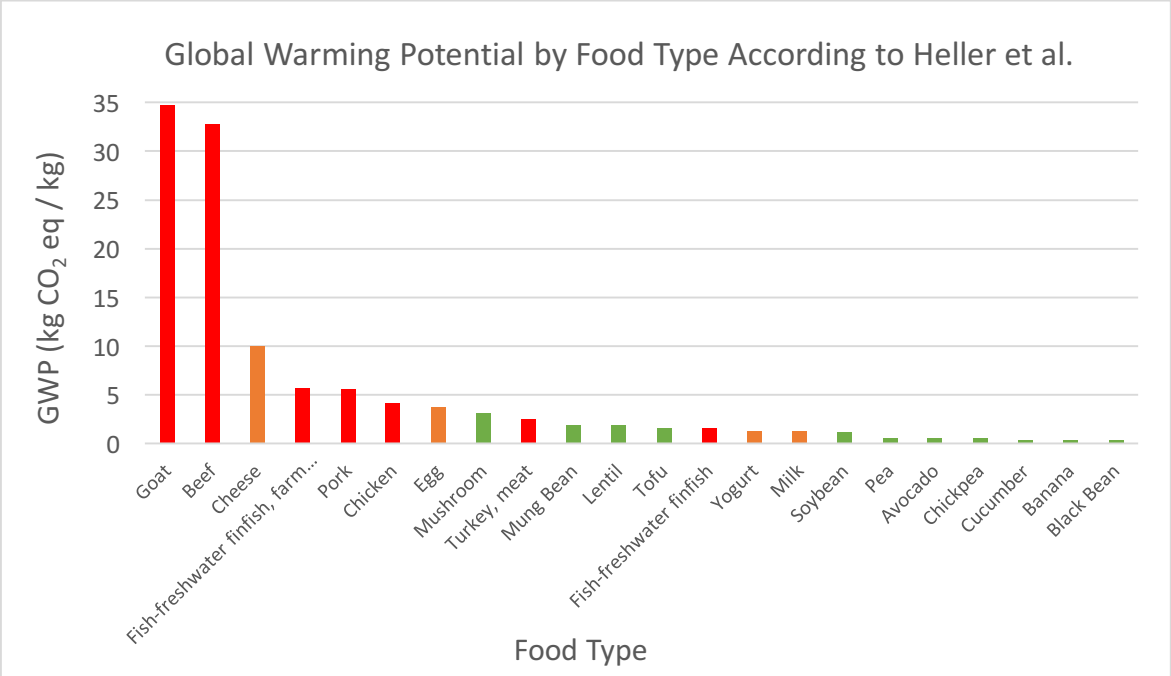

Figure 2. Global Warming Potential (GWP) by Food Type According to Heller et al.[52]

[50] For monogastric animals (e.g. pigs), generally, N2O was responsible for the largest part of the GWP, whereas for products from ruminants (e.g. cows) N2O and CH4 were equally important. For all livestock products, CO2 appeared to be the least important greenhouse gas. (de Vries and de Boer, "Comparing Environmental Impacts for Livestock Products," 2). These three greenhouse gases are emitted during the life-cycle of plant-based foods, but in the same ratio.

[51] $kgCO_2$ eq/kg is the base unit used by Heller et. al. to measure the amount of greenhouse gas emissions per kg of food produced, as calculated in the life-cycle analysis.

[52] Martin C Heller et al., "Greenhouse Gas Emissions and Energy Use Associated with Production of Individual Self-Selected US Diets," *Environmental Research Letters* 13, no. 4 (April 1, 2018): S14–S22, https://doi.org/10.1088/1748-9326/aab0ac. The GWP values used in this chart are cited in Heller et al., but I created this chart in excel. This is not a chart from Heller et al. See the "Methodology" section in the "GHGE Modeling Methodology, Assumptions, and Unit Conversions" document in the supplementary material for an explanation of what publications I used for the GWP values throughout this thesis and in my GHGE modeling.

2.3 The Environmental Effects from the Life-Cycles of Meat and Animal-Based Foods

Although the graph shows just a small sample of meat, animal-based, and plant-based foods, the graph clearly expresses the large amount of greenhouses gas emissions required to produce meat-based proteins, such as beef and goat, as well as animal-based foods, such as cheese. For the most part, the high amount of GHG emissions from these foods is contrasted with the less GHG-intensive plant-based foods, such as the legumes at the far right of the graph.

Another study conducted by Lucas Reijnders and Sam Soret finds that a reduction in meat consumption has the ability to decrease a large amount of greenhouse gas emissions. Producing meat protein requires between 6 to 20 times as many fossil fuels, 6 to 17 times more land, and 4.4 to 26 times as much water as producing a plant-based soy product with an equivalent amount of protein.[53] Although these ranges may appear large and imprecise, the variance expresses how producing different types of meat requires different amounts of energy, land, and water. A study conducted by Williams, Audsley, and Sandars supports the large variance from Soret and Reijnders as shown by this table:

Impacts & resources used per t of carcass, per 20,000 eggs (about 1 t) or per 10m^3 milk (about 1 t dm)	**Beef (0.8%)**	**Pig meat (0.6%)**	**Poultry meat (0.5%)**	**Sheep meat (1%)**	**Eggs, (1%)**	**Milk, (1%)**
Primary energy used, GJ	28	17	12	23	14	25
GWP_{100}, t CO_2	16	6.4	4.6	17	5.5	10.6
Eutrophication potential, kg PO_4^{3-}	158	100	49	200	77	64
Acidification potential, kg SO_2	471	394	173	380	306	163
Pesticides used, dose ha	7.1	8.8	7.7	3.0	7.7	3.5
Abiotic resource use, kg antimony	36	35	30	27	38	28
Land use (1)						
Grade 2, ha	0.04			0.05		0.22
Grade 3a, ha	0.79	0.74	0.64	0.49	0.67	0.98
Grade 3b, ha	0.83			0.48		
Grade 4, ha	0.67			0.38		

(1): Grazing animals use a combination of land types from hill to lowland. Land use for arable feed crops was normalised at grade 3a.

[53] Lucas Reijnders and Sam Soret, "Quantification of the Environmental Impact of Different Dietary Protein Choices," *The American Journal of Clinical Nutrition* 78, no. 3 (2003): 665S. There is a large range in the calculations for meat protein because each animal requires a different quantity of resources and land in order to grow to the right size for slaughter.

Figure 3. The Main Environmental Burdens and Resources Used to Produce Meat and Animal Based Products (with the amount of organic share shown in parentheses)[54]

As expressed in the chart, there is a large range in emissions of CO_2-eq between producing beef and sheep (lamb) compared to poultry and eggs. Producing poultry and eggs has a global warming potential about three times smaller than beef and sheep, which provides some justification for Reijnders and Soret's large range for fossil fuel use. Additionally, the large range for land use from Reijnders and Soret is expressed in the chart by milk requiring almost 50% more grade 3a land than sheep and over 30% more 3a land than poultry. The chart clearly shows that on average, beef production requires the most amount of emissions, land, and resources, while also causing the largest amount of acidification,[55] which results because of the high GWP to produce beef. On the lower end of the spectrum is poultry production, which has low eutrophication and acidification potential, while requiring a relatively high amount of pesticides. Each type of meat and animal-based food is different in taste, nutrition, and texture, so it makes sense that producing each type of food requires vastly different amounts of feed, land, and resources while causing vastly different environmental effects.

[54] A. Williams, E. Audsley, and D. Sandars, "Determining the Environmental Burdens and Resource Use in the Production of Agricultural and Horticultural Commodities: Defra Project Report IS0205," *Zu Finden in: Http://Randd. Defra. Gov. Uk/Default. Aspx*, 2006: 4. Even though Williams's study was conducted in 2006, Heller et al., 2018 confirms that poultry production emits the least amount of CO_2-eq, while production of pork, beef, and lamb emits more CO_2-eq.

[55] Ocean acidification is a "reduction in the pH of the ocean over an extended period of time, caused primarily by an uptake of carbon dioxide (CO_2) in the atmosphere." (National Oceanic and Atmospheric Administration US Department of Commerce, "What Is Ocean Acidification?," accessed March 17, 2019, https://oceanservice.noaa.gov/facts/acidification.html.)

Chapter 3: Sustainable Food at Emory

3.1 History of Sustainable Food at Emory

Emory University's 2005 Strategic Plan outlined seventeen university-wide initiatives for the school to focus on from 2005 to 2015. One of those initiatives was "sustainability."[56] Within the broad topic of sustainability, Emory's strategic planning committee developed a list of goals ranging from adding more green buildings to building a more sustainable food system for both Emory and Oxford campuses as well as Emory's hospitals and clinics.[57] The committee was "particularly aware of the rise in obesity in the US, the links between diet and rates of heart disease, cancer, diabetes, and stroke, and the negative impacts of food production on the earth."[58] Thus, Emory viewed creating a more sustainable food system as a way to positively impact the health of faculty, staff, and students on Emory's campus as well as the environment.

Emory's approach to developing a more sustainable food system is multi-faceted, outlining a wide range of goals created by the strategic planning committee: "begin a farmers market, establish community gardens in the Emory landscape, provide and encourage healthy food choices at all times of day, and procure 75% of ingredients from local or sustainably-grown sources by 2015."[59] To date, Emory has already accomplished many of these goals. Emory's weekly farmers market began in 2008 and now hosts more than 20 weekly vendors, such as local farmers and locally-owned food based-businesses.[60] Emory has also established educational community gardens around the Atlanta campus, where students can volunteer to work.

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[56] "Emory University Strategic Plan 2005-15," accessed October 13, 2018, https://www.emory.edu/EMORY_REPORT/pdf/ER_Sept26_web.pdf.
[57] Peggy F. Barlett, "Emory's Sustainable Food Initiative" (Emory University, February 2018), 1.
[58] Peggy F. Barlett, 1.
[59] Sustainability Committee, "Sustainability Vision for Emory" (Emory University, August 10, 2006), 5.
[60] "Emory Farmers Market | Campus Dining," accessed October 15, 2018, http://www.emory.edu/dining/emory_farmers_market.php.

Additionally, in 2014, Emory started operating an 11-acre organic farm at the Oxford campus. The produce from the farm is served at the Oxford campus dining hall, is sold at Emory's weekly farmers market, and is part of a weekly produce subscription service to local community members around Atlanta and Oxford.[61]

Emory also continues to "provide and encourage" healthy food choices on campus. Much of the reason Emory can supply healthy food on campus is because of Emory's food provider—Bon Appétit Management Company, which became the official food provider of the university in 2015.[62] Bon Appétit shares many of the sustainable food values that Emory Dining takes seriously, such as always sourcing beef from cattle who are not treated with antibiotics and always sourcing cage-free eggs certified humane eggs.[63] This alignment of a mission dedicated to a more sustainable food system has resulted in a strong partnership and an increase in the sourcing of "local" and "sustainable" food. In the 2015-2016 school year, the first year Bon Appétit started providing food for Emory, Emory Dining's purchases of sustainably or locally-grown food increased to 38% of all food purchased, for a total over $2 million.[64]

Bon Appétit not only provides food in Emory's dining facilities, but it also encourages students to eat healthier on campus. One of Bon Appétit's strategies to encourage healthier eating is by using the following "well-being indicator":

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[61] "Oxford Organic Farm | Oxford College | Emory University," accessed October 15, 2018, http://oxford.emory.edu/offices-and-services/organic-farm.html.

[62] Emory Dining and Emory's Sustainable Food Committee determine the food sourcing sustainability goals, but it is the responsibility of Bon Appétit Management Company, as Emory's food provider, to source food that fits the definitions of "local" and "sustainable."

[63] Bon Appétit Management Company, "Kitchen Principles," Bon Appétit Management Co., accessed December 9, 2018, http://www.bamco.com/cooking/kitchen-principles/.

[64] Peggy F. Barlett, "Emory's Sustainable Food Initiative" (Emory University, February 2018), 24. $2 million is 0.095% of Emory University's $2.1 billion budget from the 2018-2019 school year.

Figure 4. Emory's Well-Being Indicator[65]

This indicator, developed by registered dietitians, rates each menu item, according to its "nutritionally important ingredients and cooking methods."[66] The arrow is filled-in according to the food's nutritional value. The more the arrow is filled-in, the more nutritious and the higher the well-being level, and vice versa.[67] From the above comparison between a grass-fed beef burger and lo mein noodles with tofu and a sides of vegetables, the indicator expresses that the plant-based option has a higher well-being level, denoting a higher nutritional value. Although this is just one example, Bon Appétit provided me with the well-being scores of meals served at the "Vegan" and "Family Meal" station in the DUCling for the week of February 25th to March

[65] "Emory | Diet & Nutrition," accessed September 23, 2018, http://www.emory.edu/dining/Diet_nutrition%20-%20Well%20Being%20Indicator.php.
[66] "Emory | Diet & Nutrition," accessed September 23, 2018, http://www.emory.edu/dining/Diet_nutrition%20-%20Well%20Being%20Indicator.php.
[67] "Emory | Diet & Nutrition," accessed September 23, 2018, http://www.emory.edu/dining/Diet_nutrition%20-%20Well%20Being%20Indicator.php.

3rd.[68] Between February 25th and March 3rd, the average score (out of a total of 14) from the Vegan station was 6.5 and the average score from the Family Meal station was 5.75.

Although I could only analyze one-weeks worth of well-being scores, the trend is that plant-based dishes receive higher well-being scores than most meat-based foods because the vegetarian and vegan dishes have leaner sources of protein, incorporate whole grains and vegetables, and have lower levels of saturated fat. The well-being indicator is displayed on all of Bon Appétit's daily menus, allowing students to visually understand the health implications associated with the food on the menu.[69] This is just one example of the way Emory Dining and Bon Appétit work together to encourage and provide healthy food options on campus.

With the installation of Emory's educational gardens and Emory's weekly farmers market as well as the continuing effort by Bon Appétit and Emory Dining to provide and encourage healthy options on campus, three of Emory's four sustainable food goals from 2006 have been accomplished. But, there is one goal Emory is still seeking to achieve: the goal to procure 75% of ingredients from local or sustainably-grown sources. Though this goal was proposed in 2006, with the hopes of being achieved by 2015, Emory is still in pursuit of this goal and plans to achieve it by 2025. Currently, the University sources 40.6% of its food locally or sustainably, which is quite admirable, especially in a state like Georgia that does not have a year-round growing season.[70] Emory appears to be on the right trajectory to sourcing 75% of food

[68] The well-being level is calculated according to the macronutrient composition for the whole meal, which for the Vegan station is a vegan entrée and two vegan sides. For the Family Meal station, a meal is a meat-based entrée, usually a lean protein, and two vegetarian or vegan sides, so the meal is more balanced nutritionally than at the Fireside Grill station, which is grilled meats.

[69] Although Bon Appétit has a log of the well-being scores for each meal served in the DUCling, I am not aware of Bon Appétit or Emory Dining tracking the consumption of foods with a high well-being score. Thus, I cannot say whether or not there is a large or small amount of student interest in consuming foods with a high well-being score.

[70] "Food & Dining – Emory Office of Sustainability Initiatives," accessed September 21, 2018, https://sustainability.emory.edu/initiatives/food-dining/.

locally or sustainably in the next ten to twenty years. If Emory attains its 75% sourcing goal, theoretically that would result in a large reduction in GHGE.

3.2 Emory's Definition of "Local" and "Sustainable" Food

But, what does Emory classify as "local" and "sustainable" food? To answer these questions and to provide guidance on "strategies and implementation for the food goals," Emory's president created the "Sustainable Food Committee" in 2007.[71] In February of 2008, Emory's Sustainable Food Committee released Emory's "Sustainability Guidelines for Food Service Purchasing" to officially define "local" and "sustainable food."[72] Emory defines "local" food as food grown in Georgia—this is the priority—as well as food grown in the eight-state Southeast region of Georgia, Florida, South Carolina, North Carolina, Tennessee, Kentucky, Alabama, and Mississippi.[73] Because Georgia does not have a year-round growing season, this definition of local provides enough flexibility for Emory to provide "local" food almost year-round at an affordable cost. The Sustainable Food Committee revised their guidelines in 2015-

[71] Emory Sustainable Food Committee, "Sustainability Guidelines for Food Service Purchasing" (Emory University, May 27, 2016), 1.

[72] The goals Emory Dining has outlined are similar to Bon Appétit's company-wide sustainable sourcing standards (Bon Appétit Management Company, "Kitchen Principles"). But, Bon Appétit has a stricter standard that at least 20% of their ingredients have to be sourced from "small, owner-operated farms, ranches, and artisan producers within 150 miles of their kitchens" (Bon Appétit Management Company, "Sourcing Practices - Bon Appétit Management Company," Bon Appétit Management Co., accessed February 26, 2019, http://www.bamco.com/sourcing/). Emory's standard allows food sourced within 250 miles be counted as "local." This means Bon Appétit at Emory has to source food that fits their own company standards, while also fitting within Emory's separate standards. Bon Appétit also started the "Low Carbon Lifestyle" in 2015, with four main focus areas, one of which is "prioritizing plant-based proteins." However, Bon Appétit does not track their sourcing of plant-based proteins like they do for their "local" purchases.

[73] Emory Sustainable Food Committee, 3.

2017 to allow Bon Appétit's new category of "locally crafted" vendors,[74] such as a small chocolate company sourcing fair trade cacao beans, to be counted as "local" grocery products.[75]

Emory's definition of "sustainable" food is less straightforward, however. The definition of "sustainable" food varies with each type of food, such as milk and dairy, eggs, chicken, and many others. Emory ensures it sources "sustainable" food by mandating that Emory Dining sign contracts with specified suppliers, whose practices have been examined and labeled as "sustainable" by Emory Dining. For example, Emory Dining's contract specifies that all chicken must be sourced from Springer Mountain Farms or an equivalent farm.[76] All beef must be grass-fed.[77] All seafood must be labeled as "best" or "good" on the Monterrey Bay Aquarium's Seafood Watch or certified by the Marine Stewardship Council. All pork, turkey, and other meats must be raised without gestation crates.[78] All milk and dairy products must not use antibiotics or artificial growth hormones. All eggs must be certified humane.[79] All vegetables and fruits must be sourced from the eight state Southeast region and be Fair Food Certified, according to the Coalition of Immokalee Workers.[80] And, all grocery items, which is mainly coffee and tea, must be fair trade certified.[81]

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[74] Bon Appétit Management Company, "Locally Crafted," Bon Appétit Management Co., accessed October 16, 2018, http://www.bamco.com/timeline/locally-crafted/. Bon Appétit's locally crafted vendors must meet at least two of the following criteria: locally sourced (within 150 miles), humanely sourced, responsibly sourced (verified by a third party such as fair trade), traditional/artisan, justice through ownership (a majority minority or women-owned business), justice through training (the business seeks to provide jobs to a "disadvantaged" population).
[75] Peggy F. Barlett, "Emory's Sustainable Food Initiative," 25.
[76] Emory Sustainable Food Committee, 4. Emory does not require all chicken be "certified humane," as it does for the eggs it purchases, but Springer Mountains Farms is American Humane Certified. Springer Mountain feeds its chickens pesticide-free corn and soybean meal that does not include antibiotics. The chickens are not pasture-raised, even though Emory "has a preference for slower-growing breeds which have more opportunity to be pasture-raised." ("FAQ," Springer Mountain Farms, accessed March 18, 2019, https://www.springermountainfarms.com/faq.)
[77] Emory Sustainable Food Committee, 4.
[78] Emory Sustainable Food Committee, 5.
[79] Emory Sustainable Food Committee, 3.
[80] Emory Sustainable Food Committee, 4.
[81] Emory Sustainable Food Committee, 5.

While some of the criteria for "sustainable" food vary according to food type—for example, chicken and grocery products have a different list of criteria to be labeled "sustainable"—Emory Dining has also created a list of third-party certifications that can label a food as "sustainable." This list includes USDA Organic, grass-fed, Fair Trade, Certified Humane by Humane Farm Animal Care, Monterrey Bay Aquarium's Seafood Watch program "Best Choice" or "Good Alternative."[82] Therefore, if a certain food is certified by one of these third parties, it is automatically considered "sustainable" and is counted towards Emory's "local" and "sustainable" food goal, regardless of what food it is or where it is grown or how it is grown.

It is important to understand that Emory's goal is to source 75% of food "locally" or "sustainably" by 2025.[83] If a food falls under either the criteria for "local" or "sustainable," it counts towards the overall percentage. The food does not have to be sourced both "locally" and "sustainably," according to Emory's definition. Here is a figure from Emory's "Sustainability Guidelines for Food Service Purchasing" that outlines the university's criteria for sourcing "local" or "sustainable" food:

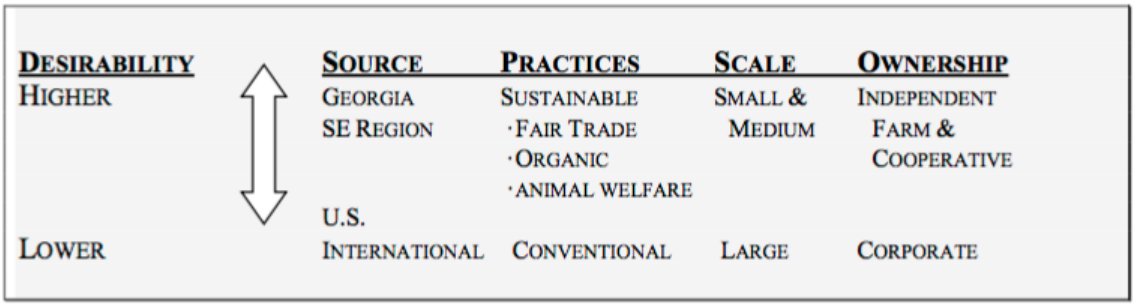

Figure 5. Emory's "Local" and "Sustainable" Sourcing Criteria[84]

[82] Emory Sustainable Food Committee, 3-5.
[83] Emory Sustainable Food Committee, 1. This goal to source 75% of food locally or sustainably was set in 2005 to be achieved by 2015. Emory has since revised the goals and now, Emory has the goal to reach 75% of locally or sustainably sourced food by 2025. At the end of fiscal year 2017, Emory was sourcing 37.3% of food locally or sustainably.
[84] Emory Sustainable Food Committee, 1.

Chapter 4: Examining Food Sustainability from a *Drawdown* Perspective

4.1 The Difference between A Plant-Based Diet Approach to Sustainability and Emory's Approach to Food Sustainability

While Project Drawdown estimates GHGE reductions on a global scale, institutions have the opportunity to reduce greenhouse gas emissions on a more micro scale and still have a substantial environmental impact. Thus, institutions need to set and hold themselves accountable to food-related GHGE reduction goals, not just goals that increase the amount of "local" or "sustainable" sourcing. Sourcing more "local" or "sustainable" food, as Emory defines it, does not necessarily result in lower amounts of food-related GHGE, which raises the question of the actual "sustainability" of Emory's "food sustainability" goals. Using the *Drawdown* approach and committing to a food-related GHGE reduction, such as the Cool Food Pledge, which utilizes GHGE as the main metric of sustainability, can be a more effective way for schools to decrease their food-related greenhouse gas emissions year-after-year. And, the most promising means to achieve that reduction of GHGE is by reducing the consumption of meat and animal-based foods and increasing consumption of plant-based foods.

In contrast to *Drawdown*'s plant-based diet approach to reduce GHG emissions, Emory's approach to sustainable food does not put enough emphasis on offering more plant-based foods with a low environmental footprint. Emory's food sustainability goal has two parts: one focuses on providing resources and education to help students understand how food is grown and what foods are healthy. The second focuses on the concrete goal of sourcing 75% of its food "locally" or "sustainably," as defined in the previous section. The first part of the goal may help to create a student body more interested in consuming "local food," for example, but it does not focus on reducing Emory's food-related GHG emissions. And, while the second part briefly touches on

how a "meat-free diet…reduces greenhouse gas emissions," Emory's "Sustainability Guidelines for Food Service Purchasing" do not clearly state that Emory has the goal of sourcing food low in GHGE. Emory's definition of food sustainability includes "preservation of biodiversity" and "safe" and "just working conditions," just to name a few aspects of the definition.[85]

These are aspirational guidelines to try and source the most socially, economically, and environmentally sustainable food, but they allow for contradictory purchasing. For example, the definition leaves room to purchase large amounts of beef, just because it is grass-fed. However, this type of purchase could lead to a large amount of GHGE. If Emory included a metric such as GHGE to track sustainability, then the amount of beef ordered might be reduced. Purchasing large amounts of grass-fed beef, for example, does not result in Emory decreasing its food-related GHGE, so it should not count as increasing Emory's percentage of "sustainable" food.

4.2 Food Sustainability Defined by Food Type, not by Food Miles

The main problem with Emory's emphasis on local food production as a key driver of its food sustainability goals is that it prioritizes where the food is produced, instead of what types of food are sourced. Although food is transported long distances in the US food system, the GHGE associated with food are "dominated by the production phase," contributing 83% of the average U.S. household's footprint for food consumption.[86] Transportation represents only 11% of life-cycle GHG emissions, and final delivery from producer to retail contributes only 4%.[87] Thus, sourcing local food only focuses on a minor percentage of all life-cycle emissions related to food. In fact, research suggests that dietary shift is "a more effective means of lowering an

[85] Emory Sustainable Food Committee, 1.
[86] Weber and Matthews, "Food-Miles and the Relative Climate Impacts of Food Choices in the United States," 3508.
[87] Weber and Matthews, 3508.

average household's food-related climate footprint than "buying local."[88] If the average American household bought local food, that would only create a maximum reduction in GHGE of 4-5%.[89] However, "shifting less than one day per weeks' worth of calories from red meat and dairy products to chicken, fish, eggs, or a vegetable-based diet achieves more GHG reduction than buying all locally sourced food."[90] Thus, purchasing plant-based foods should hold a higher priority than locality when trying to achieve the maximum level of food sustainability, especially for GHG-intensive foods like red meat and dairy products, in which food-miles are such a small percentage of the total life-cycle GHGE.[91]

4.3 The Misalignment between Emory's Food Sustainability Goals and Emory's Greenhouse Gas Reduction Goal

To decrease food-related GHGE, food sustainability goals need to focus on what food is produced and less on where or how it is produced. For Emory's food sustainability goals to align with Emory's overarching 20% GHG reduction goal by 2020 and 35% reduction goal by 2035, the food sustainability goals need to focus on increasing the amount of plant-based foods, not just the amount of local food purchases.

This misalignment in Emory's GHG reduction goal and its food sustainability goals rests on the fact that Emory's 75% sourcing goal is based on dollars spent. Thus, Emory seeks to increase its amount of "local" or "sustainable" food purchasing by purchasing more expensive foods, which tend to be meat and animal-based foods that emit more GHG than plant-based foods. Therefore, Emory is incentivized to buy more local grass-fed beef or chicken from

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[88] Weber and Matthews, 3508.
[89] Weber and Matthews, 3512.
[90] Weber and Matthews, 3508.
[91] An illustration of the small role that food-miles play in total life-cycle GHGE of beef and plant-based foods can be found in Figure 6 in Section 5.3.

Springer Mountain farms because those purchases will contribute the most to the 75% goal. Ironically, if Emory purchases non-organic plant-based foods outside of the eight-state Southeast region, those foods will not be counted towards Emory's 75% goal, even if they require far fewer GHG emissions to produce and transport than local meat.

Lastly, plant-based dairy or meat alternatives do not count as "sustainable" under Emory's guidelines. Emory serves Silk soy milk in the DUCling alongside its dairy milk, but plant-based dairy or meat alternatives are not included in Emory's food purchasing guidelines. The money spent to purchase soy milk, which produces far fewer GHG emissions than dairy milk,[92] does not count towards Emory's 75% "local" or "sustainable" goal. Dairy milk, however, which is sourced from a farm within 250 miles of Emory, counts towards the 75% goal, even though dairy milk has a GWP over five times as high as soy milk.[93]

Another reason there is a disconnect between Emory's food purchasing guidelines and Emory's 2020 and 2035 GHG reduction goal is because a decrease in purchasing of local meat replaced with an increase in purchasing of non-organic plant-based foods will decrease Emory's contribution to its 75% goal of "locally" and "sustainably" sourced food. Even though Emory is technically decreasing its food-related GHGE when it purchases less meat, when looking only at the 75% goal, it appears that Emory is sourcing less "sustainable" food. This is in fact untrue.

A food sustainability approach that focuses on increasing the consumption of plant-based foods and decreasing the consumption of meat and animal-based foods would be better aligned with Emory's university-wide 2020 and 2035 goals to reduce GHGE. With every purchase of

[92] Ashley Henderson and Stefan Unnasch, "Life Cycle Assessment of Ripple Non-Dairy Milk," 2017, 12.
[93] Heller et al., "Greenhouse Gas Emissions and Energy Use Associated with Production of Individual Self-Selected US Diets," S15, S21. Soy milk has a GWP = 0.258 and dairy milk has a GWP = 1.323.

plant-based foods in lieu of animal-based foods, Emory can decrease its food-related GHGE and move closer to its 2020 GHGE reduction goal.

Chapter 5: Comparing GHG Emissions from Emory's Local Meat and Dairy Ordering vs. Emory's Plant-Based Orders during the 2018-2019 School Year in the DUCling

5.1 Quantifying the GHGE from the DUCling's Food Purchases

Tracking the food purchases for Emory's DUCling in the first week of September 2018, October 2018, November 2018, December 2018, February 2018 and the third week of January 209[94] allowed me to extrapolate the data to estimate the amount of food-related GHGE from the DUCling's during the 2018-2019 school year.[95] This data allows me to compare the GHGE from the "local" or "sustainable" meat and animal-based foods served in the DUCling vs. the GHGE from the plant-based foods served in the DUCling.

5.2 Emory's Ordering of Dairy Milk vs. Plant-based Milk

Over the course of the six weeks of ordering data from the six separate months, the DUCling purchased 6,587.70kg of dairy milk (not including half and half or heavy whipping cream) and 815.33kg of Silk soy milk.[96] All the dairy milk Emory purchases is required to be sourced from the eight-state southern region, which means it counts towards Emory's 75% "local" or "sustainable" goal.[97] However, Silk soy milk is not USDA Organic certified and not sourced from within the eight-state region, so it is not counted as "local" or "sustainable" under Emory's guidelines. This is problematic because dairy milk has a GWP of 1.323 $kgCO_2$-eq/kg

[94] The third week of DUCling ordering data was used because the DUCling was not open during the first week of January due to winter break.
[95] A full methodology for the data modeling and extrapolation can be found in the "GHGE Modeling Methodology, Assumptions, and Unit Conversions" document in the supplementary material.
[96] See "Sept to Feb Pivot" excel tab in the supplementary material.
[97] Emory Sustainable Food Committee, "Sustainability Guidelines for Food Service Purchasing," 3.

and soy milk has a GWP of 0.258 $kgCO_2$-eq/kg, meaning the emissions produced from the life-cycle of dairy milk warm the earth 79.5% more than the emissions from the life-cycle of soy milk. Even though sourcing dairy milk contributes to climate change in a much stronger manner than sourcing soy milk, the DUCling is incentivized by Emory's current food sustainability goals to source a large quantity of dairy milk, while not incentivized to source soy milk.

Soy milk's life-cycle is much less GHG-intensive than dairy milk's, but even if it is assumed Emory sources the same quantity of soy milk as dairy milk, and it is assumed the soy milk is sourced from Denver, Colorado (1210 miles from Atlanta), while the dairy milk is sourced within Emory's "local" definition (250 miles from Emory), the GHGE from dairy milk would still be larger:

GHGE Total of Dairy Milk vs. Soy Milk (assuming the same weights but different distances)							
Food	**Weight (kg)**	**Distance (miles)**	**Emissions Factor from Transport[98] (kgCO2)**	**GWP[99] (kgCO2/kg)**	**GHGE (kgCO2)**	**Calories per 240mL Serving**	**Total Calories**
Skim Dairy Milk	6,587.70	250	1.7	1.323	3,704,099.02	90	2,470,387.50
Vanilla Soy Milk	6,587.70	1210	1.7	0.258	3,496,131.92	100	2,744,875.00

Figure 6. Comparing Life-Cycle GHGE of Dairy Milk and Soy Milk Assuming the Same Quantity of Milk is Ordered and Assuming the Soy Milk is Sourced from Denver while the Dairy Milk is Sourced within Emory's 250-mile "local" range[100]

[98] Jason Mathers et al., "The Green Freight Handbook: A Practical Guide for Developing a Sustainable Freight Transportation Strategy for Business" (New York, NY: Environmental Defense Fund, 2014): 11, http://business.edf.org/files/2014/07/EDF-Green-Freight-Handbook.pdf. The "Emissions Factor," which is equal to 1,700g CO_2 (1.7$kgCO_2$), as calculated by the Environmental Defense Fund's Green Freight Handbook, represents the $kgCO_2$ emitted per mile of transport by a truck. It can be thought of as the GWP of transportation. Thus, weight*distance*emissions factor*GWP = GHGE. * is multiplied by.

[99] See the "Methodology" section in the "GHGE Modeling Methodology, Assumptions, and Unit Conversions" document in the supplementary material for an explanation of what publications I used for the GWP values throughout this thesis and in my GHGE modeling.

[100] See "dairy milk vs. soy milk" excel tab in the supplementary material. The vanilla soy milk is from the "Silk" brand, which is served in the DUCling. The skim milk is from "Dairy Pure," which is distributed by Mayfield Dairy to the DUCling. I used skim dairy milk because the calorie count and nutritional value was most similar to that of vanilla soy milk. I computed the total calories of 6,587.7kg of dairy and soy milk assuming that 1L of milk = 1kg. The density of milk is about 1.03kg per liter so assuming a liter of milk = 1kg is not much different ("The Weight of

Even with the long transport distance of the soy milk and creating a scenario where the DUCling ordered the same amount of soy and dairy milk, the total GHGE from soy milk has a smaller environmental footprint by 207,967.10kgCO_2-eq, while delivering more calories and a similar amount of protein.[101]

5.3 Emory's Ordering of Beef vs. Beyond Burgers, Tofu, and Black Beans

Over the course of the six weeks of ordering data from the six separate months, the DUCling purchased 2,655.33kg of beef, 108.86kg of Beyond Burgers, 671.32kg of black beans, and 336.94kg of tofu.[102] Here is a table to show the difference in GHGE from each food:

GHGE from 6 Weeks of DUCling Ordering Data			
Food	**Weight (kg)**	**GWP (kgCO2-eq)**	**GHGE (kgCO2-eq)**
Beef	2655.329734	32.846	87,216.96
Beyond Burger	108.8621688	3.527	383.96
Tofu	336.9352331	1.664	560.66
Black Bean	671.3167076	0.308	206.77

Figure 7. Life-Cycle GHGE from Beef, Beyond Burgers, Tofu, and Black Beans Using the Quantity Ordered in the DUCling during the 6-week Period[103]

There is clearly a large disparity in the total GHGE from beef in comparison to the GHGE from the plant-based products. Even if I were to assume that the DUCling ordered the same quantity of beef, Beyond Burgers, tofu, and black beans in terms of calories, the comparison of GHGE is still a disproportionate comparison:

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1 Litre of Milk - Math Central," accessed March 16, 2019, http://mathcentral.uregina.ca/QQ/database/QQ.09.07/h/imran1.html.).

[101] Dairy Pure skim milk has 8g of protein per serving and Silk vanilla soy milk has 6g of protein per serving. To ensure the dairy and soy milk have the same amount of protein, the DUCling could order the Silk "Original" soy milk, which has 8g of protein per serving. Also, if this calorie estimation used 1% dairy milk, instead of skim, the total number of calories would be higher for the dairy milk than the skim milk.

[102] See "Sept to Feb Pivot" excel tab in the supplementary material.

[103] See "Beef, blk bean, Bey. B., tofu" excel tab in the supplementary material.

GHGE from 6 weeks of DUCling Ordering Data (assuming all foods have the same number of calories)					
Food	**Calories per 1kg serving[104]**	**Weight (kg)**	**Total Calories**	**GWP (kgCO2-eq)**	**GHGE (kgCO2-eq)[105]**
Beef	2,506.00	2,655	6,654,256.31	32.846	87,216.96
Beyond Burger	2,389.38	2,784.93	6,654,256.31	3.527	9,822.45
Tofu	758.00	8,778.70	6,654,256.31	1.664	14,607.76
Black Bean	3,391.00	1,962	6,654,256.31	0.308	604.4

Figure 8. GHGE from 6 weeks of DUCling Ordering Data Assuming all plant-based foods have the equivalent number of calories as 2,655.33kg of beef[106]

Even when the plant-based foods have the same number of calories as beef, the plant-based foods still emit a disproportionately lower amount of GHGs throughout their life-cycle. Even tofu, which is a low-calorie food, has a GHGE total almost 6 times smaller than beef.[107] Additionally, the Beyond Burger, a dense plant-based meat alternative with 270 calories per 4oz burger and 20g of protein,[108] has total GHGE almost nine times lower than beef. Lastly, black beans are so efficient per calorie that their total GHGE are over 144 times lower than beef's.

[104] USDA Agricultural Research Service, "USDA Food Composition Databases," Database (United States Department of Agriculture), accessed March 16, 2019, https://ndb.nal.usda.gov/ndb/. This USDA database provided the number of calories per 1 kg of serving of 80/20 beef, black beans, and tofu. To compare the GHGE from each food, based on the same calorie count, I found the number of calories in 1kg of 80/20beef, which is 2,506 calories. I then multiplied that by the total amount of beef the DUCling ordered over the 6 weeks, which is 2,655kg. That equals 6,654,256.31 calories. Because I wanted to compare the GHGE from each food, assuming they had the same calories, I used this calorie count from beef as the reference amount. As a result, I made the calorie totals for each food equal to 6,654,256.31 calories. I then calculated how many kg of food 6,654,256.31 calories would correspond to for tofu, Beyond Burgers, and black beans, based on their specific number of calories per 1kg serving. Because the Beyond Burger calorie count was not available in the USDA database, I calculated the calories per 1kg serving of Beyond Burgers using the fact that a 113g Beyond Burger has 270 calories. After converting grams to kg, the Beyond Burger has 2,389.38 calories per 1kg serving

[105] The formula to calculate GHGE can be found in the "Beef, blk bean, Bey. B., tofu" excel tab in the supplementary material, but the formula is: weight*GWP = GHGE. * is multiplied by.

[106] See "Beef, blk bean, Bey. B., tofu" excel tab in the supplementary material. I found the total GHGE by multiplying the calculated weight for each food by the corresponding GWP value.

[107] Because tofu is so low in calories, a very large weight of tofu needs to be ordered to equate to the total calories of 2,506kg of beef.

[108] "The Beyond Burger®," *Beyond Meat - The Future of Protein™* (blog), accessed March 16, 2019, https://www.beyondmeat.com/products/the-beyond-burger/.

Coupled with the low GWP's of these plant-based foods is the fact that the DUCling orders far less of these plant-based foods than they do of beef, chicken (7370.88kg), and pork (2489.78kg), as well as some animal-based foods, such as cheese (2989.62kg).[109] Although chicken (GWP = 4.188), pork (GWP = 5.560), and cheese (GWP = 9.974) have lower GWP values than beef, they each have higher GWPs than the plant-based foods from Figure 8. Herein lies the contradiction that Emory is incentivized to source more of the GHG-intensive meat and animal-based foods to increase the percentage of "local" or "sustainable" food. But, if the plant-based foods are not organic or sourced within 250 miles of Emory, they are not counted as "local" or "sustainable," even though they have GWP values substantially lower than the meat and dairy products listed above.[110]

I created another model to illustrate the effect that food-miles have on the total GHGE of beef, Beyond Burgers, black beans, tofu, and black beans, assuming the DUCling orders the same amount of each food in terms of weight, not calories.[111] This model assumes the three plant-based food items are shipped by truck from Los Angeles to Atlanta, a distance of 2,173 miles, and the beef is shipped from within Emory's 250-mile "local" region:

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[109] See "Sept to Feb DUCling also orders far less weight of these plant-based foods compared to other meat-based foods, such as chicken (7370.88kg) and pork (2489.78kg), as well as animal-based foods, such as cheese (2989.62kg).

[110] Because chicken and pork have significantly lower GWP values than beef, serving chicken or pork in place of beef provides university dining halls the opportunity to still serve meat without emitting as many GHGs.

[111] The reference weight is the 2655.33kg of beef ordered in the DUCling over the six weeks of ordering data that I tracked. This model assumes the DUCling ordered 2655.33kg of beef, Beyond Burgers, Black Beans, and Tofu, so the model can depict a fair comparison between each food. Comparing these foods based on the actual quantity the DUCling ordered would yield even more disproportionate results because the DUCling orders far less Beyond Burgers, black beans, and tofu than beef. The reason this model does not include calories is because comparing GHGE with the equivalent number of calories for each food and then adding food-miles is an unfair comparison for tofu because it is so low in calorie. To have an equivalent number of calories to beef, the DUCling would need to order almost four times as much tofu as beef, in terms of weight, which would result in the total tofu GHGE having more total GHGE than beef shipped from 250 miles away. This quantification of GHGE per calorie count with added food-miles can be found in the "Beef, blk bean, Bey. B., tofu" excel tab of the supplementary material.

GHGE from 6 weeks of DUCling Ordering Data with Food-Miles					
Food	**Weight (kg)**	**Distance (miles)**	**Emissions Factor (kgCO2)**	**GWP (kgCO2-eq/kg)**	**GHGE (kgCO2-eq)**
Beef	2655.329734	250	1.7	32.846	37,067,208.19
Beyond Burger	2655.329734	2173	1.7	3.527	34,596,531.94
Tofu	2655.329734	2173	1.7	1.664	16,322,265.14
Black Bean	2655.329734	2173	1.7	0.308	3,021,188.50

Figure 9. Life-Cycle GHGE of Beef, Beyond Burgers, Tofu, and Black Beans Assuming the Same Quantity of Each Food is Ordered and Assuming all Plant-Based Foods are Shipped by Truck from Los Angeles, CA while the Beef is Sourced within Emory's 250-mile "local" range[112]

Even adding the emissions from 2,173 miles of truck transport and assuming the DUCling orders the same amount of beef, Beyond Burgers, tofu, and black beans, results in the total GHGE from "local" beef as over 2 million $kgCO_2$-eq greater than the biggest plant-based emitter, the Beyond Burger. The GHGE from tofu is less than half the GHGE from "local" beef, and black beans have such a small GHG-footprint that they could be transported from 21,730 miles away and their GHGE total would still be less than beef.[113] Thus, food-miles do not cause a large effect on the total GHGE of the food Emory orders. Because college and university dining halls order such large quantities of food, the emissions from transportation are small relative to the cumulative emissions from the life-cycle of the food.

5.4 The Distribution Between the DUCling's Ordering of Meat and Animal-Based Foods vs. Plant-Based Foods

While I argue that an increase in plant-based foods will allow Emory to decrease its food-related GHGE, it is first necessary to understand how many GHGE are currently produced from

[112] See "Beef, blk bean, Bey. B., tofu" excel tab in the supplementary material.
[113] See "Beef, blk bean, Bey. B., tofu" excel tab in the supplementary material.

the food the DUCling serves. Using ordering data from November through February, I was able to see what quantity of meat, animal-based, and plant-based foods are ordered by the DUCling, both by weight and by GHGE:

Food Type	Sum of Weight (kg)	Average of GWP (kg CO2-eq/kg)	Sum of GHGE (kg CO2-eq)
Animal-based	14.62%	5.617842822	21.64%
Meat	13.48%	10.93465188	53.16%
Plant-based	71.90%	1.146397254	25.20%

Figure 10. Distribution of Food Served in the DUCling by Food Type between November and February by Total Weight (%), Average GWP, and Total GHGE (%).[114]

The table has two important takeaways. The first is that even though plant-based foods far outweigh (kg) both animal-based and meat-based foods, plant-based foods only account for a little over 25% of total greenhouse gas emissions. While this percentage is larger than the GHGE from animal-based foods, Emory orders a significantly smaller weight of animal-based foods than it does plant-based foods, so comparing these two categories strictly by GHGE is not fair. Secondly, the average GWP of each food category expresses the difference in GHG-intensity between meat, animal-based, and plant-based foods categories. The GWP average for meat is almost double that of animal-based foods and almost eleven-times that of plant-based foods.

But within the "meat" category, there are more sustainable options, and these are the options Emory's DUCling should be serving more of to decrease food-related GHGE. Beef and lamb have by far the highest GWP of any meat-based food,[115] while turkey (GWP = 2.571),

[114] See "Sept to Feb Pivot" excel tab in the supplementary material. Modeling the GHGE from the DUCling's food from one week in the months of November through February showed me that the DUCling's food orders are very similar over the course of the year. Although I did not input data from September and October, the amount of GHGE from each of the four weeks I modeled provided GHGE totals that were all within 2,000kgCO_2-eq of each other, which is very close.

[115] Meat has a GWP = 32.846. Lamb has a GWP = 34.475 according to Heller et al.

chicken (GWP = 4.188), and pork (GWP = 5.56) are more environmentally sustainable options that can be served to ensure students interested in consuming meat-based foods are still satisfied.

Within the animal-based foods category, there are more sustainable and less sustainable food options as well. Products, such as cheese (GWP =9.974) and butter (GWP = 11.52) are far above the average GWP in this category. But, butter only accounts for 0.64% of all food-related GHGE in the DUCling, so it is not as big of a sustainability concern for the DUCling. In terms of cheese, which makes up 9.23% of all GHGE from the DUCling, there are a number of plant-based alternatives (e.g. Miyoko's, Daiya, Follow Your Heart) that use cashews and almonds to make cheese, which could be substituted for some part of the DUCling's cheese orders.[116] Decreasing the amount of menu items that include cheese, however, would be the most effective option to decrease cheese-related GHGE.

Chapter 6: Implementing a Plant-Forward Dining Approach at U.S. Colleges and Universities

6.1 "Menus of Change" Plant-Forward Dining Strategies

The "Menus of Change" organization aims to tackle Project Drawdown's plant-based diet solution by helping create plant-forward menus at colleges, universities, and companies to improve the health of consumers as well as the environment. They achieve this vision by (1) "bringing attention to protein," both animal and plant-based, and (2) by making plant-forward dining a mainstream concept in the culinary profession and foodservice industry. [117]

[116] None of the studies I used for the GHGE modeling (Heller et al., Clune et al., Berners-Lee et al.) provided different GWP values for specific types of cheese (e.g. mozzarella vs. cheddar), so I cannot recommend the DUCling source a specific type of cheese with a lower GHGE footprint.

[117] "Menus of Change - The Culinary Institute of America," accessed January 31, 2019, http://www.menusofchange.org/. "Menus of Change" is an initiative from The Culinary Institute of America and Harvard's T.H. Chan School of Public Health with the vision to integrate optimal nutrition and public health, environmental stewardship, and social responsibility concerns within the foodservice industry and the culinary profession.

"Plant-forward" is a way of cooking and eating that emphasizes and celebrates, but is not limited to, plant-based foods, and that reflects evidence-based principles of health and sustainability.[118] Central to a plant-forward menu is a strategy called the "protein flip." This flip focuses on rebalancing the food on the plate so that meat-based proteins, specifically red meat become more of a condiment, while plant proteins move to the center of the plate.[119] There are many strategies to serve more plant-based dishes. This is why "Menus of Change" created the Menus of Change Research Collaborative (MCURC) to test the applicability of plant-forward food innovations in campus dining halls across the country.[120] Based on their experiments, the collaborative outlines best practices for serving healthy, sustainable food in exciting and nutritious dishes.[121] MCURC suggests three plant-forward strategies that have been well-received by students and chefs at college and university dining halls around the country:[122]

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[118] Sophie Egan et al., "Menus of Change 2018 Annual Report" (The Culinary Institute of America, June 19, 2018). Plant-forward is an umbrella term that extends beyond just vegan and vegetarian approaches and is more inclusive of recipes, menus, and concepts that may contain poultry, fish, dairy, or small amounts of meat.

[119] The Culinary Institute of America and The Department of Nutrition, Harvard T.H. Chan School of Public Health, "The Protein Flip," (2016).

[120] "Members - Menus of Change University Research Collaborative," accessed February 4, 2019, http://www.moccollaborative.org/members/.
Stanford University and The Culinary Institute of America co-founded and jointly lead the Menus of Change University Research Collaborative (MCURC). This collaborative is made up of academic scholars, foodservice business leaders, and executive chefs that outline best practices for serving healthy and sustainable food in dining halls. To date, the Collaborative consists of 225 members, 64 of which are institutions, 38 of which are colleges and universities.

[121] "Members - Menus of Change University Research Collaborative." The MCURC has not published any journal articles about their findings regarding plant-forward dining in university dining halls, so their recommendations and the case studies that follow are not based in peer-reviewed scholarship, but based on the fact that the two institutions that founded the Collaborative are very reputable universities, one of which is a reputable research university, I am applying the MCURC's recommendations as innovations that can be used at other institutions. Their strategies have been implemented at the 38 colleges and universities that are part of the Collaborative, and the case studies provide evidence that the practices are well-received by students and chefs, while also decreasing the amount of food-related GHGE from the university's using these strategies.

[122] The Culinary Institute of America and The Department of Nutrition, Harvard T.H. Chan School of Public Health, "Protein Flip Strategies for College and University Foodservice," (n.d.), https://www.moccollaborative.org/images/uploads/pdf/Protein_Flip_Strategies_for_College_and_University_Foodservice_high_res1.pdf.

1. Replace a portion of the meat with a vegetable or grain (example: The Blend)[123]
2. Look to global cuisine where meat is a condiment to a vegetable or grain dish (example: bowls)
3. Develop new items that are plant-protein based (ex: quinoa, black beans, etc.)

The three strategies suggested by the MCURC do not force students to eat foods they do not regularly consume. The top two strategies still allow students to eat meat, just less of it. The third strategy provides an opportunity for chefs to create plant-inspired dishes they believe students will enjoy. These three "protein flip" strategies continue to be well-received by students and chefs in college and university dining halls, as evidenced by the following case studies:

6.2 Harvard University: The Blend

Harvard University Dining created 10 beef-based dishes, but replaced a portion[124] of the meat with mushrooms in every dish. The recipes included beef chili, shepherd's pie, beef lasagna, meatloaf, and filling for both tacos and burritos.[125] The chefs experimented with each dish and settled on recipes that, on average, reduced saturated fat by 31% and calories by 20%. [126] Serving these blended dishes had a significant reduction in food-related GHGE: in a single five-pound meatloaf recipe, replacing beef with mushrooms reduced GHGE by 44 pounds of

[123] The Blend is a strategy that involves blending beef with a plant protein, usually mushrooms, and sometimes other vegetables such as eggplant and peppers, as well as grains. By blending beef with plant proteins, chefs can reduce the amount of beef required to make certain beef dishes. Some common examples of blended dishes include burgers, meatloaf, and lasagna.
[124] The "Protein Flip" presentation that included this case study did not specify what portion of the meat was replaced with mushrooms. The standard tends to be replacing beef with 25% mushrooms, as discussed in footnote 166.
[125] Harvard University Dining Services used these recipes because they already had these items on the residential dining menu. This is an important component because HUDS did not add new menu items, which students may have been reluctant to try without a sampling.
[126] The Culinary Institute of America and The Department of Nutrition, Harvard T.H. Chan School of Public Health, "The Protein Flip."

CO_2-equivalent.[127] Within a single meal service to 6,600 undergraduate students, this reduction in beef results in the equivalent GHG reduction of "taking a car off the road for six months."[128] In terms of customer satisfaction, Harvard reports that students love the recipes, and Harvard University Dining has made the meat/mushroom blend chili a regular on the daily lunch menu. In addition, one quarter of Harvard's burgers are now blended turkey with brown rice and vegetables, "both reducing meat consumption and moving to a healthier protein that's better for the environment."[129]

Although it is great when chefs can innovate to create healthier food with a low GHG footprint, if students do not enjoy the food, the low GHG food innovations are not effective. Harvard's recipe innovations using The Blend show how giving chefs the autonomy to create a great-tasting dish that includes meat and vegetables can result in a positive response from students and a lower GHG footprint.

6.3 University of California Riverside: Global Cuisine

University of California Riverside utilizes global cuisine to create grain bowls that are protein-rich, without using large portions of meat-based protein. At the University of California Riverside's dining hall "The Barn,"[130] chefs served a Moroccan Quinoa Bowl with a base of harissa quinoa, roasted Brussels sprouts, edamame, asparagus, eggplant, squash, and red onion, which are tossed with a Moroccan spice blend.[131] Although this dish incorporates only plant-

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[127] The Culinary Institute of America and The Department of Nutrition, Harvard T.H. Chan School of Public Health.
[128] The Culinary Institute of America and The Department of Nutrition, Harvard T.H. Chan School of Public Health.
[129] The Culinary Institute of America and The Department of Nutrition, Harvard T.H. Chan School of Public Health.
[130] Sandra Baltazar Martinez, "Come Say 'Barn Voyage' to Beloved Eatery Before Its Renovation," *UCR Today*, June 5, 2018, https://ucrtoday.ucr.edu/53805.
The Barn was closed after the 2018 school year and is scheduled to open after an 18-month renovation.
[131] The Culinary Institute of America and The Department of Nutrition, Harvard T.H. Chan School of Public Health, "Protein Flip Strategies for College and University Foodservice."

based ingredients, grain bowls and global cuisine often incorporate chicken, pork, beef or some meat-based protein, which UC Riverside offers some days of the week. UC Riverside's dining halls also feature a station called "Seeds of Change" (SOC), which serves a grain bowl or a plant-based option almost every day.[132] The SOC station features farro, brown rice, or quinoa as the base of each dish to provide plant-based proteins that are less GHG-intensive than meat.

UC Riverside has another station— "Worlds Fare Starboard"—in their "A-I Residential Restaurant" and a "Global Sizzle" station in their "Lothian Restaurant." Both stations offer global, plant-forward cuisine. The Worlds Fare serves a variety of cuisines ranging from Jasmine Rice with Filipino Pork Adobo to Udon Salad.[133] The Global Sizzle also serves global cuisine, with dishes ranging from Cheese Enchiladas with Refried Beans to Cajun Rice with Chicken Shrimp Gumbo.[134] Because many global cuisines involve meat-based protein, it makes sense for these two stations at UC Riverside to serve meat. But, these stations are selective in the meat they serve. Both stations predominantly serve lower-GHG meat, such as chicken, seafood, and pork, while beef and lamb are infrequently served.[135]

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[132] "Lothian Residential Restaurant Menu," February 8, 2019, http://138.23.12.141/foodpro/shortmenu.asp?sName=University+of+California%2C+Riverside+Dining+Services&locationNum=02&locationName=Lothian+Residential+Restaurant&naFlag=1&WeeksMenus=This+Week%27s+Menus&myaction=read&dtdate=2%2F8%2F2019. On Friday, February 8, 2019, for example, the SOC station at the "Lothian" featured a farro, wild mushroom & grilled asparagus salad with roasted acorn squash for lunch. For dinner, the SOC station served a brown rice, grilled sweet thai chili tofu, and patty pan squash dish.

[133] "A - I Residential Restaurant Menu," February 4, 2019, http://138.23.12.141/foodpro/shortmenu.asp?sName=University+of+California%2C+Riverside+Dining+Services&locationNum=03&locationName=A+%2D+I+Residential+Restaurant&naFlag=1&WeeksMenus=This+Week%27s+Menus&myaction=read&dtdate=2%2F4%2F2019.

[134] "Lothian Residential Restaurant Menu," February 8, 2019.

[135] According to two weeks of menu offerings at the "Worlds Fare Starboard" station in UC Riverside's A-I Residential Restaurant, beef was only offered once in a beef chili recipe and lamb was only offered once, in a shepherd's pie recipe. Chicken was offered ten times, pork was offered twice, turkey was offered once, but there was at least one vegetarian protein or side dish with every single meal (vegetarian proteins were offered 22 times). Over the course of two weeks, there were 22 meal periods, where the "Worlds Fare Starboard" was open. The station is open for lunch and dinner Monday through Friday and open only for dinner on Sunday. This equals 10 meals over the course of Monday through Friday and one meal on Sunday. Because I calculated two weeks, that equates to 22 meals in all.

An increasing amount of college students are interested in seeing more international food offerings on dining hall menus. According to a survey conducted by Y-Pulse, food service providers from colleges and universities across the country noted that students are demanding more "authentic and varied international offerings," such as Mediterranean and Asian, each of which lends itself well to grain bowls and generally more plant-forward and meat-accompanying cuisine.[136] Not only can serving international cuisine actively reduce meat consumption and increase plant-based foods consumption in dining halls, but global cuisine is also a compelling food category to students.

6.4 Boston College: Develop new Plant-Based Protein Menu Items

Boston College developed their own award-winning "Power Bowl" as a strategy to put more plant-based proteins at the center of the plate. [137] The Power Bowl has a base of red quinoa, sautéed kale, butternut squash, roasted beets, red peppers, edamame, red onions, scallions, and an acai berry Pomodoro sauce.[138] What started out as a recipe in BC's test kitchen is now served in one of their dining halls, and the student response has been positive.[139] BC Dining has found it effective to market the bowl weeks in advance, with signage in the dining hall as well as on social media to ensure students are aware the bowl is going to be served. And, because the bowl

[136] "Y-Pulse Survey: What Does Gen Z Want to Eat?" (Food Management, August 5, 2015), https://ypulse.org/clips/fm_july8_2015.pdf.
[137] The Power Bowl won NACUFS' Bronze Award Winner for Best Vegan Recipe in 2016. NACUFS stands for the National Association of College and University Food Services.
[138] Leora L'Heureux, BC Dining Services - The Power Bowl, Interview, 2016, https://vimeo.com/160823473. While this interview with Leora L'Heureux is not from a peer-reviewed journal, which is a limitation of this piece of evidence, it provides helpful insights into how a university dining program (1) thinks through developing a new plant-based protein item and (2) continues to improve the menu item using student feedback. The fact the interview points out that the Power Bowl is consumed by all eaters, not just vegans and vegetarians, provides even more evidence that menu items with plant-based protein continue to be attractive to meat-eating students.
[139] Leora L'Heureux.

is a recipe designed in the test-kitchen, students are encouraged to provide feedback on the bowl, so the chefs can make changes to improve the recipe in the future.

Through receiving feedback from students, BC has found that the Power Bowl appeals to all eaters, not just vegans.[140] Because BC has seen success with the Power Bowl and notices culinary trends moving towards plant-forward dining, they want to "keep up with the times" and serve innovative dishes with a variety of plant-based proteins, like quinoa, edamame, and kale.[141]

Chapter 7: Utilizing Strategic Language and Formatting on Dining Hall Menus and Dining Hall Food Stations to Increase Plant-Based Foods Consumption

7.1 Indulgent Descriptions of Plant-Based Foods on Dining Hall Menus

Attracting consumers to plant-based foods needs to start before consumers have even seen the food. When promoting plant-based foods, the first step is to use the right language and wording on menus. Universities display their dining hall menus on their website and in the physical dining hall, so students have a chance to see what is offered. The menu provides an opportunity to highlight plant-based options and boost consumption of plant-based foods. A simple strategy to increase plant-based foods consumption is to use indulgent descriptions for plant-based dishes. Describing plant-based dishes in a way that highlights great taste and indulgence is more effective to make consumers choose a particular dish than describing the dish in a "basic," "healthy restrictive," or "healthy positive" way.[142] Here are some example

[140] Leora L'Heureux.
[141] Leora L'Heureux.
[142] Bradley P. Turnwald, Danielle Z. Boles, and Alia J. Crum, "Association Between Indulgent Descriptions and Vegetable Consumption: Twisted Carrots and Dynamite Beets," *JAMA Internal Medicine* 177, no. 8 (August 1, 2017): 1217, https://doi.org/10.1001/jamainternmed.2017.1637.

descriptions of plant-based foods:

Indulgent	Basic	Healthy Restrictive	Healthy Positive
Dynamite chili and tangy lime-seasoned beets	Beets	Lighter-choice beets with no added sugar	High-antioxidant beets
Rich buttery roasted sweet corn	Corn	Reduced-sodium corn	Vitamin-rich corn
Sweet sizzlin' green beans and crispy shallots	Green beans	Light 'n' low-carb green beans and shallots	Healthy energy-boosting green beans and shallots

Figure 11. Example Descriptions of Plant-Based Dishes by Condition[143]

The study, which was conducted in a "large university cafeteria,"[144] shows that the descriptions of vegetable-based dishes has a statistically significant impact on the number of people who select each dish and on the mass of vegetables consumed. Labeling vegetables indulgently resulted in 25% more people selecting the vegetable than in the basic condition, 41% more people than in the healthy restrictive condition, and 35% more people than in the healthy positive condition.[145] Similarly, labeling vegetables indulgently resulted in a 23% increase in mass of vegetables consumed compared with the basic condition, a 33% increase in mass of vegetables consumed compared with the healthy restrictive condition, and a 16% increase in mass consumed compared with the healthy positive condition. This increase in vegetable consumption, without any changes to how the dish is prepared, demonstrates that using indulgent descriptions on menus is more effective to promote plant-based eating than highlighting a food's health properties. This simple intervention can be implemented on the menus at college and university dining halls to increase the consumption of healthier plant-based food options.

7.2 Dining Hall Menu Formatting[146]

[143] Turnwald, Boles, and Crum, 1217.
[144] The specific university where the study was conducted is not specified in the journal article.
[145] Turnwald, Boles, and Crum, 1217.
[146] Although the studies cited in section 6.2 were conducted using menus at restaurants, dining halls also display menus with the available food options, so this section assumes the same findings from restaurant menu studies can be applied to menus in the dining hall. This is not an outlandish assumption because restaurant and dining hall menus are similar and both inform a consumer's decision on what foods to choose.

An easy step to encourage consumption of plant-based foods is to create menus that have plant-based foods listed throughout the menu, instead of in a separate section just for vegetarian options. A study by Linda Bacon and Dario Krpan compared the percentage of those who ordered vegetarian dishes when provided with four different restaurant menu conditions.[147] The study found that putting vegetarian dishes in a separate vegetarian section of a menu can reduce consumer ordering by 56%.[148] When provided with the "vegetarian menu," which had a separate section for vegetarian dishes, only 6% of participants ordered a vegetarian option, compared to 13% of participants who chose a vegetarian dish when provided with the "control menu" that did not have a separate section for vegetarian options.[149] Additionally, the "vegetarian menu" decreased the likelihood that frequent vegetarian eaters chose a vegetarian dish.[150] Therefore, a menu with vegetarian options listed throughout, instead of in a separate section, can increase the likelihood that consumers choose vegetarian options. But, formatting a menu with a separate vegetarian or vegan section can have a negative impact on choosing plant-based food.

Another strategy to increase the likelihood of choosing plant-based foods is by implementing what Bacon and Krpan call the "recommendation menu." This menu presents a vegetarian dish as the chef's recommendation at the top of the menu in a large box.[151] When provided with the "recommendation menu," 15% of participants ordered a vegetarian dish, the highest proportion of participants who chose a vegetarian dish, compared to the other three menu

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[147] Linda Bacon and Dario Krpan, "(Not) Eating for the Environment: The Impact of Restaurant Menu Design on Vegetarian Food Choice," *Appetite* 125 (June 1, 2018): 190, https://doi.org/10.1016/j.appet.2018.02.006. The four different restaurant menu conditions were (1) control (all dishes presented in the same manner), (2) recommendation (vegetarian dish presented as chef's recommendation), (3) descriptive (more appealing description of vegetarian dish), and (4) vegetarian (vegetarian dishes placed in a separate section). All menus also labeled the vegetarian dishes with a (v).
[148] Bacon and Krpan, 196.
[149] Bacon and Krpan, 196.
[150] Bacon and Krpan, 197.
[151] Bacon and Krpan, 194.

options.[152] This concept of highlighting a plant-based dish as the chef's recommendation can be easily implemented on dining hall menus. However, few if any universities have actually implemented the "chef's recommendation" box or a menu that calls more attention to plant-based offerings.[153] Here are the "recommendation" and "control" menus:

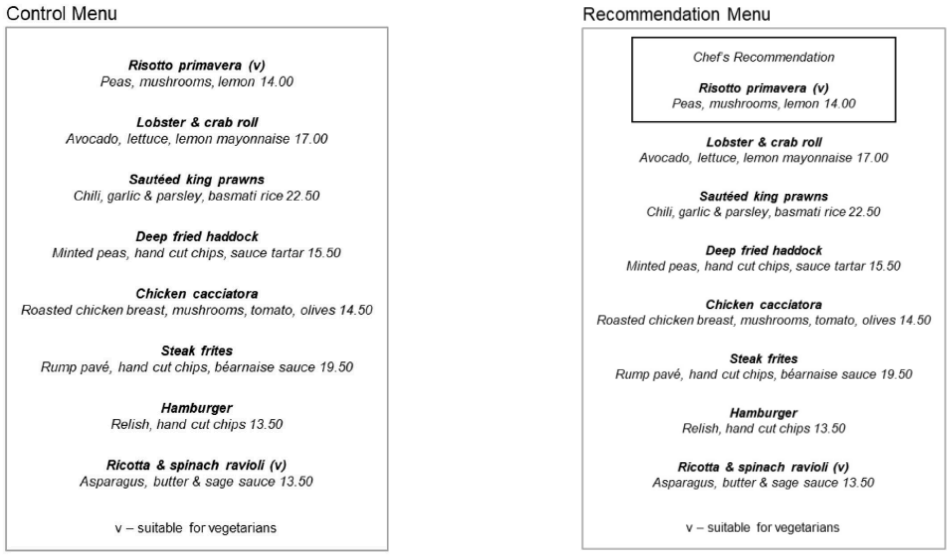

Figure 12. Control Menu and Recommendation Menus from Bacon and Krpan's Study[154]

7.3 Using Inclusive Naming of Food Stations in Dining Halls

Providing a menu that motivates consumers to choose plant-based food is a concept that can be applied to the naming of "food stations"[155] in dining halls.[156] In all-you-care-to-eat dining

[152] Bacon and Krpan, 194.
[153] After researching a large number of universities, I have not found a university dining hall that labels the "chef's recommendation" on the menu. While restaurant menus tend to call attention to certain items, dining hall menus are usually more straightforward and list the food options available at each station along with the food's nutritional information (e.g. calorie count) or allergen information (e.g. gluten free, vegetarian, vegan).
[154] Bacon and Krpan, 194.
[155] A "food station" is the place in a dining hall where the food is served. There are multiple food stations throughout a dining hall, which usually serve a specific type of food or cuisine. As displayed in the UC Riverside menu, some of their food stations are named "My Gourmet," "Seeds of Change," "The Grill," etc. In the Emory DUCling, the food stations are "Kettles," "Italian Bar," "Global Market," "Fireside Grill," "Family Meal," "Vegan," "Deli," "Avoiding Gluten," and "Kosher."
[156] This section makes the assumption that consumers will respond to the names of food stations in a dining hall similarly to the way consumers respond to labels on a menu. For example, just as consumers were deterred from ordering vegetarian food if there was a separate vegetarian section on the menu, consumers will be deterred from ordering from a station in the dining hall labeled "vegan" or "vegetarian."

facilities, some barriers to eating sustainable food, such as affordability, are not as relevant because the facilities do not charge per item. Barriers such as availability and support from others, on the other hand, still need to be addressed in university dining halls.

First, the names of "food stations" need to be inclusive, not exclusive. This means that a specific demographic of people or type of eater should not feel excluded from a certain station because they do not associate or identify with the name of the station. A simple example of an exclusive station is one named "Vegan" or "Vegetarian." Labeling a station as "Vegan" or "Vegetarian" will decrease the number of omnivorous consumers who choose that station for food. This can be due to the consumer not self-identifying as vegan or vegetarian or because the consumer has negative perceptions or stereotypes about the people who eat vegan or vegetarian food. For example, there still remain gender stereotypes about eating a vegetarian diet. Men following a vegetarian diet are "perceived as less masculine than omnivorous men," and there is a link between "men, meat, and masculinity."[157] This means that a station named "Vegetarian" will have trouble attracting men that do not already identify as vegetarian. The name "Vegetarian" also excludes omnivores and pescatarians, limiting the total addressable market of students interested in eating plant-based, but not interested in being labeled "Vegetarian"

7.4 Case Study: University of California Riverside's Food Station Names

The University of California Riverside utilizes dining hall menus with inclusive food station names (e.g. "My Gourmet," "Seeds of Change," "The Grill"). None of their stations are labeled "Vegan" or "Vegetarian," even though each station has plant-based options. This allows students interested in consuming less meat, but not interested in being "vegetarians," to feel

[157] Matthew B. Ruby and Steven J. Heine, "Meat, Morals, and Masculinity," *Appetite* 56, no. 2 (April 1, 2011): 450, https://doi.org/10.1016/j.appet.2011.01.018.

supported and feel comfortable choosing plant-based food at each station. Students can choose vegetarian food without worrying about the social pressures or stereotypes that are likely to come along with eating food from the "vegan" or "vegetarian" food station.

In addition to the inclusive station names, Riverside utilizes a color-coding system to highlight the healthier food offerings that follow the "Seeds of Change" (SOC) principles. This highlighting system calls attention to the Seeds of Change menu items. The SOC principles do not exclude meat-based foods, but a majority of the SOC foods on the menu are plant-based and not GHG-intensive (this further shows the link between healthy foods and foods that emit low amounts of GHGE). By color-coding and highlighting SOC menu items, such as brown rice, soy "beef" tips, and salmon charmoula, the menu calls the consumer's attention to these foods, without placing them under a "vegan" or "vegetarian" section of the menu.[158]

[158] There has not been any research conducted on the efficacy of this menu in increasing plant-based foods consumption and decreasing meat consumption. I am not making the claim that this menu has such an effect. What I am saying is this menu is an example of the way dining hall menus can highlight plant-based offerings and have inclusive section names, instead of exclusive section names, like "vegan."

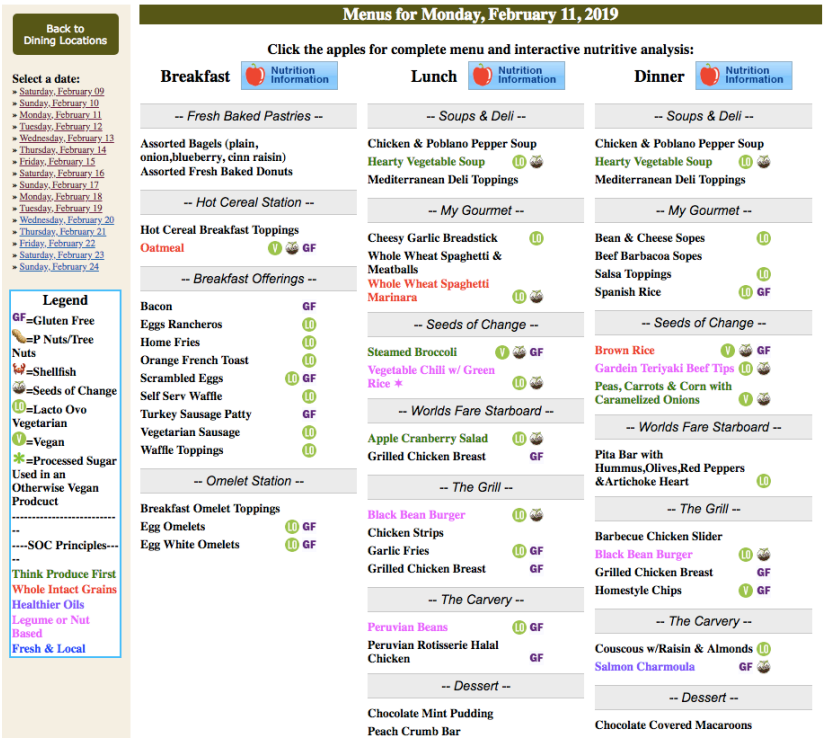

Figure 13. University of California Riverside's "A - I Residential Restaurant" Menu from Monday, February 11, 2019[159]

Chapter 8: Programmatic Recommendations for Emory Dining Facilities to Decrease Food-Related GHGE and Achieve the Cool Food Pledge

8.1 Pledging to Achieve the "Cool Food Pledge"

The first step for Emory to decrease its food-related GHGE is to purchase food based less on the "where"—food miles and local sourcing—and more on the "what"—plant-based food. Adopting a new food sustainability goal focusing solely on the purchasing of plant-based food may not seem plausible to Emory Dining, so I suggest that if Emory wants to truly serve "sustainable" food, it should set a greenhouse gas-based food target. I suggest Emory pledge to

[159] UC Riverside. "A - I Residential Restaurant Menu." http://dining.ucr.edu. http://138.23.12.141/foodpro/shortmenu.asp?sName=University+of+California%2C+Riverside+Dining+Services&locationNum=03&locationName=A+%2D+I+Residential+Restaurant&naFlag=1&WeeksMenus=This+Week%27s+Menus&myaction=read&dtdate=2%2F4%2F2019 (accessed February 11, 2019)

achieve the Cool Food Pledge,[160] which sets the target of a 25% reduction in food-related GHGE by 2030, relative to 2015, in order to attain a 67% GHGE reduction by 2050.[161] To achieve these GHGE reductions, Emory will need to shift its emphasis away from its 75% "local" or "sustainable" sourcing goal, which does not cause a decrease in food-related GHGE. Emory will, instead, need to shift towards decreasing the purchases of GHG-intensive meat and animal-based foods, while increasing the purchases of plant-based foods. The following sections outline the programmatic steps Emory's dining facilities can implement to achieve the Cool Food Pledge.[162]

8.2 Implementing Menu and Dining Hall Food Station Innovations

Emory can implement a small number of low cost programmatic innovations to achieve the Cool Food Pledge and substantially decrease its food-related GHGE. The first step is implementing the simple menu and dining hall innovations, as described in chapter 7:

1. Using indulgent language on dining hall menus to describe plant-based food
2. Not having a "vegan" or "vegetarian" section of the menu or a "vegan" or "vegetarian" food station in the dining hall
3. Incorporating a "recommendation" menu-style, where the chef can highlight his/her favorite plant-based dish of the day as the "Chef's Recommendation"

[160] "The Cool Food Pledge | World Resources Institute."
[161] The Cool Food Pledge only accounts for the food-related GHGE that are produced from sourcing the food served in dining facilities. This means institutions or companies can only achieve the 2030 Pledge by sourcing food that emits 25% fewer GHGs, relative to their food-related GHGE from 2015. The pledge does not account for emissions that result from food waste, cooking, or other types of emissions-producing activities that occur in a dining facility.
[162] The recommendations and GHGE modeling use the DUCling as a case study, mainly because my GHGE model only has food purchasing data from the DUCling and because the DUCling serves the largest quantity of food of any dining facility on Emory's campus. But, it is safe to assume the programmatic recommendations that can reduce food-related GHGE in the DUCling can be implemented at the other campus dining facilities to have a similar GHGE reduction.

8.3 Implementing the "Blended Burger"[163]

An innovative strategy to still provide meat-based food, but just in a reduced capacity, is by implementing the Menus of Change "Blended Burger." The Blended Burger concept, which Stanford, Harvard, and a number of other universities have successfully implemented in their dining halls, is a plausible way to substitute 25% to 50% of beef in hamburgers with mushrooms, without sacrificing taste or nutrition. In fact, a study by the Culinary Institute of America and UC Davis found that blending mushrooms with beef reduces sodium and calories, while providing a more "enhanced flavor" than traditional beef dishes.[164]

Transitioning to only serving Blended Burgers in the DUCling can help the DUCling reduce its food-related GHGE by 2030.[165] The DUCling orders beef patties every week, but if those patties were blended with 75% beef and 25% mushrooms, instead of 100% beef, that could decrease a substantial amount of GHGE.[166] Over the course of the one-week periods from September through February (6 weeks of data in total), the DUCling ordered 1,596lbs (723.93kg)

[163] The Blended Burger model calculates a reduction in GHGE based on the amount of beef patties the DUCling orders over the course of the 2018-2019 school year. The Blended Burger scenario focuses on the DUCling achieving the Cool Food Pledge because I only have ordering data from the DUCling, so I cannot say how many GHGE other Emory dining facilities will need to decrease to achieve the Cool Food Pledge. However, it can be assumed that the Blended Burger, if successful at reducing GHGE in the DUCling, would be effective at reducing GHGE in other Emory Dining facilities.

[164] A. Myrdal Miller et al., "Flavor-Enhancing Properties of Mushrooms in Meat-Based Dishes in Which Sodium Has Been Reduced and Meat Has Been Partially Substituted with Mushrooms," *Journal of Food Science* 79, no. 9 (2014): S10, https://doi.org/10.1111/1750-3841.12549.

[165] Bon Appétit at Emory has expressed that the DUCling cannot implement blended burgers because the DUCling serves such a high volume of students. Thus, it is only possible to order beef patties because assembling blended burgers in the DUCling kitchen is not plausible. While this is certainly an obstacle, Stanford University also does not have the capacity to assemble thousands of blended burgers in their dining hall kitchens, but they found a way to serve blended burgers. To serve the blended burgers, Stanford worked with its culinary team and its meat distributor to teach the distributor how to create a blended burger that could be shipped and then served in Stanford's dining halls. (The Culinary Institute of America and The Department of Nutrition, Harvard T.H. Chan School of Public Health, "Protein Flip Strategies for College and University Foodservice.) Emory can try to take these steps with its main beef distributor—White Oak Pastures—to serve blended burgers in the DUCling.

[166] A 25% mushroom and 75% beef blended burger is in line with the criteria of the James Beard Foundation's Blended Burger Project (https://www.jamesbeard.org/blendedburgerproject.).

of beef patties, which equates to a GHGE total of 23,778.32 $kgCO_2$-eq.[167] Because the 2018-2019 school year has 29 weeks of ordering, and the model has 6 weeks of GHGE data, I extrapolated the data over the 29 weeks, yielding 3,499.01kg of beef patties.[168] This amount of beef patties emits 114,928.53$kgCO_2$-eq.

With the implementation of a 75% beef 25% mushroom blended patty, the quantity of beef decreases by 25% and the quantity of mushrooms increases by 25%, so there is not a net loss in the weight of the burger.[169] Over the course of the 29 weeks of ordering in a school year, implementing the 75/25 Blended Burger in the DUCling would result in a net loss of 26,026.52 $kgCO_2$-eq.[170] For the DUCling to achieve the Cool Food Pledge by 2030, the DUCling would have to reduce emissions by 37,103.65 $kgCO_2$-eq each year.[171] By just incorporating the 75/25 Blended Burger instead of 100% beef burgers, the DUCling would already be well over halfway to its yearly Cool Food Pledge reduction total. Furthermore, if the DUCling chose to adopt a 50% beef 50% mushroom blend instead of the 75/25 blend, as Stanford did in 2016,[172] that would equate to a yearly decrease in the DUCling's food-related GHGE of 52,053.05 $kgCO_2$-

[167] See "Blended Burger" excel tab in the supplementary material.
[168] I multiplied the combined weight of beef patties from the six weeks of ordering times 4.833 (723.93kg*4.833) because 4.833 is 29 divided by 6. This yields a total weight of beef patties over the course of the 29 weeks of DUCling ordering.
[169] In this model, I assumed the weight of the blended burger did not decrease. 75% of the blended burger's weight was beef and 25% of the blended burger's weight was mushrooms.
[170] See "Blended Burger" excel tab in the supplementary material.
[171] See "Cool Food Pledge" excel tab in supplementary material. This model assumes the DUCling will start to implement my programmatic solutions and start to reduce its food-related GHGE in the 2020-2021 school year. To follow the yearly reduction from the Cool Food Pledge, the DUCling will have to reduce its food-related GHGE by 37,103.65 $kgCO_2$-eq by the end of the Spring 2021 semester. It does not seem reasonable to assume the DUCling will immediately start implementing my programmatic solutions in the 2019-2020 school year, so I wanted to give a full school year as a buffer.
[172] Arielle Rodriguez, "Stanford Shifts Menu to Primarily 50/50 Burgers," *The Stanford Daily* (blog), March 4, 2016, https://www.stanforddaily.com/2016/03/04/stanford-shifts-menu-to-primarily-5050-burgers/.

eq.[173] On its own, implementing the 50/50 blended burger would allow the DUCling to achieve the 25% GHGE reduction by 2028.

8.4 Developing More Plant-Protein Menu Items

If the DUCling implements the 75/25 Blended Burger, the DUCling will still need to decrease food-related emissions by over 10,000kgCO_2-eq each year to achieve the 2030 Cool Food Pledge. To achieve this reduction and to create a platform for future GHGE reductions, the DUCling has the opportunity to implement the third Menus of Change strategy: "Develop new items that are plant-protein based."[174] While the model by Westhoek et al. compensates for the decrease in beef and dairy by an increase in cereals, the DUCling's culinary team has the ability to serve a broader range of plant-based protein options, such as tofu, seitan, and legumes, in addition to plant-based meat and dairy alternatives, such as Beyond Meat and Silk Soy Milk.[175] Over the course of September 2018 through February 2019, 53.16% and 21.64% of the DUCling's food-related GHGE came from meat and animal-based foods, respectively. This means the DUCling has a large opportunity to develop new plant-protein dishes and reduce ordering of meat and animal-based foods to decrease the DUCling's total GHGE by 2030.[176]

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[173] See "Blended Burger" excel tab in supplementary material.

[174] The Culinary Institute of America and The Department of Nutrition, Harvard T.H. Chan School of Public Health, "Protein Flip Strategies for College and University Foodservice."

[175] Because the DUCling already serves the listed plant-based options, the chefs should not have to learn how to cook new ingredients or new cooking techniques to serve more plant-based food. If more cooking guidance is necessary to help the DUCling chefs create new menu items or find new recipes, there are great programs, such as the Humane Society of the United States' "Forward Food Program." This program provides free culinary and nutrition training on how to create and cook plant-based recipes. The training also provides university chefs with a recipe booklet of over 100 recipes as well as detailed instruction on how to create delicious, plant-based meals. Universities, such as Harvard, Tufts, Stanford, and UC Berkeley have already hosted a Forward Food culinary and nutrition training. ("Forward Food Program," ForwardFood, accessed March 14, 2019, https://forwardfood.org/events).

[176] See "Sept to Feb Pivot" excel tab in the supplementary material. The extrapolated model adds the months of March through the first half of May. To create a 25% GHGE reduction scenario, I will assume the ordering data from September through February is representative of the rest of the school year. This means that the total weight

Over the 6 one-week periods from September 2018 to February 2019, the largest components of Emory's greenhouse gas emissions were beef (28.46% of total GHGE), chicken (10.07%), cheese (9.91%), eggs (5.18%), lamb (4.85%), and pork (4.52%).[177] This large amount of emissions from meat and animal-based products is not because these types of food are ordered in higher quantities than plant-based foods. Over the same September to February period, plant-based foods make up 71.90% of total weight of the food ordered in the DUCling, meat makes up 13.48%, and animal-based foods make up 14.62%.[178] The fact that such a large weight of plant-based foods still produces so few GHGE supports the argument that the DUCling can achieve the 2030 Cool Food Pledge by decreasing the amount of meat ordered and increasing the amount of plant-based foods ordered.

Based on the extrapolated model, Emory can achieve the Cool Food Pledge by 2030 by enacting the following ordering changes, using the 2018-2019 school year as the reference year:

29 Week (full school-year) Weight and GHGE					
Food Type	Weight (kg)	% Change in Weight	Weight (kg) after Reduction/Increase	Weight Change (kg)	GHGE Change (Weight Change*GWP)
Beef	12834.09371	-10%	11550.68434	-1283.409371	-42154.86421
Chicken	35625.90073	-5.00%	33844.60569	-1781.295036	-7460.063612
Cheese	14449.81053	-5.00%	13727.32	-722.4905263	-7206.120509
Tofu	1628.520293	30.00%	2117.076381	488.556088	812.9573304
Black Beans	3244.69742	30.00%	4218.106646	973.409226	299.8100416
Chickpeas	8024.049025	30.00%	10431.26373	2407.214708	1181.942421
Quinoa	105.2334298	30.00%	136.8034588	31.57002895	10.95480005
Beyond Burger	526.1671492	30.00%	684.017294	157.8501448	556.7374606
Mushroom	3676.592955	30.00%	4779.570842	1102.977887	3890.203006
Soy Milk	3940.772711	30.00%	5123.004525	1182.231813	305.0158078
Total					**-49763.42747**

(kg) and the total GHGE (kgCO2-eq) from the 6 weeks of ordering data can be multiplied by 4.833, which is equal to 29/6, because there are 29 weeks of ordering data in the 2018-2019 Emory school year.

[177] See "Sept to Feb Pivot" excel tab in the supplementary material.

[178] See "Sept to Feb Pivot" excel tab in the supplementary material.

Figure 14. Weight and GHGE Yearly Reduction Scenario to Achieve Cool Food Pledge by 2030

As summarized by the table, a 10% decrease in beef and a 5% decrease in chicken and cheese each year, accompanied by a 30% increase in each of the listed plant-based foods will achieve a net loss of 49,763.43 $kgCO_2$-eq per year.[179] The Cool Food Pledge only requires the DUCling to decrease GHGE by 43,420.85 $kgCO_2$-eq per year over the next ten years, so this reduction scenario allows the DUCling to comfortably achieve the Cool Food Pledge by 2030.

Chapter 9: Limitations to My Strategies to Increase Consumption of Plant-Based Food and to Achieve the Cool Food Pledge

9.1 Applying the Rational Choice Model and The "Utilitarian Trade-off Condition" to "Sustainable Food"

Increasing the number of plant-based options in dining halls and properly marketing those options are great initiatives to try and increase the consumption of plant-based foods. But, there are still limitations to consumers' willingness to choose plant-based foods. Students have shown they mainly choose food according to taste preference,[180] which outlines an important

[179] The model calculates weight change using the 2018-2019 school year as the base year, but it is clear that because the quantities of beef, chicken, and cheese will decrease, while the quantities of the plant-based products will increase in this model, the percent change in weight will not remain constant year-after-year. This also means the GHGE increase or decrease from each food type will not remain the same year-after-year. I accounted for this limitation by creating a reduction scenario where the yearly decrease in GHGE is more than 6,000$kgCO_2$-eq more than the Cool Food Pledge mandates. This should provide enough margin for error as the weight of beef, chicken, and cheese decreases each year, and thus the %change will be calculated from a lower weight. This will cause the net decrease in GHGE from beef, chicken, and cheese to decrease each year, even though the %change of weight will stay the same. It will also allow the %change in plant-based food weight and the %change in GHGE to increase, which will offset some of the decreases in weight and GHGE from beef, chicken, and cheese. If this data table does not compensate enough plant-based protein for the decrease in meat and animal-based protein, I created another reduction scenario that can be found in the "Altered Reduction Scenario" excel tab in the supplementary material. This altered model has a reduction in GHGE closer to the yearly reduction target for the Cool Food Pledge, so it assumes a larger increase in the weight of the plant-based foods. The final disclaimer about this model is that I have not had the opportunity to trial the reduction scenario from the model in a dining hall, so it is challenging to say if it will work operationally the first time it is trialed. Likely after some refinement, this reduction scenario should be plausible and will help the DUCling achieve the Cool Food Pledge.

[180] Abraham, Noriega, and Shin, "College Students Eating Habits and Knowledge of Nutritional Requirements," 16.

theory of consumer behavior: the "rational choice model." The model contends that consumers make decisions "by calculating the individual costs and benefits of different courses of action and choosing the option that maximizes their expected net benefits."[181] This utilitarian concept shows that behavior is ultimately a medium to "pursue gains" and achieve goals.[182] Thus, consumers value the attributes of a product, the goals the product can potentially fulfill, and then choose to buy it if they believe the product will satisfy their goals.[183]

Applying this concept to purchasing sustainable food yields evidence for what is called the "attitude-behavior gap" or the "values-action gap." Iris Vermeir and Wim Verbeke's study on sustainable food purchasing finds that about 30% of UK consumers believe sustainable food products are "better with respect to taste, quality, safety, and freshness," while providing more benefits "with respect to human health, the environment, and regional economies."[184] Additionally, the study found that 30% of UK consumers are concerned about environmental issues and have "generally favorable attitudes" about organic food (between 46 and 67% of the population). But, only 4 to 10% of the same consumers actually purchased organic food in the same food categories.[185]

9.2 Motives and Deterrents to Buying "Organic" Sustainable Food

In order to decrease the substantial behavior-attitude gap with regard to sustainable food, it is necessary to identify the motives and deterrents of purchasing sustainable food. By

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[181] Tim Jackson and Guildford Surrey, "Motivating Sustainable Consumption," January 2005: vii.
[182] Michael Luchs and Minu Kumar, "'Yes, but This Other One Looks Better/Works Better': How Do Consumers Respond to Trade-Offs Between Sustainability and Other Valued Attributes?," *Journal of Business Ethics* 140, no. 3 (February 2017): 568, https://doi.org/10.1007/s10551-015-2695-0.
[183] Luchs and Kumar, 568.
[184] Vermeir and Verbeke, 173.
[185] William Young et al., "Sustainable Consumption: Green Consumer Behaviour When Purchasing Products," *Sustainable Development* 18, no. 1 (2010): 22, https://doi.org/10.1002/sd.394.

interviewing buyers and non-buyers of organic food, Hughner et al. finds 15 themes that either motivate or deter consumers from buying organic food:

Table 2. Themes identified among buyers and non-buyers of organic food

I. Consumers' purchasing motives	
Theme 1.	Health and nutritional concern
Theme 2.	Superior taste
Theme 3.	Concern for the environment
Theme 4.	Food safety, lack of confidence in the conventional food industry
Theme 5.	Concern over animal welfare
Theme 6.	Support of local economy
Theme 7.	More wholesome
Theme 8.	Nostalgia
Theme 9.	Fashionable/Curiosity
II. Deterrents	
Theme 10.	High price premiums
Theme 11.	Lack of organic food availability, poor merchandising
Theme 12.	Skepticism of certification boards and organic labels
Theme 13.	Insufficient marketing
Theme 14.	Satisfaction with current food source
Theme 15.	Sensory defects

Figure 15. Consumer Motives and Deterrents to Purchasing Organic Food among Buyers and Non-Buyers of Organic Food[186]

Although Hughner et al. finds motives and deterrents to purchasing "organic food," I will assume consumer motives and deterrents to buying organic food are similar to consumer motives and deterrents to buy plant-based food in the grocery store or choose plant-based food in an all-you-care-to-eat dining hall. [187] This assumption is made (1) because plant-based foods are another type of "sustainable food," just like organic food, and (2) because many of the people

[186] Renée Shaw Hughner et al., "Who Are Organic Food Consumers? A Compilation and Review of Why People Purchase Organic Food," *Journal of Consumer Behaviour* 6, no. 2–3 (2007): 101, https://doi.org/10.1002/cb.210. The themes are listed in terms of most mentioned to least mentioned in the interviews, meaning that "health and nutritional concern" was the number one most common motive for buying organic food and "high price premiums" was the number one most common deterrent for not buying organic food. The motives and deterrents cited by Hughner et al. confirm the findings of the research mentioned before, as conducted by Robinson, Smith 2002 and Vermeir, Verbeke 2006.

[187] One challenge with this assumption is that choosing organic food in a grocery store is likely an individual activity where consumers shop and then bring home their food. In contrast, students in a dining hall often eat with classmates and student food choice in a dining hall can be influenced by what they see other students eating, due to the social atmosphere of the dining hall. This more individual experience in the grocery store tends to have fewer social pressures and consumers do not have to worry about eating their food in the physical grocery store.

who consume organic foods are "likely to be interested in or are currently eating a 'plant-based diet.'"[188] While this is not a perfect assumption, many of the motives and deterrents of buying organic food are relevant for other types of sustainable food and can be informative for consumer behavior regarding a plant-based diet and general consumption of plant-based foods.

9.3 Consumer Behavior Regarding Plant-Based Diets and Consumption of Plant-Based Foods

To confirm the findings of Hughner et al., and to confidently make the assumption that consumer behavior regarding organic food is similar to behavior regarding plant-based foods, I found research on consumer perceptions of plant-based diets. Lea et al. provides a wider-scope analysis of plant-based consumption habits, while Wyker and Davison's survey of university students in the "northeastern United States" provides insights into consumer behavior patterns of university students.[189] Here is a summary of the findings from Wyker and Davison:

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[188] E. J. Lea, D. Crawford, and A. Worsley, "Public Views of the Benefits and Barriers to the Consumption of a Plant-Based Diet," *European Journal of Clinical Nutrition* 60, no. 7 (July 2006): 829, https://doi.org/10.1038/sj.ejcn.1602387.

[189] It is important to notice that both studies test consumer behavior regarding the adoption of "plant-based diets," not just the consumption of "plant-based foods." A plant-based diet is different from the consumption of plant-based foods. Lea et al. defines a "plant-based diet" as "an eating pattern dominated by fresh or minimally processed plant foods and decreased consumption of meat, eggs and dairy products. Compared to meat-centred diets, it involves increased consumption of a variety of grains (including whole grains), fruits, vegetables, legumes, nuts and seeds" (Lea, Crawford, and Worsley, 829). The second study by Wyker and Davison uses the same definition of plant-based diets from Lea et al. It is also important to realize that my paper does not argue for the full adoption of plant-based diets, like these two articles are testing. This thesis focuses on increasing the consumption of plant-based foods, however many of the themes from these studies are relevant to overall consumption of plant-based foods.

Table 2. Index of Salient Beliefs in University Students (n = 204)

Outcome Beliefs					
Advantages of following a plant-based diet in the coming year					
Male	n	%	Female	n	%
Improved health	39	34	Improved health	70	43
Weight loss	16	14	Weight loss	33	20
Reduced fat intake	15	13	Reduce harm to animals	10	6
Increased nutrient intake	10	9	Reduced fat intake	8	5
Increased energy	9	8	Other	42	26
Lower cholesterol	8	7			
Other	19	16			
Disadvantages of following a plant-based diet in the coming year					
Male	n	%	Female	n	%
Lack of protein	31	32	Lack of protein	38	32
Nutritiously deficient	16	16	Nutritiously deficient	28	24
Dislike the taste of food	15	15	Lack of options/variety	19	16
Muscle loss	11	11	Miss food eat now	17	14
Other	14	14	Iron deficient	6	5
			Other	11	9
Normative Beliefs					
Individuals/groups who would approve of following a plant-based diet	n	%	Individuals/groups who would disapprove of following a plant-based diet	n	%
Vegetarians	37	26	Family	25	34
Friends	29	21	Friends	18	25
Family	19	13	Parents	9	12
Animal rights groups	15	11	Father	5	7
Parents	11	8	Mother	4	5
Mother	9	6			
Other	11	8			
Control Beliefs					
Factors/circumstances that would enable you to follow a plant-based diet	n	%	Factors/circumstances that would make it difficult to follow a plant-based diet	n	%
Food available	28	29	Lack of availability	21	25
Affordable food items	16	16	Few affordable food items	20	24
Support from others	15	15	Temptation to eat non-plant-based food	12	14
News of disease/illness from animal-based food	8	8	Poor taste of food	6	7
Other	30	31	Holiday meals	5	6
			Other	18	23

Figure 16. Salient Beliefs in University Students about Following a Plant-Based Diet[190]

The findings from Wyker and Davison show that better health is the greatest advantage of adopting a plant-based diet for both males and females, who also find lack of protein and nutritional deficiencies to be major disadvantages.[191] A disadvantage only highlighted by females is that there are a lack of options/variety in a plant-based diet, which Hughner et al. also highlights as the second-most-common deterrent from buying organic food.[192] Also, when analyzing what factors influence participants to follow a plant-based diet, "availability" and "affordability" of food were the most common enablers to follow a plant-based diet. The lack of

[190] Brett A. Wyker and Kirsten K. Davison, "Behavioral Change Theories Can Inform the Prediction of Young Adults' Adoption of a Plant-Based Diet," *Journal of Nutrition Education and Behavior* 42, no. 3 (May 1, 2010): 173, https://doi.org/10.1016/j.jneb.2009.03.124.

[191] Brett A. Wyker and Kirsten K. Davison, "Behavioral Change Theories Can Inform the Prediction of Young Adults' Adoption of a Plant-Based Diet," 173. Better health as the number one advantage of a plant-based diet is aligned with the finding from Hughner et al. that cites "health and nutritional concern" as the number one motive for consuming organic food.

[192] Hughner et al., "Who Are Organic Food Consumers?," 101.

affordability and availability were also the two most common deterrents from following a plant-based diet.[193] An additional factor that influences whether college students follow a plant-based diet is "support from others."[194] Support from others is not only about the social or emotional support from friends, but it can also be support from the foodservice outlet offering the plant-based food as well as the company or farm where the food is sourced from.

Because the switch towards plant-based diets is a relatively new trend, there needs to be adequate support and information for students trying to eat more plant-based foods. This education should mainly highlight the "availability" and "affordability" of plant-based foods because those are the most common motives and deterrents from following a plant-based diet. One strategy to tackle the availability perception is having ongoing marketing campaigns that reinforce that plant-based foods are available in multiple campus dining facilities. To tackle affordability, there needs to be ongoing marketing of cheaper plant-based options, and there needs to be menu innovation to highlight the less expensive plant-based options. This support can take many forms and can appear in many places—on the tables with table tents, on the menu denoting a less GHG-intensive food, on flyers, at the food station, at educational workshops—but it should start with marketing and providing information about plant-based food.

[193] Wyker and Davison, "Behavioral Change Theories Can Inform the Prediction of Young Adults' Adoption of a Plant-Based Diet, 174."

[194] Wyker and Davison, 174. Although the study discusses what groups of people would approve or disprove of following a plant-based diet, an important component not measured in this study is the possible social perceptions and pressures on students who do follow a plant-based diet and understanding how following a plant-based diet can impact relationships or social behavior. These findings could help inform how to counteract social pressures of continuing to follow a plant-based diet during college.

Chapter 10: Utilizing Marketing as a Strategy to Increase Consumption of Plant-Based Foods

10.1 The Importance of Marketing Plant-Based Foods

Initiatives like Menus of Change show that college and universities are taking steps to add more plant-based menu options. These initiatives are mirroring the restaurant and grocery industry, which are also seeing an increase in the number of plant-based menu items. The Good Food Institute released a report which found that 55% of the 100 largest US restaurant chains offer at least one plant-based entrée, with many restaurants, such as Panera and Chipotle, offering more than one entrée.[195] And, there is clear evidence that plant-based food sales are growing in the retail industry, as shown by the fact that plant-based foods grew 8% in retail locations in 2017 and 20% in 2018, while sales of all food only grew 2% combined.[196] This increase in sales is not just due to an increased number of plant-based options in retail stores, such as grocery stores. Companies launching plant-based products utilize marketing and sampling as a way to drive consumer traffic to their products in the grocery store.

A similar marketing approach should be taken in university dining halls. First, there needs to be marketing of the current plant-based options already in the dining hall to diminish the perception that there is a lack of available plant-based foods. This can be accomplished by many of the strategies described in previous case studies, such as creating menus that highlight a plant-

[195] The Good Food Institute, "The 2018 Good Food Restaurant Scorecard" (Washington, DC: The Good Food Institute, January 30, 2019).
[196] Michael Robbins, "Plant-Based Food Sales Grow 20 Percent" (San Francisco, CA: Plant Based Foods Association, July 30, 2018). This data defines "plant-based food" as foods that replace meat and animal products, including meat, seafood, eggs, and dairy (e.g. meat and milk alternatives, tofu, egg substitutes), as well as meals that contain animal foods replacements. This category of "plant-based foods" does not contain produce or nuts.

based dish as the chef's recommendation[197] and by consistently posting on social media about students' favorite plant-based dishes, just as Boston College does for their "Power Bowl."[198]

Second, there needs to be marketing of new plant-based food products that are tested or are new additions to the dining hall menu. With a new product, there should be marketing support coming from the company providing the product and the management company choosing to serve the product (e.g. Bon Appétit, Sodexo). The two entities need to work together to create an effective marketing campaign.

10.2 Case Study: The Launch of The Beyond Burger at Yale University

On April 26, 2017, Yale University launched The Beyond Burger in all 13 of its on-campus dining locations. Yale Hospitality led a marketing campaign leading up to the burger launch, by posting about the Beyond Burger on its Instagram account. The two entities also worked together prior to the launch to create flyers with Beyond Meat and Yale Hospitality branding, so there would be one uniform message sent about the launch. On the day of the launch, Yale Hospitality made flyers and posted them around campus and in the dining hall. The flyer is below on the left:

[197] Bacon and Krpan, "(Not) Eating for the Environment," 194.
[198] Leora L'Heureux, BC Dining Services - The Power Bowl.

Figure 17. A flyer from The Beyond Burger Launch at Yale University (on the left) and an Instagram Post from Beyond Meat about the Beyond Burger Being Served at Yale

The flyer was just one of the ways Yale Hospitality supported the launch of The Beyond Burger. Yale Hospitality posted seven times on Instagram about The Beyond Burger, and Beyond Meat also posted on their Instagram (picture on the right), in addition to writing a press release.[199] Lastly, a Beyond Meat foodservice representative worked with Yale Dining chefs to sample the Beyond Burgers in "Commons" dining hall, which included a photo opportunity and raffle "to engage students as they tasted the burgers."[200]

Yale and Beyond Meat's partnership provides an example of how a university's management company/hospitality group can work with the company providing the plant-based product to launch an engaging marketing campaign. Their campaign was multi-faceted and

[199] Carly Rebecchi, "Yale to Become First University to Offer The Beyond Burger at Its On-Campus Dining Halls," *Business Wire*, April 26, 2017, https://www.businesswire.com/news/home/20170426006453/en/Yale-University-Offer-Burger-On-Campus-Dining-Halls.
[200] Daniella Cohen and Ryan Gittler, "Beyond Burger Launched at Dining Halls," *Yale Daily News*, April 28, 2017, sec. University, https://yaledailynews.com/blog/2017/04/28/beyond-burger-launched-at-dining-halls/.

included social media, physical signage on Yale's campus, an article in the school newspaper, burger samplings, and student engagement through pictures and raffles. This launch was covered in various news channels (e.g. VegNews, OneGreenPlanet), but did require time, effort, and resources from both Beyond Meat and Yale Hospitality.[201] There are other ways to effectively launch a plant-based product, such as leveraging the interest and support of food-based student groups, if the university itself does not have as many resources to promote the launch.

10.3 Case Study: The Opening of "Decadence" Gelato Restaurant at Stanford University

Tresidder Memorial Union, a food court at Stanford University, offers a variety of quick service restaurants from American staples like Starbucks to a fresh salad shop "Heirlooms" to a sweets shop called "Decadence."[202] Decadence serves sweet treats in addition to its flagship non-dairy gelato and fruit-based sorbets, supplied by Italian gelato company "Alberto Gelato."[203] To celebrate the opening of Decadence, Stanford Residential & Dining Enterprises worked with Alberto Giovanni, the founder of the company, to attend the grand opening. Bringing the founder to campus built excitement about the restaurant opening, but more than the excitement, Alberto gave away 2,000 gelato samples during the first week of Decadence's opening.[204]

Decadence has proven to be a "big hit," ever since Alberto passed out 2,000 gelato samples during Decadence's first week of operation.[205] Stanford's partnership with Alberto

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[201] There have not been any reports since the launch by Yale, Beyond Meat or news outlets about whether or not the Beyond Burger has effectively reduced meat consumption in campus dining facilities. One reason there has not been a publication about this is because universities do not openly share their dining records with the public. While it would be helpful to have a journal article on the efficacy of the Beyond Burger being served at Yale, there was not one available. Unless authorized by the food provider on campus, you have to sign a Non-Disclosure Agreement (as I did for Emory) to see ordering data, which prohibits journal articles to be written about dining hall ordering data.
[202] "Decadence | Stanford R&DE," accessed February 25, 2019, https://rde.stanford.edu/decadence.
[203] "Alberto Gelato - La Tua Gelateria Artigianale - Alberto Gelato | La Tua Gelateria Artigianale," accessed February 15, 2019, http://www.albertogelato.com/.
[204] Stanford Residential & Dining Enterprises, "Exciting Changes at Tresidder," 2017, https://rde.stanford.edu/hospitality/exciting-changes-tresidder.
[205] Stanford Residential & Dining Enterprises. "Exciting Changes at Tresidder," 2017.

Gelato created a marketing strategy focused on sampling the gelato and establishing a feeling of authenticity about the gelato brand. Seeing the creator of the gelato company allowed students to put "a face to the brand" and his active sampling introduced new students to his product in order to increase the likelihood they will purchase the gelato on the day of sampling and in the future.

10.4 Sampling as an Effective Marketing Strategy

Sampling is an effective way to introduce consumers to a new product, acquire new customers, receive customer feedback, and retain existing customers. A study conducted by Heilman et al. found that sampling food products noticeably affects the purchasing behavior of "samplers" (those who sampled the product), relative to the behavior of "non-samplers" (those who did not sample the product). In fact, 40% of samplers purchased the sampled food product, while only 7% of non-samplers purchased that same product.[206] Additionally, 60% of samplers purchased the sampled product, even when it was not their "preferred" brand, but only 29% of non-samplers purchased the sampled product when it was not their "preferred" brand.[207]

The two statistics most relevant to boosting the consumption of plant-based foods is the fact that 50% of samplers chose the sampled product even if they were not planning to (compared to 29% for non-samplers) and 54% of samplers purchased a product in the same category as the sampled product (compared to 14% for non-samplers).[208] These two statistics are particularly important. If applied to consuming plant-based foods, the data make the case that 50% of students who enter the dining hall not planning to eat a plant-based food can be convinced to eat a plant-based option through sampling. And, even if students sample the plant-

[206] Carrie Heilman, Kyryl Lakishyk, and Sonja Radas, "An Empirical Investigation of In-store Sampling Promotions," *British Food Journal*, April 11, 2013, 23, https://doi.org/10.1108/00070701111177674.
[207] Heilman, Lakishyk, and Radas, 23.
[208] Heilman, Lakishyk, and Radas, 23.

based food and do not enjoy the sample itself, they are 54% more likely to choose a plant-based option because it is the same category as the food they sampled.

While these are short-term purchasing statistics, sampling has been shown to increase the likelihood of future purchasing of sampled products. This showcases the impact that sampling can have on customer loyalty and retention. 58% of consumers who sample products plan to buy the products again, while 85% of customers who already know the product and try a sample in the store, plan to buy the sampled product again in the future.[209]

Free sampling of plant-based foods provides an effective way to introduce and retain students as consumers of plant-based foods. Sampling can be easily executed in university dining halls to not only support the launch of new plant-based products, but also to increase the likelihood that students choose plant-based foods during repeat visits to the dining hall.

Conclusion

With the world's population expected to reach 8.6 billion people by 2030, the food system, which is a major contributor to climate change, will be required to produce more food to feed a growing population. This expected increase in population is accompanied by increasing urbanization and income per capita around the world, both of which are correlated with an increasing consumption of meat-based protein. [210] These societal changes are expected to

[209] Munir Yousef Thakur, "Product Sampling Study" (Arbitron Media Research, November 13, 2016), 9, 10. The two studies of sampling efficacy, unfortunately do not track whether or not consumers who sampled the products actually buy the product in their next shopping trip. While this data would be helpful to analyze, I was unable to find data on sampling's true effect on purchasing sampled products in the future.

[210] P. Sans and P. Combris, "World Meat Consumption Patterns: An Overview of the Last Fifty Years (1961–2011)," *Meat Science*, 61st International Congress of Meat science and Technology (61st ICoMST), 23-28 August 2015, Clermont Ferrand, France, 109 (November 1, 2015): 109, https://doi.org/10.1016/j.meatsci.2015.05.012. Sans and Combris declare that economic development and urbanization have driven animal-based protein (ABP) consumption to increase worldwide over the last 50 years, rising from 61g per person per day in 1961 to 80g per person per day in 2011.

increase the environmental impact of the food system by 50–90%, reaching levels beyond the planetary boundaries that define a "safe operating space for humanity."[211] Similar to Hawken's *Drawdown,* Springmann et al. analyzes several options for keeping the food system within environmental limits and identifies two of the best options—enacting "dietary changes towards healthier, more plant-based diets" and management and reductions in food loss and waste.[212]

United States colleges and universities have the ability to play a pivotal role in enacting this dietary change towards more plant-based diets. This can help keep the food system within environmental limits and shape the diets of thousands of students who are making their own dietary choices independently for the first time. As evidenced by "Menus of Change" and the numerous institutions participating in their organization, many colleges and universities are starting to offer more plant-forward menus that embrace plant-based foods as the center of the plate and meat-based proteins as the condiment or off the plate altogether.

Some sources of GHGE on university campuses are more challenging to decrease, such as the amount of electricity a university has to use or the amount of energy a college has to purchase. Decreasing the amount of GHGE from food, specifically meat and animal-based foods, is one area where a university can implement programmatic and actionable steps to decrease their overall GHGE. Providing a more plant-forward menu, marketing plant-based offerings, and implementing simple changes to menu language and dining hall layout can have a large effect on university-wide emissions. As shown by the large amount of GHGs emitted by the DUCling, food is a substantial contributor to institution-wide GHGE. But, it is often overlooked as

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[211] Marco Springmann et al., "Options for Keeping the Food System within Environmental Limits," *Nature* 562, no. 7728 (October 10, 2018): 519, https://doi.org/10.1038/s41586-018-0594-0.

[212] Springmann et al, 519. The findings of Springmann et al. regarding plant-based diets supports the findings of *Drawdown*, which state that a plant-rich diet is the number four most important climate solution and reducing food waste is number three.

evidenced by the many universities that do not count food-related GHGE as part of their university-wide greenhouse gas inventory.

Universities, however, can easily alter their approach by first including food-related GHGE as part of university wide-GHGE. Second, institutions can set reduction targets to decrease food-related GHGE, just as they set quantitative reduction goals for university-wide GHGEs. A major obstacle to reducing food-related emissions at universities is that sourcing plant-based foods is often not the core principle in university-wide food sustainability goals. Most institutions and food providers have goals to source more "local" or more "humane" food, not more plant-based food. This is in spite of a growing body of research providing evidence that consuming more plant-based foods is one of the most effective avenues to help shift the food system away from emitting unsustainable amounts of greenhouse gasses. Sourcing more plant-based foods provides a viable, healthy, and sustainable alternative to sourcing meat and animal-based products. Thus, colleges and universities should seize this opportunity to transition the focus of food sustainability away from sourcing locally and more towards sourcing plant-based food. This type of approach will allow universities to decrease their food-related GHGE and ensure they are doing their part to keep the food system within environmental limits.

Epilogue

In addition to researching plant-forward dining concepts at other colleges and universities, I worked for almost a year and a half with Bon Appétit at Emory to try and introduce plant-based options in Emory's dining facilities. As the food provider of Emory University, Bon Appétit coordinates and orders all the food served in Emory's main dining hall, the DUCling, as well as in Emory's other dining facilities on campus. As part of my research, I worked with almost everyone on the staff of Bon Appétit at Emory, including the nutritionist,

residential manager, director of operations, numerous chefs, and bookkeepers. While many people on Emory's campus only hear about "Emory Dining," the Bon Appétit team is the one effectively operating dining facilities all across Emory, while ensuring that student voices are taken into consideration when thinking about menu options, dining hours, and much more.

While my research for this project was focused on identifying the most effective ways for colleges and universities to serve low-GHG food to decrease total GHGE, I also had the opportunity to work with Bon Appétit's nutritionists and chefs to test plant-based options in both Emory's main dining hall, the DUCling, and at one of the restaurants in Emory's food court, Cox Hall. This experience was akin to that of working as an "intrapreneur" trying to enact change within a large company. The process of introducing a new plant-based item received more resistance than I thought it would, given the pace at which restaurants and retailers are introducing plant-based foods on their menus and on their store shelves today. I soon realized that I needed to prove myself to Bon Appétit at Emory, just as food companies need to convince a grocery store that their product deserves to be sold on store shelves. I continued the conversation with Bon Appétit's nutritionist team, and at the end of almost a full semester working with Bon Appétit's nutritionists and chefs, we tested the plant-based Beyond Burger in the DUCling between April 9th and April 13th during the Spring 2018 semester. Over the course of the week, there was a substantial amount of Beyond Burgers consumed, which demonstrated that students are interested in consuming plant-based alternatives, even when there are meat-based options available. One of the limitations of the test was that it was only one week, so it was difficult to see whether continuing The Beyond Burger on the daily menu could decrease grilled meat consumption (e.g. grilled chicken, hamburger) in the DUCling over a longer period of time. Another limitation was there was no sampling or marketing allowed, with the exception

of allowing me to create a flyer for the test and to stand in the DUCling on the first day of the burger test to tell people about the Beyond Burger.

While not directly caused by the Beyond Burger test in the DUCling, but nevertheless a great step towards reducing food-related GHGE, in the Fall 2018 semester, Bon Appétit reduced the number of meat-based grill options from three to two in the DUCling. This meant that instead of serving grilled chicken, hot dogs, and hamburgers every day, only grilled chicken and hot dogs were served one day and grilled chicken and hamburgers would be served another day. The Beyond Burger was also featured as a vegetarian special at the grill section of the dining hall one to two times per week following the test.

With the clear interest in plant-based meat alternatives, Bon Appétit came to me with the idea to test the Beyond Burger at the "Char'd House Grill" station in Cox Hall food court at the end of the Fall 2018 semester. The Beyond Burger was tested for three weeks, and it was a relatively popular item, outselling the chickpea burger, which is a staple on the menu. The addition of the Beyond Burger correlated with a decrease in the number of "House Burgers" sold by over 4%, which seems to suggest that some of the consumers of the House Burger chose the Beyond Burger instead. Over the course of three weeks when the Beyond Burger was tested, there was a net reduction in 62.81 kg CO_2-eq, the equivalent amount of CO_2 emissions from driving a car 155.46 miles. This is not an insignificant amount of GHGE, considering all that was added to the menu was a plant-based burger.

Working within the large system of Emory University to move Emory's dining menus towards a more plant-forward approach was not always smooth or fast-paced. But, it taught me valuable lessons of patience, and with the help of my advisor Dr. Wes Longhofer, with whom I conducted an independent study during the Spring 2018 semester, I learned that I should not

expect to enact change within a large institution at the flip of a switch. Not always receiving a "yes" to my requests for more plant-based foods to be offered forced me to think why my ideas were not accepted. I realized it was not because Bon Appétit was stubborn; it was because I had not conducted the due diligence to propose the most compelling ideas for Bon Appétit to implement plant-based options. Realizing that my ideas were not as convincing as I thought they would be are what forced me to ground this thesis in scholarship and in best practices of plant-forward dining. These practices have worked effectively at other universities to not only decrease food-related GHGE, but also to provide students with healthier, plant-based options.

I have come to admire the universities mentioned in this thesis, who have implemented numerous plant-forward dining initiatives. Emory can become one of these universities. Allowing me to play a role in testing the plant-based Beyond Burger was a great start and offering plant-based options at every meal in the DUCling is a step in the right direction. But, Emory and many other institutions can and need to do more to promote a plant-forward dining approach, where plant-based foods are at the center of the plate and students are supported in consuming more plant-based foods. I hope this thesis helps Emory and other colleges and universities take steps towards decreasing food-related greenhouse gas emissions, not just to achieve a greenhouse gas reduction goal, but more importantly to play a larger role in ensuring the future sustainability of our food system.

Bibliography

"A - I Residential Restaurant Menu," February 4, 2019. http://138.23.12.141/foodpro/shortmenu.asp?sName=University+of+California%2C+Riverside+Dining+Services&locationNum=03&locationName=A+%2D+I+Residential+Restaurant&naFlag=1&WeeksMenus=This+Week%27s+Menus&myaction=read&dtdate=2%2F4%2F2019.

Abraham, Sam, Brooke R. Noriega, and Ju Young Shin. "College Students Eating Habits and Knowledge of Nutritional Requirements." *Journal of Nutrition and Human Health* 2, no. 1 (2018).

"Alberto Gelato - La Tua Gelateria Artigianale - Alberto Gelato | La Tua Gelateria Artigianale." Accessed February 15, 2019. http://www.albertogelato.com/.

Aramark. "Aramark Brings Gen Z Food Trends to Life with New Back-to-School Offerings on College Campuses Nationwide." August 9, 2018. https://www.aramark.com/about-us/news/aramark-general/back-to-school-2018.

Bacon, Linda, and Dario Krpan. "(Not) Eating for the Environment: The Impact of Restaurant Menu Design on Vegetarian Food Choice." *Appetite* 125 (June 1, 2018): 190–200. https://doi.org/10.1016/j.appet.2018.02.006.

"Blended Burger Project™ | James Beard Foundation." Accessed March 14, 2019. https://www.jamesbeard.org/blendedburgerproject.

Cohen, Daniella, and Ryan Gittler. "Beyond Burger Launched at Dining Halls." *Yale Daily News*. April 28, 2017, sec. University. https://yaledailynews.com/blog/2017/04/28/beyond-burger-launched-at-dining-halls/.

Company, Bon Appétit Management. "Kitchen Principles." Bon Appétit Management Co. Accessed December 9, 2018. http://www.bamco.com/cooking/kitchen-principles/.

Davis, Courtney, Janet Bryan, Jonathan Hodgson, and Karen Murphy. "Definition of the Mediterranean Diet; A Literature Review." *Nutrients* 7, no. 11 (November 2015): 9139–53. https://doi.org/10.3390/nu7115459.

"Decadence | Stanford R&DE." Accessed February 25, 2019. https://rde.stanford.edu/decadence.

Derbyshire, Emma J. "Flexitarian Diets and Health: A Review of the Evidence-Based Literature." *Frontiers in Nutrition* 3 (January 2017): 1–8. https://doi.org/10.3389/fnut.2016.00055.

"Emory | Diet & Nutrition." Accessed September 23, 2018. http://www.emory.edu/dining/Diet_nutrition%20-%20Well%20Being%20Indicator.php.

"Emory Farmers Market | Campus Dining." Accessed October 15, 2018. http://www.emory.edu/dining/emory_farmers_market.php.

Emory Sustainable Food Committee. "Sustainability Guidelines for Food Service Purchasing." Emory University, May 27, 2016.

EPA. "Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017." Environmental Protection Agency, April 12, 2019. https://www.epa.gov/sites/production/files/2019-02/documents/us-ghg-inventory-2019-main-text.pdf.

FAO. "Cattle Ranching and Deforestation." Policy Brief 03. Rome, Italy, 2006. http://www.fao.org/3/a-a0262e.pdf.

"FAQ." Springer Mountain Farms. Accessed March 18, 2019. https://www.springermountainfarms.com/faq.

Flessa, H, R Ruser, P Dörsch, T Kamp, M. A Jimenez, J. C Munch, and F Beese. "Integrated Evaluation of Greenhouse Gas Emissions (CO2, CH4, N2O) from Two Farming Systems

in Southern Germany." *Agriculture, Ecosystems & Environment* 91, no. 1 (September 1, 2002): 175–89. https://doi.org/10.1016/S0167-8809(01)00234-1.

"Food | Sustainability." Accessed March 2, 2019. https://sustainability.berkeley.edu/our-performance/food.

"Food & Dining – Emory Office of Sustainability Initiatives." Accessed September 21, 2018. https://sustainability.emory.edu/initiatives/food-dining/.

Forster, P., V. Ramaswamy, P. Artaxo, T. Berntsen, R. Betts, D. W. Fahey, J. Haywood, et al. "Changes in Atmospheric Constituents and in Radiative Forcing. Chapter 2." *Climate Change 2007. The Physical Science Basis*, 2007. http://inis.iaea.org/Search/search.aspx?orig_q=RN:39002468.

"Forward Food Program." forwardfood. Accessed March 14, 2019. https://forwardfood.org/events.

Gerber, Pierre J., Henning Steinfeld, Benjamin Henderson, Anne Mottet, Carolyn Opio, Jeroen Dijkman, Allessandra Falcucci, and Giuseppe Tempio. *Tackling Climate Change through Livestock: A Global Assessment of Emissions and Mitigation Opportunities.* Food and Agriculture Organization of the United Nations (FAO), 2013.

Hawken, Paul, ed. *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming*. New York, New York: Penguin Books, 2017.

Heilman, Carrie, Kyryl Lakishyk, and Sonja Radas. "An Empirical Investigation of In-store Sampling Promotions." *British Food Journal*, April 11, 2013, 1–27. https://doi.org/10.1108/00070701111177674.

Heller, Martin C, Amelia Willits-Smith, Robert Meyer, Gregory A Keoleian, and Donald Rose. "Greenhouse Gas Emissions and Energy Use Associated with Production of Individual Self-Selected US Diets." *Environmental Research Letters* 13, no. 4 (April 1, 2018): S1–41. https://doi.org/10.1088/1748-9326/aab0ac.

Henderson, Prepared Ashley, and Stefan Unnasch. "Life Cycle Assessment of Ripple Non-Dairy Milk," 2017, 24.

Hughner, Renée Shaw, Pierre McDonagh, Andrea Prothero, Clifford J. Shultz, and Julie Stanton. "Who Are Organic Food Consumers? A Compilation and Review of Why People Purchase Organic Food." *Journal of Consumer Behaviour* 6, no. 2–3 (2007): 94–110. https://doi.org/10.1002/cb.210.

Jackson, Tim, and GUILDFORD Surrey. "Motivating Sustainable Consumption," January 2005, 1–170.

Jason Mathers, Elena Craft, Marcelo Norsworthy, and Christina Wolfe. "The Green Freight Handbook: A Practical Guide for Developing a Sustainable Freight Transportation Strategy for Business." New York, NY: Environmental Defense Fund, 2014. http://business.edf.org/files/2014/07/EDF-Green-Freight-Handbook.pdf.

Jeff Jones, and Lydia Saad. "Americans Who Are Vegetarians or Vegans (Trends)." Washington, DC: Gallup, Inc., July 1, 2018. https://news.gallup.com/poll/238346/americans-vegetarians-vegans-trends.aspx?g_source=link_newsv9&g_campaign=item_238328&g_medium=copy.

Lea, E. J., D. Crawford, and A. Worsley. "Public Views of the Benefits and Barriers to the Consumption of a Plant-Based Diet." *European Journal of Clinical Nutrition* 60, no. 7 (July 2006): 828–37. https://doi.org/10.1038/sj.ejcn.1602387.

Leora L'Heureux. BC Dining Services - The Power Bowl. Interview, 2016. https://vimeo.com/160823473.

"Locally Crafted." Bon Appétit Management Co. Accessed October 16, 2018. http://www.bamco.com/timeline/locally-crafted/.

"Lothian Residential Restaurant Menu," February 8, 2019. http://138.23.12.141/foodpro/shortmenu.asp?sName=University+of+California%2C+Riverside+Dining+Services&locationNum=02&locationName=Lothian+Residential+Restaurant&naFlag=1&WeeksMenus=This+Week%27s+Menus&myaction=read&dtdate=2%2F8%2F2019.

Luchs, Michael, and Minu Kumar. "'Yes, but This Other One Looks Better/Works Better': How Do Consumers Respond to Trade-Offs Between Sustainability and Other Valued Attributes?" *Journal of Business Ethics* 140, no. 3 (February 2017): 567–84. https://doi.org/10.1007/s10551-015-2695-0.

"Members - Menus of Change University Research Collaborative." Accessed February 4, 2019. http://www.moccollaborative.org/members/.

"Menus of Change - The Culinary Institute of America." Accessed January 31, 2019. http://www.menusofchange.org/.

Micha, Renata, and Dariush Mozaffarian. "Saturated Fat and Cardiometabolic Risk Factors, Coronary Heart Disease, Stroke, and Diabetes: A Fresh Look at the Evidence." *Lipids* 45, no. 10 (October 2010): 893–905. https://doi.org/10.1007/s11745-010-3393-4.

Miller, A. Myrdal, K. Mills, T. Wong, G. Drescher, S. M. Lee, C. Sirimuangmoon, S. Schaefer, S. Langstaff, B. Minor, and J.-X. Guinard. "Flavor-Enhancing Properties of Mushrooms in Meat-Based Dishes in Which Sodium Has Been Reduced and Meat Has Been Partially Substituted with Mushrooms." *Journal of Food Science* 79, no. 9 (2014): S1–10. https://doi.org/10.1111/1750-3841.12549.

Munir Yousef Thakur. "Product Sampling Study." Arbitron Media Research, November 13, 2016. https://docuri.com/download/productsamplingstudy_59c1cab3f581710b28607af9_pdf.

Neff, Roni A., Danielle Edwards, Anne Palmer, Rebecca Ramsing, Allison Righter, and Julia Wolfson. "Reducing Meat Consumption in the USA: A Nationally Representative Survey of Attitudes and Behaviours." *Public Health Nutrition* 21, no. 10 (July 2018): 1835–44. https://doi.org/10.1017/S1368980017004190.

"Oxford Organic Farm | Oxford College | Emory University." Accessed October 15, 2018. http://oxford.emory.edu/offices-and-services/organic-farm.html.

Pan, An, Qi Sun, Adam M. Bernstein, Matthias B. Schulze, JoAnn E. Manson, Meir J. Stampfer, Walter C. Willett, and Frank B. Hu. "Red Meat Consumption and Mortality: Results from Two Prospective Cohort Studies." *Archives of Internal Medicine* 172, no. 7 (April 9, 2012): 555–63. https://doi.org/10.1001/archinternmed.2011.2287.

Peggy F. Barlett. "Emory's Sustainable Food Initiative." Emory University, February 2018.

Rebecchi, Carly. "Yale to Become First University to Offer The Beyond Burger at Its On-Campus Dining Halls." *Business Wire*. April 26, 2017. https://www.businesswire.com/news/home/20170426006453/en/Yale-University-Offer-Burger-On-Campus-Dining-Halls.

Robbins, Michael. "Plant-Based Food Sales Grow 20 Percent." San Francisco, CA: Plant Based Foods Association, July 30, 2018.

Rodriguez, Arielle. "Stanford Shifts Menu to Primarily 50/50 Burgers." *The Stanford Daily* (blog), March 4, 2016. https://www.stanforddaily.com/2016/03/04/stanford-shifts-menu-to-primarily-5050-burgers/.

Ruby, Matthew B., and Steven J. Heine. "Meat, Morals, and Masculinity." *Appetite* 56, no. 2 (April 1, 2011): 447–50. https://doi.org/10.1016/j.appet.2011.01.018.

Sandra Baltazar Martinez. "Come Say 'Barn Voyage' to Beloved Eatery Before Its Renovation." *UCR Today*, June 5, 2018. https://ucrtoday.ucr.edu/53805.

Sans, P., and P. Combris. "World Meat Consumption Patterns: An Overview of the Last Fifty Years (1961–2011)." *Meat Science*, 61st International Congress of Meat science and Technology (61st ICoMST), 23-28 August 2015, Clermont Ferrand, France, 109 (November 1, 2015): 106–11. https://doi.org/10.1016/j.meatsci.2015.05.012.

Sophie Egan, Greg Drescher, Arlin Wasserman, Walter Willett, Jim Norman, and Jason Wright. "Menus of Change 2018 Annual Report." The Culinary Institute of America, June 19, 2018.

"Sourcing Practices - Bon Appétit Management Company." Bon Appétit Management Co. Accessed February 26, 2019. http://www.bamco.com/sourcing/.

Springmann, Marco, Michael Clark, Daniel Mason-D'Croz, Keith Wiebe, Benjamin Leon Bodirsky, Luis Lassaletta, Wim de Vries, et al. "Options for Keeping the Food System within Environmental Limits." *Nature* 562, no. 7728 (October 10, 2018): 519–25. https://doi.org/10.1038/s41586-018-0594-0.

Stanford Residential & Dining Enterprises. "Exciting Changes at Tresidder," 2017. https://rde.stanford.edu/hospitality/exciting-changes-tresidder.

"The Beyond Burger®." *Beyond Meat - The Future of Protein™* (blog). Accessed March 16, 2019. https://www.beyondmeat.com/products/the-beyond-burger/.

"The Cool Food Pledge | World Resources Institute." Accessed March 12, 2019. https://www.wri.org/our-work/project/cool-food-pledge.

The Culinary Institute of America, and The Department of Nutrition, Harvard T.H. Chan School of Public Health. "Protein Flip Strategies for College and University Foodservice." n.d. https://www.moccollaborative.org/images/uploads/pdf/Protein_Flip_Strategies_for_College_and_University_Foodservice_high_res1.pdf.

The Good Food Institute. "The 2018 Good Food Restaurant Scorecard." Washington, DC: The Good Food Institute, January 30, 2019.

"The Protein Flip." 2016.

"The WaterHub at Emory University – Emory Office of Sustainability Initiatives." Accessed January 29, 2019. https://sustainability.emory.edu/programs/the-waterhub-at-emory-university/.

"The Weight of 1 Litre of Milk - Math Central." Accessed March 16, 2019. http://mathcentral.uregina.ca/QQ/database/QQ.09.07/h/imran1.html.

Tilman, David, and Michael Clark. "Global Diets Link Environmental Sustainability and Human Health." *Nature* 515, no. 7528 (2014): 518–22.

Turnwald, Bradley P., Danielle Z. Boles, and Alia J. Crum. "Association Between Indulgent Descriptions and Vegetable Consumption: Twisted Carrots and Dynamite Beets." *JAMA Internal Medicine* 177, no. 8 (August 1, 2017): 1216–18. https://doi.org/10.1001/jamainternmed.2017.1637.

"UMass: Local Food." UMass: Local Food. Accessed March 2, 2019. https://www.LocalUMass.com/.

US Department of Commerce, National Oceanic and Atmospheric Administration. "What Is Ocean Acidification?" Accessed March 17, 2019. https://oceanservice.noaa.gov/facts/acidification.html.

USDA Agricultural Research Service. "USDA Food Composition Databases." Database. United States Department of Agriculture. Accessed March 16, 2019. https://ndb.nal.usda.gov/ndb/.

Vermeir, Iris, and Wim Verbeke. "Sustainable Food Consumption: Exploring the Consumer 'Attitude – Behavioral Intention' Gap." *Journal of Agricultural and Environmental Ethics* 19, no. 2 (April 1, 2006): 169–94. https://doi.org/10.1007/s10806-005-5485-3.

Vries, M. de, and I. J. M. de Boer. "Comparing Environmental Impacts for Livestock Products: A Review of Life Cycle Assessments." *Livestock Science* 128, no. 1 (March 1, 2010): 1–11. https://doi.org/10.1016/j.livsci.2009.11.007.

Weber, Christopher L., and H. Scott Matthews. "Food-Miles and the Relative Climate Impacts of Food Choices in the United States." *Environmental Science & Technology* 42, no. 10 (May 15, 2008): 3508–13. https://doi.org/10.1021/es702969f.

Westhoek, Henk, Jan Peter Lesschen, Trudy Rood, Susanne Wagner, Alessandra De Marco, Donal Murphy-Bokern, Adrian Leip, Hans van Grinsven, Mark A. Sutton, and Oene Oenema. "Food Choices, Health and Environment: Effects of Cutting Europe's Meat and Dairy Intake." *Global Environmental Change* 26 (May 1, 2014): 196–205. https://doi.org/10.1016/j.gloenvcha.2014.02.004.

Williams, A., E. Audsley, and D. Sandars. "Determining the Environmental Burdens and Resource Use in the Production of Agricultural and Horticultural Commodities: Defra Project Report IS0205." *Zu Finden in: Http://Randd. Defra. Gov. Uk/Default. Aspx*, 2006.

Wyker, Brett A., and Kirsten K. Davison. "Behavioral Change Theories Can Inform the Prediction of Young Adults' Adoption of a Plant-Based Diet." *Journal of Nutrition Education and Behavior* 42, no. 3 (May 1, 2010): 168–77. https://doi.org/10.1016/j.jneb.2009.03.124.

Young, William, Kumju Hwang, Seonaidh McDonald, and Caroline J. Oates. "Sustainable Consumption: Green Consumer Behaviour When Purchasing Products." *Sustainable Development* 18, no. 1 (2010): 20–31. https://doi.org/10.1002/sd.394.

"Y-Pulse Survey: What Does Gen Z Want to Eat?" Food Management, August 5, 2015. https://ypulse.org/clips/fm_july8_2015.pdf.