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Breaking Down Barriers to Sustainable Eating at the University of Dayton

Honors Thesis

Lauren Murray

Department: Health and Sport Science

Advisor: Diana Cuy Castellanos, Ph.D., R.D.

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Abstract

Sustainability is at the forefront in many conversations and innovations at the University of Dayton (UD), ranging from the Hanley Sustainability Institute to the Sustainability club. However, sustainability extends beyond water and energy conservation. In addition to these, students and faculty at UD can impact their carbon footprint through sustainable eating. The purpose of this research was to define sustainable eating, determine the carbon footprint of foods served in the UD dining halls, and develop and evaluate an educational intervention aimed at UD students within the Virginia West Kettering dining hall. The results of this research were considered in the creation of a fully plant-based dining station with a permanent education program.

Dedication

To Dr. Diana Cuy Castellanos, Professor Dalton, Professor Gonter-Dray, and all of the incredible people in the Health and Sport Science Department that have helped to shape me academically and personally.

Table of Contents

Introduction

Due to the urgency of climate change, now is an imperative time to assess the carbon footprint of food. The carbon footprint measures environmental impact through greenhouse gas emissions - greenhouse gases (GHGs) include carbon dioxide, methane, nitrous oxide, water vapor, and others. Further, it is well known that food production and distribution contribute to GHGs.

The Western diet is defined as a diet high in domestic meats, refined sugars, cereals, oils, and nonhuman milk (Carraro-Bastos et al. 2011). Research suggests the Western diet results in 20-30% of all GHGs in the US (Beverland, 2014). Further, 37% of methane and 65% of nitrous oxide emissions are due to animal agriculture (Conrad, 2012). Methane and nitrous oxide are particularly potent gases because of their ability to absorb energy. The Global Warming Potential and the lifetime of these gases are two key factors in their environmental impact. The GWP of methane is 28-36 times that of CO2 and nitrous oxide is 265-298 times that of CO2. Carbon dioxide stays in the atmosphere for thousands of years, while methane lasts approximately 10 years and nitrous oxide over 100 years (US EPA, 2017). Research indicates the reduction of methane and nitrous oxide emissions will affect the temperature of the atmosphere faster due to their shorter lifetimes (Conrad, 2012).

Although meat is one of the main pressures on the environment, the human demand for meat is constantly increasing (Ritchie and Roser, 2017). Reasons for this increase include the subsidization of animal products in developed countries, cultural influences, and institutional factors (Conrad, 2012 and Beverland, 2014). Therefore, it is important to develop interventions that encourage sustainable eating to decrease GHGs while still promoting the consumption of a balanced and nutrient dense diet.

Encouraging reduced meat and dairy intake and increased fruit, vegetable, and grain intake could reduce the environmental impact of food production, which calls for a change in consumer behavior. Therefore, this research examines the impact of an educational intervention on consumer behavior around sustainable food choices.

Theory

This research is based on the Knowledge, Attitudes, and Behavior Model, which describes a relationship existing among the three. The cognitive aspect of this model

includes all knowledge and understanding that a person accrues about a particular subject. The affective aspect of this model includes all attitudes and feelings that a person has against or for a particular subject. The behavioral aspect includes observable actions taken for or against a subject. These aspects are measured as a part of evaluating the impact of the intervention.

Methodology

Purpose and objectives

This study developed, implemented, and evaluated the effectiveness of a sustainable eating education intervention directed at sophomores that live in Virginia West Kettering (VWK) residence hall. This study aimed to 1) measure sustainable eating practices of second-year consumers in the VWK dining hall, 2) determine behavior, knowledge, and attitudes post-intervention implementation, and 3) evaluate intervention by comparing behaviors, knowledge, and attitudes post-intervention to the behaviors, knowledge, and attitudes pre-intervention.

Study design and ethical review

An experimental design was utilized to examine the effects of a sustainable education intervention on second-year students that live and eat in VWK. This study was reviewed by the University of Dayton Institutional Review Board.

Participants

Participants were recruited from the VWK residence hall from January 2018 - May 2018. The participants included students that responded to an online questionnaire administered through Orgsync, an online campus engagement network that connects students to school organizations. Eligible participants include undergraduate, second-year students that live in the Virginia West Kettering residence hall, are attending the University of Dayton, visit the VWK dining hall for food at least once a week, and have an Orgsync account through the school. Students that are not eligible include graduate students, undergraduate students that are not second-year students, students that live in other areas of residence, students that do not attend UD, students that do not visit VWK dining hall at least once a week for food, and students that do not have access to an Orgsync account. The questionnaire carried a personal incentive for students to participate in the study. Incentives included a free fruit or a free cookie voucher, which could be claimed in one of the UD dining halls before May 2018. These incentives were approved by the University of Dayton Dining Services.

Participants for face-to-face interviews were recruited by locating second-year students eating in the VWK dining hall. The researcher asked for participants' consent for a short interview if the student was eligible for participation.

Protocol

Prior to the implementation of the intervention, the carbon footprint of the foods served in the VWK dining hall had to be determined. UD foodservice providers supplied sales reports for a 6 month period. The reports included the name of the product purchased, product region, and distance traveled.

The Food Carbon Emissions Calculator by Clean Metrics was utilized to determine the greenhouse gas emissions from each product. The Food Carbon Emissions Calculator is a web-based LCA software tool for the modeling and analysis of life cycle greenhouse gas (GHG) emissions, energy use, and water use in food and beverage products. The GHGs examined within the Calculator include nitrous oxide, methane, and carbon dioxide, which are reported in terms of CO^2 equivalents. The production and transportation GHG emissions were calculated by inputting the product and distance traveled into the Food Carbon Emissions Calculator. This estimated the kilograms of CO2e emissions per pound of product, which was later converted into pounds of CO2e emissions per pound of product. Once the carbon footprint of each individual product was assessed, the weighted average emissions were calculated for the products. For example, all chicken products were averaged to estimate the average emissions of chicken served at VWK. These calculations were entered into an excel spreadsheet, and products were compared in regard to their emissions.

After calculating the average product emissions, the average emissions of meals commonly sold in VWK were calculated. UD dining services supplied the standardized recipes for meals served at VWK. The average product emissions and the weight of products within meals were combined to calculate the average pounds of CO_2e emissions per pound of meal. The meal emission calculations were also put into an excel spreadsheet and compared by their emissions. The educational intervention was based on these findings.

The educational program has two parts: 1) a food carbon footprint ranking system and 2) general sustainable eating education. Each station within VWK received a carbon footprint scale that ranked the foods being served that day. The goal of the ranking system was to help customers visually conceptualize the carbon footprint of their food options. The ranking scales were color-coded to aid customers in assessing the carbon footprints: the top 25% of emitters are colored red, the second 25% colored yellow, and the bottom 50% colored green. Dining stations that allow customers to build their own meal received ingredient ranking scales whereas dining stations that serve meals based on recipes received meal ranking scales (See Appendix 1).

The second part of the educational program is general sustainability knowledge and attitude change. Table tents were developed to address specific barriers to sustainable eating that were identified in preliminary research. The table tents were placed on each table in the VWK dining hall to allow students to read the information while eating. The barriers that were addressed include: lack of pre sustainability literacy, lack of knowledge about sustainable eating, lack of knowledge about the impact of sustainable eating, the concept that diet is a private matter and any criticism of food choice is a restriction of liberty, and the inconvenience of lifestyle changes. To address attitudes, posters included reasons why sustainability mattered and an excerpt from *Laudato Si* to touch on the Marianist values of the University of Dayton (See Appendix 2).

In January of the 2018 academic school year, the Director of VWK, administered the questionnaire by sending out an email to VWK residents via the Orgsync portal that included an attachment to the online questionnaire. The questionnaire was created through Google forms, which allowed for viewing of results in an organized format. It measured behavior, attitudes, and knowledge of students at baseline. The education intervention was implemented in VWK dining hall in the form of posters and ranking scales. The posters addressed pre-determined barriers to sustainable eating while the ranking scales rank foods according to greenhouse gas emissions that were determined prior to the intervention. The questionnaire was administered again post-intervention to re-assess behavior, attitudes, and knowledge of participants after being exposed to the educational intervention.

In May 2018, face-to-face interviews were conducted post-intervention to assess behaviors, attitudes, and knowledge of participants and to gather critiques of the intervention (See Appendix 3). The interviews were conducted with open-ended semi-structured questions to allow participants to freely express opinions. All interviews were recorded and later transcribed verbatim for thematic analysis.

In addition, a meal comparison was completed, which compared the potential carbon emissions of an omnivore diet, a lacto-ovo-vegetarian diet, and a plant-based diet. The hypothetical meals were created by using foods served at the University of Dayton, and NDSR software was used to ensure that meals were all nutritionally adequate and similar in calories.

Instruments and Measurements

Behavior

To measure the behavior of participants, the questionnaire contained a food screening that assesses the frequency of the consumption of particular foods. Food choices were foods that are accessible in the VWK dining hall. Each question contained "During the past month, how often did you eat [insert food]?" Options for answers include: Never, 1 time last month, 2--3 times last month, 1 time per week, 2 times per week, 3--4 times per week, 5--6 times per week, 1 time per day, and 2 or more times per day. The food screening was consistent with the self-administered dietary screening developed by the National Institute of Health to assess food intake. (National Health and Nutrition Examination Survey, 2009)

Behavior was measured again by evaluated sales trends over the course of the intervention implementation. Food choices are categorized as either "green" or "red" foods to assess which foods consumers prefer to purchase.

Attitudes

Attitudes were measured through a Likert scale that rated the importance that participants place on different aspects of sustainability. Each asked participants to "Please indicate the degree of importance you place on the following." Questions were followed by 5 possible answers: not at all important, not too important, neutral, somewhat important, and very important. This is consistent with other campus surveys that assess the attitudes of

students (University of Michigan, 2015 and University of Arizona, 2015). Results were then be tested for significance against a p-value of 0.05 through t-tests.

Knowledge

Knowledge of participants was measured by asking participants to rank foods according to greenhouse gas emissions. These asked participants to "Please put the following list in order of the food with the most greenhouse gas emissions to those with the least greenhouse gas emissions:" Answers allow participants to rank three foods as 1, 2, or 3. Additional multiple choice questions were administered that address other topics included in the general sustainability education. Results were tested for significance against a p-value of 0.05 through t-tests.

Results

Food Carbon Emissions

Over the course of six months, the products in Marycrest and VWK produced over 2,517,277lbs of CO2e emissions, and the top ten products bought by Marycrest and VWK constitute 92.97% of these GHG emissions.

After comparing products, it was discovered that lamb contributed the most GHGs per pound of product whereas mushrooms contributed the least. Generally, meat products like pork, salami, bacon, and seafood had the highest average emissions per pound of product. On the other hand, vegetables and fruits had significantly lower average emissions (See Appendix 4). After comparing meals, it was found that the Hot Dogs contributed the most GHGs per pound of meal whereas the Cream of Asparagus Soup contributed the least.

Intervention

45 participants responded to the baseline questionnaire, 4 of which were excluded due to the inability to meet inclusion criteria (n=41). On average, participants chose to eat animal products 2.4451 times per day, and they chose to eat fruits, vegetables, and grains 3.5016 times per day. Participants had an average attitude score of 20.146 out of a possible 24 points, and they had an average knowledge score of 3.976 out of a possible 5 points. There was a significant positive correlation between sustainable eating knowledge score and fruit, vegetable, and grain intake (p-value = 0.16). Also, there was a significant negative correlation between the number of animal products and total attitude score (p-value = 0.046).

18 participants responded to the post-intervention questionnaire, 1 of which was excluded due to the inability to meet inclusion criteria (n=17). Of these 17 participants, 7 had also responded to the baseline questionnaire. On average, participants chose to eat animal products 1.738 times per day, and they chose to eat fruits, vegetables, and grains 3.4189 times per day. Participants had an average attitude score of 18.8824 out of a possible 24 points, and they had an average knowledge score of 3.8236 out of a possible 5 points. There were no significant differences between the two samples in behavior, attitude, or knowledge.

Face-to-face Interviews

Eight face-to-face semi-structured interviews were conducted with students before data saturation was reached. A thematic analysis of the transcribed interviews illuminated multiple themes including increased knowledge, increased awareness, but little behavior impact. Students explained that although they were more aware of sustainable eating and the differences between the emissions of food groups, the intervention did not make an impact on their behavior. When students were asked about barriers to sustainable eating, students pointed to inadequate or inaccessible information and lack of convenience. Students explained that the ranking scales were sometimes removed and not replaced, which made it difficult to choose foods based on emissions. In addition, students commented on not having ranking scales in other dining halls, which didn't allow for the translation of behavior change in other dining halls. Lastly, students complained about the lack of sustainable options, which limited their ability to eat sustainable foods. These results called for a permanent, visible education program in the dining halls and environmental change to make sustainable eating more convenient.

Meal comparison

The plant-based diet emitted 4.6lbs of CO2e/day, the lacto-ovo-vegetarian diet emitted 8.2lbs of CO2e/day, and the omnivore diet emitted 11.9lbs of CO2e/day. Overall, the lacto-ovo-vegetarian diet could save about 1,350.5lbs of CO2e per year, and the plant-based diet could save about 2,664.5lbs of CO2e per year compared to the omnivore diet, which is equivalent to 3,000 miles of tailpipe emissions.

Discussion

The carbon emission calculations illustrated the significant difference between animal products and plant-based products. Although other factors should be considered when discussing the sustainability of food, such as economic sustainability and health, the greenhouse gas emissions of livestock make a significant impact. The meal comparison data indicates the impact of saving almost 2,700lbs of CO2e of emissions per year by eating a plant-based diet and almost 1,400lbs of CO2e of emissions per year by eating a lacto-ovo-vegetarian diet. However, educating students about the significance of sustainable eating did not make a significant impact on food choices. Students indicated that the lack of behavior change was due to the inconvenience of choosing sustainable options and the inconsistent visibility of the educational program.

The Green Life Development

The evaluation of the intervention suggested that other change needed to occur, including an environmental change that increased the convenience of sustainable food options and a permanent educational program. The Green Life is a completely plant-based dining station that was opened in VWK in Fall 2018. The Green Life menu includes 6 permanent menu items and one menu item that changes daily on a 5 week cycle. The rotating menu imitates the animal-based menu item served at another dining station in VWK. For example, the Green Life serves eggplant parmesan to imitate chicken parmesan or cauliflower wings to imitate chicken wings. In addition to the Green Life, a permanent education program was developed based off of this research. The education focuses on the sustainability of plant-based foods and the health benefits of including plant-based foods in one's diet. Subjects include deforestation, human slave labor in agriculture, fruit and vegetable recommendations, and more. There are 8 large posters that rotate weekly in front of the Green Life (See Appendix 5). The VWK managers anticipated serving 20-25 meals per day from the Green Life, but they have been serving approximately 100 meals per day since opening.

Conclusion

Overall, the findings of the carbon emissions were consistent with other preexisting research that plant-based foods have been found to be more sustainable foods by primary studies using Life Cycle Analysis tools (Conrad, 2012). In addition, the correlations between food choices and attitudes and knowledge about sustainable eating are consistent with other research that found a correlation between an increase in sustainable eating knowledge and an increase in sustainable eating (Wikoff, Rainbolt, and Wakeland, 2012). However, the intervention had an insignificant impact on the behavior of student consumers, which indicated further barriers to explore. These barriers were identified in the face-to-face interviews and addressed with the creation of the Green Life dining station. The success of the Green Life indicates that environmental change is necessary for student behavior change around sustainable eating. Convenience may play a large role in how students choose food, and increasing knowledge and positive attitudes towards sustainable eating is not sufficient for behavior change.

The results of this study can contribute to the development of sustainability initiatives within dining services at other Universities. Factors that should be taken into consideration when attempting to make sustainable decisions for university dining halls include the convenience of sustainable options for consumers, consumer knowledge about sustainable eating, and consumer attitudes. These factors may also be weighed when making decisions in other food industry sects, such as restaurants, grocery stores, and the production of food. Lastly, sustainable food choices coincide with the Academy of Nutrition and Dietetics recommendation that Americans eat less red meat and increase fruit and vegetable intake. Sustainability may be a motivation for someone to improve the content of their diet.

Limitations

There are multiple limitations of this study. Because this study focuses on sophomore students living within a residence hall that provides a dining hall, these results may not generalize onto students that have kitchens and do their own grocery shopping. In addition, the educational intervention ranking scales cannot address the emissions of overly-processed foods due to their exclusion from the food carbon calculations.

Therefore, the intervention will only be able to target students that tend to eat foods prepared by the VWK dining hall employees. This would exclude those students that tend to eat only processed foods, which often have higher emissions than unprocessed foods. Lastly, the low response rate to the post-intervention questionnaire caused a small sample size. Because of this, the evaluation of change in behavior, attitude, and knowledge may have been skewed.

Further research

Further research should be conducted to determine the role of educational interventions in impacting student food choices. In addition, further research should examine the impact of multiple student populations including students that eat at dining halls, students that buy food at grocery stores, and students that commute. Education aimed at students using grocery stores and students commuting from home may look different from the education provided to students that eat at school dining halls. Multifactorial approaches to behavior change, such as an educational program along with environmental change, should be studied. Research should also examine the lasting impact of sustainable eating education after students graduate. Finally, further research should examine the impact of sustainable eating education in different settings such as workplace cafeterias, hospitals, restaurants, and at home.

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Appendix 1

Ingredient Scales

Make Your Own Omelete

Food	CO_{2e} emissions
Mushrooms	0.07
Onions	0.53
Peppers	0.6
Broccoli	0.64
Spinach	0.66
Eggs	2.06
Ham	9.43
Bacon	9.43
Sausage	9.44
Shredded Cheese	10.03

Grainary BYO Sandwich

Food	CO_{2e} emissions
Mushrooms	0.07
Cucumber	0.25
Tomatoes	0.29
Olives	0.30
Carrots	0.33
Cabbage	0.44
Oranges	0.44
Onion	0.53
Mixed Lettuce	0.82
Edamame	0.82
Walnuts	0.83
Peanuts	1.01
Romaine Lettuce	1.04
Pecans	1.67
Almonds	1.96
Egg	2.06
Chicken	3.89
Turkey	4.58
Ham	9.43
Bacon	9.43
Cheese	10.03

Meal Scales

Ginny's Dinner Chicken Enchiladas

Food	CO_{2e} emissions/lb
Refried Beans	0.41
Fiesta Rice	1.39
Chicken Enchilada	2.19
Beef Tamale	17.74

VWK Soups

Food	CO_{2e} emissions/lb
Vegetarian Vegetable	0.12
Cheeseburger Soup	2.47
Mac and Cheese	3.13

Ginny's Lunch Chicken Italiano

Food	CO_{2e} emissions/lb
Chicken Italiano	4.55

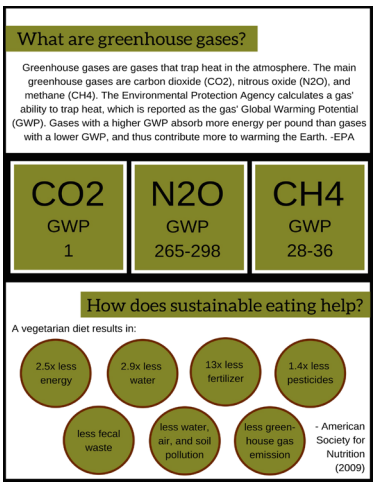
Ginny's Dinner Chicken Parmesan

Food	CO_{2e} emissions/lb
Roasted Vegetables	0.55
Breadstick	0.72
Chicken Parmesan	2.05
Chicken Parmesan Sandwich	4.00

VWK Soups

Food	CO_{2e} emissions/lb
French Onion	0.58
Cheddar Potato	2.67
Mac and Cheese	3.13

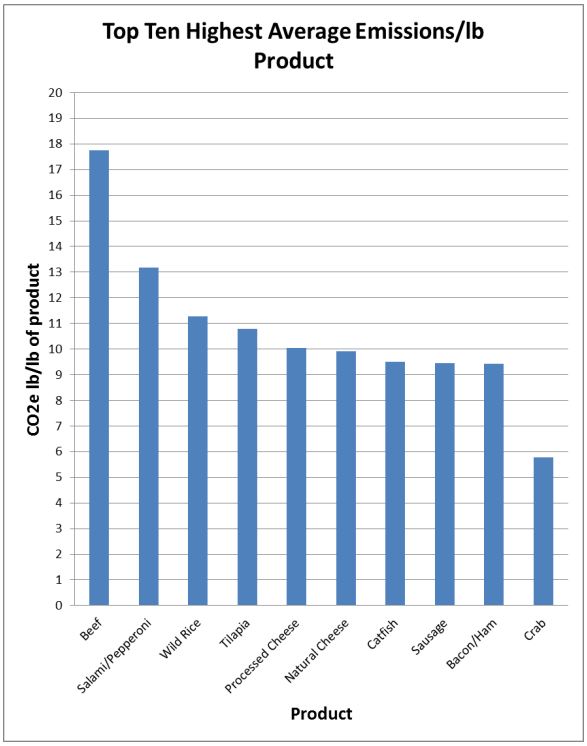
Appendix 2

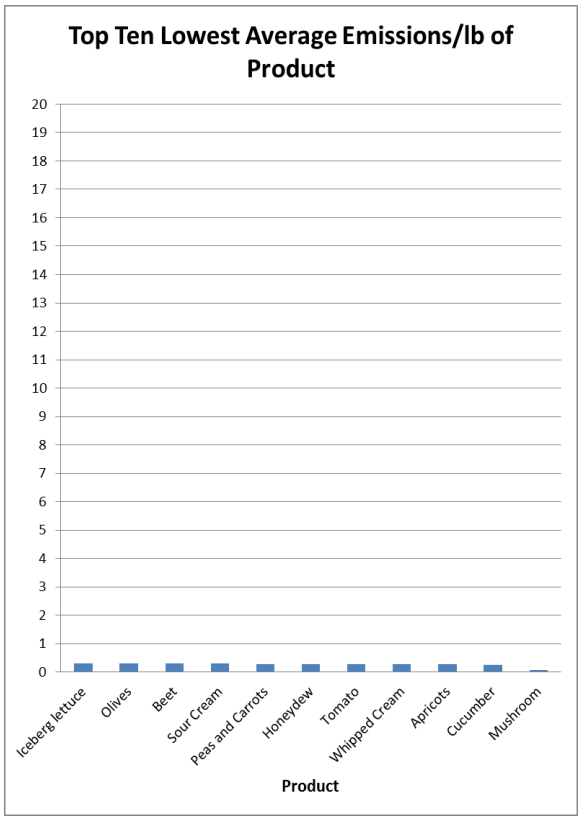


Appendix 3

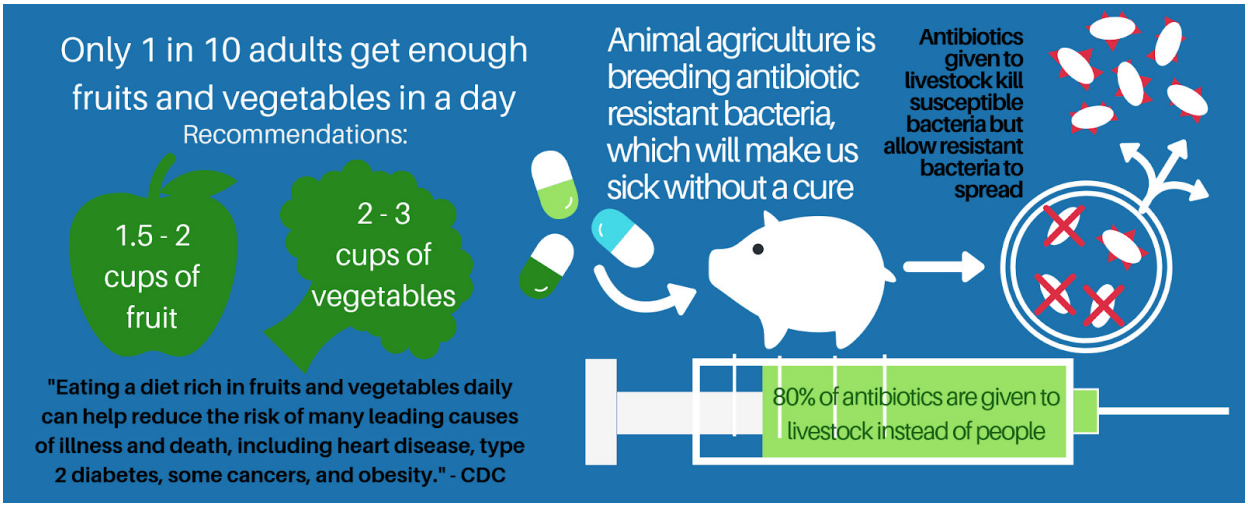
1. Give consent document
2. Ask eligibility questions:
    a. Are you currently a second-year student at the University of Dayton?
    b. Do you currently live in Virginia West Kettering?
    c. Do you purchase food from the VWK dining hall at least once a week?
    d. Have you noticed the ranking scales and table tents that address sustainable eating?
3. Ask behavioral questions:
    a. How has the education intervention impacted your behaviors, if at all, regarding sustainable eating?
    b. Is there anything that the researcher should change about the intervention that would make more of an impact on your behaviors?
4. Ask attitude questions:
    a. How has the education intervention impacted your attitude, if at all, about sustainable eating?
    b. How important is sustainable eating to you? And what can the researcher change to make sustainable eating more important to you?
5. Ask knowledge questions:
    a. How has the education intervention impacted your knowledge, if at all, about sustainable eating?
    b. How has the education intervention impacted your knowledge, if at all, about greenhouse gases?
    c. What else do you want to learn about sustainable eating?

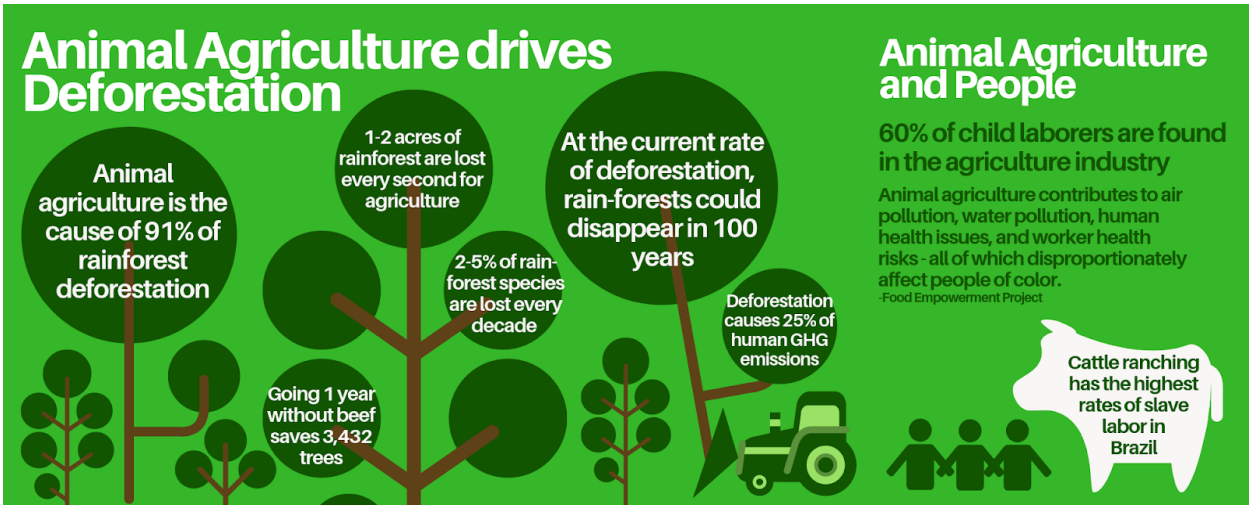
Appendix 4


Top Ten Highest Average Emissions/lb Product
CO2e lb/lb of product
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Beef
Salami/Pepperoni
Wild Rice
Tilapia
Processed Cheese
Natural Cheese
Catfish
Sausage
Bacon/Ham
Crab
Product


Top Ten Lowest Average Emissions/lb of Product
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Iceberg lettuce
Olives
Beet
Sour Cream
Peas and Carrots
Honeydew
Tomato
Whipped Cream
Apricots
Cucumber
Mushroom
Product

Appendix 5


Only 1 in 10 adults get enough fruits and vegetables in a day
Recommendations:
1.5 - 2 cups of fruit
2 - 3 cups of vegetables
"Eating a diet rich in fruits and vegetables daily can help reduce the risk of many leading causes of illness and death, including heart disease, type 2 diabetes, some cancers, and obesity." - CDC
Animal agriculture is breeding antibiotic resistant bacteria, which will make us sick without a cure
Antibiotics given to livestock kill susceptible bacteria but allow resistant bacteria to spread
80% of antibiotics are given to livestock instead of people


Animal Agriculture drives Deforestation
Animal agriculture is the cause of 91% of rainforest deforestation
1-2 acres of rainforest are lost every second for agriculture
At the current rate of deforestation, rain-forests could disappear in 100 years
2-5% of rain-forest species are lost every decade
Deforestation causes 25% of human GHG emissions
Going 1 year without beef saves 3,432 trees
Animal Agriculture and People
60% of child laborers are found in the agriculture industry
Animal agriculture contributes to air pollution, water pollution, human health issues, and worker health risks - all of which disproportionately affect people of color.
-Food Empowerment Project
Cattle ranching has the highest rates of slave labor in Brazil