ENVIRONMENTAL AND ECONOMIC IMPACTS OF UIUC FOOD PURCHASING

BY

DANE WILLIAM HUNTER

THESIS

Submitted in partial fulfillment of the requirements
for the degree of Master of Science in Natural Resources and Environmental Sciences
in the Graduate College of the
University of Illinois at Urbana-Champaign, 2015

Urbana, Illinois

Advisor:

Professor Michelle Wander

ABSTRACT

This work summarizes the increased attention American universities have paid to sustainability and reducing carbon emissions in recent decades through greenhouse gas (GHG) emissions inventories, as well as application of values based assessments such as the Real Food Challenge and then applies selected metrics to food procured by campus dining services at the University Illinois at Urbana Champaign (UIUC) in 2013. The American College and University Presidents' Climate Commitment (ACUPCC) is a voluntary effort through which signatories have agreed to perform baseline carbon inventories and publish climate action plans with emission reduction targets. UIUC's Climate Action Plan, iCAP, calls to increase the amount of local food, reduce agriculturally-related emissions by 50%, and to purchase more than 30% of food from within 100 miles by 2015. This is despite the fact that the ACUPCC inventory does not include food related emissions. This project used Life Cycle Assessment models to estimate GHG, and a Local Multiplier 2 (LM2) to consider local economic impact based on three 'local' purchasing definitions. In FY13, purchased food items accounted for 2.15% of the total UIUC footprint. Meat products accounted for around 50% of the foodprint, with beef comprising over 50% of that. Dairy accounted for about 15%. Packaging composed approximately 9% of an average product's footprint. Transportation miles only composed 4% of the foodprint, so while reducing mileage does not offer the same GHG saving potential as altering consumption and production practices, LM2 models show economic benefits to the region derived from increasing local production and processing. Varying definitions of local show that UIUC's local purchases range from composing <1% under the 2010 iCAP definition to 38% of food under the broadest definition. Despite prospective benefits of regional food systems, barriers have prevented large shifts in institutional spending to local food systems. Altering the requirements for institutional spending on locally produced goods to open new market opportunities as well as improved accounting of economic and environmental gains associated with local food procurement could facilitate transition to environmentally and economically sound regional food systems. Results from this work suggest purchasing and consumption scenarios that reduce meat consumption and capitalize on the region's capacity for grain, legume, and oil crop production to support a local, sustainable food system. First steps towards realization of this transition include fostering new markets by beginning to purchase locally supplied dry beans which require minimal processing. Additionally, the Sustainable Student Farm and Food Science and Human Nutrition Pilot Processing Plant can model and refine practices of producing and processing grain and oil crops for a regional food system.

ACKNOWLEDGEMENTS

I would like to thank my advisor, Dr. Michelle Wander for guidance, confidence, and patience along the way. Additionally, my committee consisting of Jeremy Guest, Bruce Branham, and the late Jody Endres for their time, interest, expertise, and perspective on this project. Special thanks to: Chris Henning and Kit Smith from University Dining Services; Doug Lavey and Lauren Galang for their work with processing and modeling food purchase data; Brian Schoener for assistance with Crystal Ball; lab members, Dr. Carmen Ugarte, Dr. Rafter Sass-Ferguson, Tito Lavaire, Yushu Xia, Ron Revord, Lakiah Clark. Additional thanks to the Agroecology and Sustainable Agriculture Program for funding this research, including the undergraduate assistance. Last but certainly not least, like so many graduate students in this department, I would never have made it through all this without the assistance of Karen Claus who gently but firmly keeps all of us herded in the right direction.

Table of Contents

Chapter 1: CAMPUS SUSTAINABILITY ACTIVITIES AND FOOD PURCHASING

ABSTRACT

This chapter reviews how public interest in local food fits within the larger sphere of general sustainability efforts that have increased over the past 25 years before considering how progress towards sustainability goals and increased local food procurement might be facilitated. Educational institutions have increased attention to reducing carbon emissions and the American College and University Presidents' Climate Commitment has emerged as a guide, requiring institutions perform baseline carbon inventories and publish climate action plans with emissions reduction targets. While Scope 1 agricultural emissions are accounted for, the Climate Action Plans are not required to account for, or address scope 3 emissions related to food despite estimates that agriculture accounts for around 15% of all anthropogenic emissions. Life Cycle Assessment (LCA) models' inability to describe a wide range of food products has limited campus' ability to estimate their foodprints. The release of improved food LCA tools, including CleanMetrics FoodCarbonScope, allows U.S. institutions to reasonably estimate emissions from dining services and estimate impacts of purchasing choices. Additionally, emerging methods to estimate 'local multiplier models', which estimate economic returns to the community derived from local purchasing, may help campuses show how anchor institutions can have a positive impact by measuring the benefits of economic recirculation within their region. Despite prospective benefits of regional food systems, barriers have prevented large shifts in institutional spending to local food systems. Altering the requirements for institutional spending on locally produced goods and improved accounting of economic and environmental gains associated with local food procurement could facilitate transition to environmentally and economically sound regional food systems.

INTRODUCTION

The Illinois Climate Action Plan (iCAP) was adopted by the University of Illinois Urbana Champaign (UIUC) campus in 2010 as a roadmap for UIUC to become carbon neutral by 2050. The current iCAP seeks to direct the purchasing power of UIUC to focus on reducing greenhouse gas (GHG) emissions. The two agricultural targets developed as part of the University's "*A Climate Action Plan*" (2010) emission reduction strategy were to: 1) Reduce directly related agricultural emissions by 50 percent by 2020, and, 2) Exceed the State local food procurement standards by making more than 30 percent of food purchases from local sources (within 100 miles) by 2015. To aid in achieving the first goal, the University developed a baseline Carbon (C) inventory from the iCAP in 2008 that estimated total agricultural emissions at 1% of UIUC's overall footprint. That footprint included the South Farms, which house campus' agricultural experimental fields, estimating agricultural emissions at 7,130 MTE CO_2 equivalents, but did not include the campus Dining Services (DS) purchased food since it was not required by the ACUPCC (*A Climate Action Plan for the University of Illinois at Urbana-Champaign*, 2010).

Research is needed to fill that gap in campus' C footprint and evaluate the benefits derived from an increase in local purchasing. The primary benefit of local-food purchasing may not be tied to reductions in GHG emissions. Despite the public concern for reducing food miles, GHG emissions from transportation typically account for a small proportion (2-4%) of the foodprint of a particular product, with more influence coming from production practices (Barclay, 2012; Harwell, 2005; Roy et al., 2009; Saunders, Barber, & Taylor, 2006; Webb, Williams, Hope, Evans, & Moorhouse, 2013; Weber & Matthews, 2008). Emissions from transportation must be compared against costs associated with emissions from production practices used by alternative supply chains (Barclay, 2012). For instance, apple production in New Zealand has a lower C footprint than apples grown in the UK, but the GHG cost of shipping apples from the southern hemisphere 6 months a year is higher than the GHG footprint of storing of UK grown apples for ten months (Blanke & Burdick, 2005; Webb et al., 2013). This means that in terms of GHG it makes sense for the UK to produce and store apples for the off season. This balance between production and transportation tips when it comes to lamb production, which has significantly lower GHG emissions in New Zealand than in the UK, even when the transportation costs are included in the emissions assessment (Webb et al., 2013). A favorable foodprint of imported lamb holds true as long as we assume transport by sea, but would change if transport were by air since air transport produces significantly more GHG (Barclay, 2012; Webb et al., 2013).

To properly compare GHG emissions, one must consider transportation costs along with the specific practices used to produce food items. For example, compared to field production, GHG emissions from local greenhouse production can be significantly higher than field grown produce produced in a warmer region (Webb et al., 2013). Even though transportation costs represent a much higher percentage of produce's foodprint, out of season production in heated greenhouses can lead to higher footprints than field grown produce that is imported (Carlsson-Kanyama, 1998; Edwards-Jones et al., 2008; Röös & Karlsson, 2013). This advantage might be reversed if renewable energy sources for greenhouse heating or passive heat are used (Röös & Karlsson, 2013). Accordingly, local food production cannot be ubiquitously assumed to be more environmentally friendly than transported food (Edwards-Jones et al., 2008).

Accordingly, the second iCAP goal, which encourages increasing local food procurement and reducing waste as means to reduce GHG emissions, may not provide a consistent or uniform way to achieve iCAP goals. It is interesting then, that the iCAP goal goes above and beyond the state's directive for state institutions, which advises that 20% of food expenditures be spent on items grown, processed, and distributed in Illinois by 2020 (Quinn, 2009). This is in step with other States that are calling on institutions to leverage their purchasing power to create healthy and stable communities (Democracy Collaborative, 2010). As 'anchor institutions' universities can significantly impact their regions through purchasing. Anchor institutions such as education and medical facilities in the US purchased over $373 Billion in goods and services in 2006 (Dubb & Howard, 2012), which would amount to $437B after adjusting for inflation ("Inflation Calculator," 2013). This economic investment has substantial potential to create regional jobs in addition to any GHG reductions from local purchasing. Many anchor institutions are deeply rooted in their communities and therefore such institutions have an inherent self interest in the economic and social well-being of their region (Dubb & Howard, 2012). Anchor institutions' investments in local economies can significantly impact community employment. Current campus sustainability plans make the direct connection to local communities by setting local food procurement goals (*A Climate Action Plan for the University of Illinois at Urbana-Champaign*, 2010). A report titled "The 25% Shift", concluded that shifting 25% of northeastern Ohio's $15 billion spent on food to local sources would create over 27,000 jobs, increase tax revenue, food security, entrepreneurship, and civic pride (Masi, Schaller, & Shuman, 2010). A prime example of University agency in this arena is the 10% Campaign in North Carolina, which has been led by NC State University, where all residents have been urged to spend 10%, -about $1.05 per person per day- of the $35 Billion spent annually on local foods, which would result in approximately $3.5 billion spent in state ("The NC 10% Campaign," 2015). Accordingly, inclusion of local food purchasing goals might address economic dimensions of sustainability.

To inform future UIUC foodprinting efforts, this chapter will review the landscape of methodologies and norms being applied by campus sustainability efforts to decide how to best leverage campus purchasing power to reduce greenhouse gas (GHG) emissions and benefit Illinois economies through local food procurement.

LITERATURE REVIEW

Sustainability on Campus Today

To explore how food fits into the sustainability discourse on college campuses over the past 25 years, this review assessed how the prevalence of related search terms have varied since the early 1990's. To gauge the level of interest in campus sustainability, terms listed in Figure 1 were searched in five year intervals since 1991 in Google Scholar. These results were scaled against the more generic term, “Methods” to account for a general increase in overall knowledge and internet usage in the same time frame. Results for each timeframe were divided by 5 to represent the results ‘per year’, except the results from the 2011-2015 category which was denominated by 4.18 to account for only 18% of 2015 passing at the time of this search on March 10, 2015. Figure 1a shows the prevalence of those 5 campus-focused terms increasing since 1991. It demonstrates how interest in sustainability has increased rapidly for the past two decades and that interest in food, food waste, agriculture and local purchasing have grown less rapidly and that interest in terms does not vary. Figure 1b depicts the particular search terms as a proportion of the broader parameter, ‘sustainability’, and indicates that the increase in campus sustainability efforts have grown more rapidly during the last decade. This surge in interest coincides with the development of efforts related to the American College and University Presidents’ Climate Commitment (ACUPCC) which was founded in 2007 to recognize the growing public concern of climate change as the defining challenge of the 21st century and acknowledge the role of institutions of higher learning to lead the change to reducing global GHG emissions (ACUPCC, 2006). The ACUPCC emerged from a group of college and university presidents who determined the need for a cooperative, nationwide effort to address climate change. As the source of most of the scientific consensus on climate change, and an incubator for the minds of tomorrow, they believe that colleges and universities should model carbon neutral behavior and urge presidents and chancellors of academic institutions to sign the ACUPCC and agree to: create a comprehensive carbon inventory, develop an action plan to reach campus carbon neutrality as soon as possible, and report biennial progress to the ACUPCC (ACUPCC, 2006). So far 684 signatories have submitted 533 Climate Action Plans (CAPs) according to the ACUPCC. Those institutions have completed 2151 greenhouse gas (GHG) inventories and submitted 364 progress reports as of 12/3/14. Affiliated campuses range in size from less than 300 students to over 50,000. ACUPCC defines climate neutrality as having no net GHG emissions through a combination of eliminating, minimizing, and offsetting direct and indirect GHG emissions (ACUPCC, 2006). There are no legal or financial ramifications for non-fulfillment of the ACUPCC. Accountability to the voluntary commitment is monitored only through the public reporting of progress to http://rs.acupcc.org and relies on stakeholders such as students, alumni, and community to keep institutions on track(ACUPCC, 2006). For more details on implementation see Appendix A.

While campus CAPs are common and have been somewhat standardized by the ACUPCC, these are not the only mechanism a campus might use to assess sustainability. To understand the ways in which schools implement sustainability policies we summarized the sustainability efforts of 25 educational institutions in the U.S. that range in size and geographic location (Table 1). Initially CAP's were searched for using Google while using: '<Institution Name> Climate Action Plan', '<Institution Name> sustainability'. If a CAP or other sustainability plan was found it was searched for relevancy to: agriculture, food, food waste and local purchasing. If no document, such as a CAP or other sustainability plan or resolution was discovered, or if upon review, it failed to contain goals pertinent to those terms, then a web search was performed using '<Institution Name> sustainability' before the website was checked for any particular goals or definitions regarding the aforementioned terms. Institutions were selected for inclusion in this review of how agriculture and food are included in campus sustainability activities only if they had articulated specific goals, either quantifiable or at least qualifiable that could be counted. Mention of campus gardens student farms to produce food for campus consumption was not considered agriculture for significant food production unless specifically mentioned in context of documenting the footprint of such programs. We found 16 of the 25 selected institutions enacted formal CAPs as signatories of the ACUPCC. The 9 schools that have not formally created CAPs through ACUPCC have sustainability plans in place, but not all set quantitative goals. Eleven institutions affiliate with both the ACUPCC, and the Real Food Challenge (RFC), which is a campaign to shift $1 Billion dollars of existing institutional purchasing to "real food" which is defined as food that is local/community based, fair, ecologically sound, and humane (RFC, 2015). Three additional schools defer food sustainability entirely to the RFC. Officially established in 2008 as an offshoot from The Food Project, the RFC utilizes a network of student food activists from across the country to move towards its self-imposed 2020 deadline. The organization explains the concept of 'real food' as a social movement that embraces concern for the producers, consumers, communities, and the earth, a vision for a food system that balances production, human rights, and environmental sustainability. The RFC claims 170 institutions have used their calculator to research and review products institutional food spending. Twenty seven institutions have formally signed the Real Food Campus Commitment, which pledges to increase the amount of food system transparency, and 'real food' purchased to at least 20% by 2020, plus the 10 campus University of California System and the California State University system enacted a system wide policy demanding that each of the 23 CSU campuses meet the RFC (Emma Brewster Real Food Challenge, personal communication, 12/1/14). Eight schools increased their purchasing target above the required 20%, setting goals ranging between 25-40% 'real food' purchased by 2020.

Seven of the institutions formally affiliate with neither protocol. Some plans specifically mentioned RFC goals whether or not they were officially affiliated, and some RFC signatories did not place related language in their respective sustainability plans. Many of the largest institutions articulating sustainability goals are not ACUPCC signatories. Michigan State University organized a Climate Outreach Team in

2011, but had not published any quantitative goals or means for GHG reduction at the time of this review. Indiana University and Stanford have written sustainability plans with quantified goals to reduce GHG emissions but have not formally signed the ACUPCC (*Indiana University Office of Sustainability 2020 Vision*, 2010; Stagner & Ahmed, 2009). An interesting note, in the University of Wisconsin system, the two research institutions, and largest schools in that system do not have CAPs, yet 7 of the remaining smaller 11 UW universities are ACUPCC signatories.

Many of the institutions are putting effort into purchasing locally grown products, or products that align with RFC goals but it does not appear effort is being taken to determine what shift in purchasing might mean in terms of GHG or regional economic impact (RFC, 2015). The University of New Hampshire did encourage local purchasing in one line as a means to 'reduce delivery emissions', but included no goals or metrics (*WildCAP : The University of New Hampshire' s Climate Action Plan*, 2009). Many schools applied different definitions of local, with distances ranging between a 100 or 250 mile radius from the institution. UMass Amherst did not define local as a set distance, instead it established purchasing goals based on a distance that "considers the local economy, carbon neutrality, and environmental quality"(Small, 2012). Some schools equate local food with regional production. This is the case for Food Solutions New England program (Donahue et al., 2013), and Purdue University, which defines local food as that as being from Indiana or bordering states (*Purdue University Sustainability Strategic Plan*, 2010). Some schools combine distance criteria within their definitions. For example, UM Ann Arbor considers local as being food produced in Michigan, or purchased from a processing facility located within 250 miles of the Ann Arbor campus that contains at least 50% of ingredients that were sourced within 250 miles of that processing facility (*University of Michigan - Ann Arbor Sustainability Goal Reporting Guidelines*, 2014). Their definition also excludes products of Concentrated Animal Feeding Operations, products of minimal nutritional value such as soda and many candies, as well as items composed primarily of water, congruent to RFC. Nine schools list waste reduction goals for both food and non-food items and tactics frequently included composting. Some schools, including UIUC and Purdue, articulated separate nonfood and food waste goals. Several schools (Texas A&M, UC Berkeley, and Mizzou) that do not explicitly set waste reduction/diversion goals did list efforts for waste reduction and recycling on their websites (*Sustainability Master Plan for Texas A&M University*, 2010, *UC Berkeley Climate Action Plan*, 2009, *University of Missouri Climate Action Plan*, 2011).

Many schools associate local purchasing with achievement of sustainability goals without relating this to climate action. The National Association of College and University Food Services (NACUFS) awarded gold, silver, and bronze medals respectively to the University of Massachusetts at Amherst, Michigan State University, and Purdue University for sustainable procurement practices. The award is for modifying purchasing protocols to include more local and sustainable producers. The latter two institutions did so without formal RFC or ACUPCC affiliations. UMass Amherst currently reports the purchase of 30% local products, with a goal of 100% local food. Two unique programs at UMass include the Permaculture Initiative and the Closed Loop Food System. The UMass Permaculture Initiative converts unproductive grass areas on campus to “ecological, socially responsible, and financially sustainable permaculture landscapes that are easy to replicate.” The original installation yielded 1000 lbs. of fresh produce in its first harvest, without the use of fossil fuels, chemicals, or artificial fertilizers. Symbolic efforts like these suggest untapped potential to increase awareness, and increase food production on a campus level. Permaculture Initiative goals include producing 10,000 lbs. of food annually in 12 permaculture gardens by 2020 and producing nearly 100% of UMass produce on approximately 300 acres of university land by 2050 (“UMass Permaculture,” 2014). The Student Sustainability Committee has funded a sustainable student farm for produce, and a mixed planting of fruit and nut crops through the Student Sustainability Committee which is funded through student fees (“Student Sustainability Committee Projects,” 2015). Both projects provide food for campus dining services. Academically, UMass plans to offer courses in permaculture, either as a major or a minor/concentration. The Closed Loop Food System addresses all aspects of the food system, including production, processing, distribution, consumption, and waste management. In accordance with their CAP goals, this would entail 100% locally-grown, sustainable food production, on campus or local processing and distribution using carbon neutral energy sources and increasing waste diversion from the current 72% to between 90% and 100%. Other goals include continually auditing the UMass dining system and reducing the carbon footprint 5% every two years. “Beyond Ramen” a project of the Cornell University food team which aims to educate second semester freshmen about wholesome food choices, teach about diet, nutrition, and local food systems, as well as teaching food skills such as cooking, and waste reduction including use of leftovers (“Food Skills Initiative,” 2015). While not an exhaustive list, this review demonstrates the diversity of campus policies, goals and initiatives on sustainability and identifies ways in which schools can take measures to fit their own community and still move toward a lower emissions future.

Campus Food LCA

Reporting guidelines embedded in CAPs are now a routine part of how campus sustainability is tracked. Such guidelines have created a need for measurement techniques that can quantify contributions that local food procurement might make to GHG reductions and local economies. According to the Clean Air-Cool Planet (2008) the lack of effective tools has limited this cause, and this is why their Literature *Review of Methods and Tools for Quantifying the Indirect Environmental Impacts of Food Procurement* called for a publicly available Life Cycle Assessment tool to use as a guide for procurement decisions and measure the indirect GHG emissions, of academic institutions' food purchases. They found only limited resources were available for institutions interested in assessing their foodprints and that no resources satisfied their desired criteria which included that tools have the ability to track a broad selection of food items, be inexpensive, easy to use, and practical for evaluation of bulk food purchasing. This problem is unaddressed by the ACUPCC, which recommends use of the Campus Carbon Calculator (CCC) by signatories even though that tool does not track food-based emissions. The CCC will be reviewed more fully in chapter 2.

To date only a few examples of campus food-prints have been completed for medium-to- large sized institutions. In 2009 the University of North Carolina performed a Campus Carbon Foodprint to better inform the procurement choices of their institution (Newcomb & Rosett, 2009). They completed a baseline tier 1 assessment by drawing on two different databases. These included the U.S. based Bon Appetit Database which was created in collaboration with Ecotrust in 2007 ("Low Carbon Diet," 2015) and contained some food items and emission values that were deemed to be appropriate for North American food systems even though they relied heavily on European data (Newcomb & Rosett, 2009). The Bon Appetit database, which is no longer publicly available, required that similar products be grouped into more generic or simplified categories to fit all foods. For instance, they classify pizza dough, pie crusts, and other baking items as bread for the sake of their calculations. That database had limited capacity to describe foods produced with alternative (eg: local or organic) production practices (Newcomb & Rosett, 2009). The second database used, ProBas ("ProBas Prozessorientierte Basisdaten für Umweltmanagementsysteme," 2015) developed by Germany's Federal Environmental Agency, is still publicly available and possesses a good breadth of products and production methods. However, ProBas is only available in German, and poorly describes energy production values appropriate for North American LCA (Kim, Houser, Rosenthal, & Neff, 2008). This reliance on European production and transport models for produce and the fact that the produce numbers for ProBas involved no processing or transportation whatsoever constitute some of the main limitations of UNC's 2009 footprint. In effect, it was as if each student went to the field and directly plucked their vegetables out of the ground (Kim et al., 2008). Even with these two information sources' inherent inaccuracies, UNC's footprint identified higher and lower emission food categories and used these to develop recommendations to reduce the purchase of high GHG producing food items. They concluded that reducing beef purchases would make the largest impact of any single product. Other high climate-costly foods included other meat and dairy products. In order to reduce meat consumption via reducing meat demand they suggested creating a 'vegetarian only' meal plan. Cutting meat out of a meal plan would be a cheaper alternative for the student without changing the bottom line of the cafeteria. Since their study also included the waste in their dining halls they concluded that the next best way to cut waste in the cafeterias was to eliminate self-service food bars to reduce the total food served, wasted, and purchased (Newcomb & Rosett, 2009). Given that Americans waste approximately 40% of our food supply (Hall, Guo, Dore, & Chow, 2009), reducing food waste can save a significant amount of resources, monetarily and environmentally (Gunders, 2012).

To improve our ability to estimate emissions from domestic meat and dairy products, the Environmental Working Group (EWG) and CleanMetrics Corp. joined together in 2011 to create the "Meat Eaters Guide", based on 20 lifecycle assessments of high protein foods modeled from cradle to grave. They modeled farm gate emissions for systems with conventional practices, and assumed soil carbon was at equilibrium with inputs and then added post farm gate emissions such as processing, transportation, retail, cooking, and waste disposal. They assessed a 1 kg consumed edible product as the functional unit after considering waste at point of consumption via water and fat loss as well as the trimmed portions. Their methods will be discussed more fully in chapter 2. Their results compare to the findings of other studies including the UNC report, which show ruminants are inherently more costly in terms of GHG emissions than even other livestock. The average of the 5 studies they considered placed beef at 16.25 CO_2e/kg consumed, and lamb at 24.35 (Hamerschlag & Venkat, 2011). These factors are four to five times the mean emissions values found for pork- 5.08 and chicken- 3.1 CO_2e/kg based consumption Ruminant meat sources have greater emissions intensity because they produce enteric methane emissions where methane has a Global Warming potential of 25, which is 25 times more potent of a GHG than CO_2 (IPCC, 2007). Of the proteins, whole milk fared the best, averaging 1.11 kg CO_2e/kg consumed. Emissions from other dairy products depend largely upon the amount of milk required for their production, with cheese weighing in at an average of 9.47 kgCO_2e/kg consumed. The Meat Eaters Guide takes care to note that their modeling relies on the most commonly used agricultural practices, and that emissions might be reduced if alternative or best management practices were applied. By modifying animal nutrition, manure management, grazing, and soil management practices or altering processing methods (freezing, cooking, and end life waste management e.g. composting) foodprints might be reduced (Hamerschlag & Venkat, 2011).

Values Based Assessments (RFC)

The quantitative approach used by the ACUPCC through use of the CCC differs notably from the more subjective, and values based approach applied by the RFC. This is a non-profit organization without formal ties to university governance that acknowledges funding from a combination of charitable foundations, individual donors, and event based revenue. A complete list of donors is provided on their website (RFC, 2015). The RFC assessment tool, the Real Food Calculator, qualifies 'real food' based on four criteria listed in table 2 (RFC, 2015). The RFC comprises criteria compatible with standards developed by other leaders in the field such as Business Alliance for Local Living Economies (BALLE), Association for the Advancement of Sustainability in Higher Education (AASHE), and Leadership in Energy and Environmental Design (LEED). Food items are surveyed one by one and declared as either green light which epitomizes real food, yellow light which counts but does not hold as strictly to the standard, or red light which does not meet the criteria to be considered real food. Products can be disqualified immediately if (RFC, 2015):

> +Producer is known to be found guilty of criminal charges of slave labor or indentured servitude within the previous 10 years; producer is known to have been found guilty of, been cited, or settled a case relating to an OSHA, FSLA, or NLRB violation within the last 3 years.
> +Producer is known to be a Concentrated Animal Feeding Operation (CAFO)
> +Product is likely to contain GMOs (e.g. non-organic high fructose corn syrup, soy, beet sugar)
> +Product contains any of the following: Acesulfame-Potassium, Butlyated Hydroxyanisole (BHA), Caramel Coloring, Olestra (Olean), Partially Hydrogenated Oil (trans-fats), Propyl Gallate, rGBH/rBST, Saccharine, sodium nitrate added; Dyes; Red #3, Yellow #5, Yellow #6, Blue #3

The RFC instructs students, which it identifies as the actual paying customers of institutional dining service programs, on how to start a campaign and recommends that users retrieve school food purchasing data either for a full year or as a snapshot choosing two representative months as the sample. Also student researchers have the choice of whether to assess an entire campus dining service or to a minimum of one representative campus dining hall. They remind users that data from more months and more dining halls are beneficial for a more accurate picture but the time commitment rises with the increased number of records to review and stress that transparency of methods is most important, regardless of scope. Once an institution finishes its assessment results are reviewed and published on the RFC website and is usable by the institution for further assessment and goal setting (RFC, 2015). Each year the school is asked to complete the Baseline Survey which includes information such as number of dining halls, foodservice provider, number of meals served, annual expenditure, and primary vendors. After completion of the survey and an assessment plan, student researchers are trained on how to use the calculator and then are set to perform the assessment. RFC estimates the total process will take between 100 and 200 hours depending on scope, and the size of the investigating team. The RFCalculator helps students to track the level of 'real food' over time, encouraging students to seek transparency of their food system. This approach seeks to increase awareness and publicity to the food systems. While there has been little research on university students' food system awareness (Vo, 2008), in an era where many Americans were not raised on farms many do not understand their food systems, it is believed that values based labels and language do impact consumption choices (Vo, 2008).

The subjective nature of the RFC is likely to make this assessment tool unattractive to those required to justify shifts in purchasing through quantitative measures. Even though most would agree that use of socially-responsible, fair, ecologically sound and humane food production practices is desirable, all might not agree that meeting the RFC would be the only or best way to supply those benefits. For example, some might question whether organic agriculture is more sustainable than integrated approaches that strategically apply fertilizers and herbicides and rely on GMOs as part of their sustainable practices (Pimentel et al. 2005)(Davis, Hill, Chase, Johanns, & Liebman, 2012a, 2012b). Further, critics of organic might argue that organic pesticides that are approved for use are just as harmful to pests and beneficial organisms (Bahlai, Xue, McCreary, Schaafsma, & Hallett, 2010; Pimentel et al., 2005; Venkat, 2012) as conventional pesticides which are linked to sterility and cancer (Bassil et al., 2007; Gammon, Aldous, Carr, Sanborn, & Pfeifer, 2005; Spanò et al., 2004). Of course, organic certification discourages organic pesticide use by requiring written justification for one-time use along with a management plan to explain how they will avoid the problem, and minimize reuse-in the future. Other strategies to achieve best management practices, like Integrated Pest Management (IPM), may provide environmental services that are equal to or greater than those supplied by organic practices but there are not, as yet, widely accepted certification practices in place for consumers to rely on. While emerging and future sustainable agriculture standards might look toward science-based metrics that allow for tailored solutions where possible, values- based certifications (eg: wildlife friendly, humane and socially just) include dimensions that are inherently messy and complex (Hatanaka, Konefal, & Constance, 2012). Effective sustainability assessment tools that embrace values based purchasing will need to account for trade-offs among goals and consider site-and community specific factors to accurately project outcomes derived from different purchasing portfolios (Hatanaka et al., 2012).

Development of suitable metrics could be used for educational campaigns that could overcome apathy or reengage students who are distanced from the farm since many students are unaware of the issues at hand simply due to a detachment from their food system (Vo, 2008). Over the past 50 years the rural population has decreased from about 40% to under 20% of Illinois' population. This state of apathy might be reversed if they had a clearer understanding of what food choices might mean not only for their own health, but also for the health of society (Dunning, 2011).

Local Multiplier Effects

Assessment of the economic impact of campus purchasing is an example of a complex effect that also warrants accounting (Moretti, 2010). Two of the most basic means of increasing regional economic activity are to increase exports or to decrease imports. Purchasing local foods reduces the amount of food imported to the region and therefore keeps local money in circulation that would otherwise be sent out of the region. The amount of local economic activity stimulated by the purchase of goods or services from the local economy is known as the multiplier effect (Miller, 1992; Moretti, 2010; Swenson, 2009; Thatcher, 2004). As money is spent on goods and services, this spending generates the need for more goods, services which generates more local spending, increases taxes collected, and ripples through the region (Miller, 1992; Moretti, 2010). Benefits from locally directed spending are assessed in terms of depth and breadth (Sonntag, 2008). The depth of spending refers to the quantity of food dollars on average spent at regional businesses. Breadth here refers to the percentage of the community that spends money at locally owned businesses. Increasing the depth of local purchasing increases the multiplier, or recirculation effect, of each dollar spent. Increasing the breadth of local spending can also increase the depth, but has a larger impact on increasing the market share for local products and therefore local businesses. An important effect of local spending is that the effects can compound over time. When local spending increases and local business prosper, they can offer more products and services which in turn lead to more sales, and more successful businesses. The more local businesses that are flourishing, the easier it is for consumers to patronize those establishments, which then contributes to an overall increase of local purchasing (Miller, 1992).

The concept of a local multiplier has been criticized for mistaking wealth *redistribution* with wealth *creation*. The money that is being recirculated through local economies would otherwise be spent and recirculated in some other economy, which may be dependent on that revenue stream. Critics argue that while increased local spending might be good for Area A, it might be detrimental to Area B, and that Local Multiplier effect calculations fail to reconcile this redistribution (Sacks, 2002). Regardless of the geographic scale, local multipliers can be used to delineate and properly plan for regional economic recirculation (Miller, 1992). According to Shuman (2010) the wealthiest communities are those with: 1.) the highest percentage of jobs employed by local businesses, and 2.) maximize self-reliance. This does not necessarily mean that the these communities resist any outside interaction, only that they minimize imports by relying on local labor and products as much as possible, only importing goods and services they cannot provide competitively (Shuman, 2010) notes that while non-local big box stores can provide some products for the lowest price, this does not consider the overall value of products. Value can also encompass other factors such as products quality, after purchase service, trust in the business, how well a business treats its employees and the environment, and how the business contributes to local causes and charities (New Economics Foundation, 2002). Local businesses often have a leg up in these categories that consumers are often willing to pay more for. Food hubs manage aggregation, distribution, and marketing which can link local farms to large scale purchasers such as grocery stores, restaurants, and institutions. Hub models range from nonprofits to cooperatives that have developed to fill this niche (Enderton & Bregendahl, 2015). Additionally, while large companies have an purchasing advantage with their economies of scale, small businesses can work together through collaborative purchasing efforts which can maintain their competitiveness (Shuman, 2010).

The fact that so many campuses have adopted local purchasing goals suggests a need for suitable measurement methods. Assessment techniques that quantify multiplier effects could help campus administration evaluate and continue to justify or even expand local spending. One of the most widely used approaches to do this the New Economics Foundation's (NEF) simple model to estimate the local economic impact of spending by calculating Local Multiplier (LM) as:

1.) the income to a business
2.) local spending by the business
3.) local spending by the local recipients of the round 2 spending
4.) and so on…

Discontinuing the measurement of feedback after round 2 results in what is known as LM2. The LM2 produces a maximum multiplier of $2 recirculated for each initial dollar spent if zero cents left the local economy. Significant tertiary and quaternary local recirculation is possible in regions with strong local economies, LM3 methodology includes another iteration, best informed by a survey of the spending habits of local businesses. This thesis will only consider an LM2 multiplier.

Using the LM2 and survey data from the Central Puget Sound Local Food Economy Survey (2005), Sonntag grouped businesses into categories such as Grocers, Restaurants and Food Service, Distributors, Manufacturers and Processors, and Farms and Ranches. She compiled viable ranges for the LM2's for each category, which have been averaged in Table 3. This summary reveals that money spent directly from producers contributes recirculates the most in the local economy, as farms and ranches re-spent between 75 and 93 cents per dollar locally. Restaurants and grocers follow behind, however distribution seems to be leaking money from the local economy, returning only $.16 per dollar received. Looking further at the distributing sector, it seems that distributors might be purchasing the majority of their food outside of the region. Assuming the multiplier for that sector primarily reflects employee wages and taxes, and that the majority of the leakage comes from purchase of food from outside of the region, it stands to reason that the LM of distributors could be greatly improved by procuring more regional food. Sonntag notes that manufacturers with higher LM's have stronger links to local food sources, as do restaurants that specialize in local food. While LMs are not perfect, they appear to be an effective way to help us understand what local procurement might mean to the campus community.

Local Purchasing and University Barriers

The regional economic implications of local food production have motivated the Illinois government to call for an increase in state purchasing goals (Quinn, 2009). Illinois residents send approximately $46 billion in food sales out of state annually (Quinn, 2009). UIUC Dining Services alone spends almost $15M on purchases annually. While the impact of this single institution would be considerably smaller than that of the entire portion of a state, the research suggests that investment in the region could boost employment and community health (Masi et al., 2010). If anchor institutions have the power to redirect millions in purchasing to regional economies, and economies can benefit greatly from the recirculation of dollars, then why do we not see more local purchasing from institutions? Traditionally, institutional procurement relies on a bid system to purchase from the supplier that can reliably provide the cheapest products. This can be a hurdle for institutions looking to shift towards other goals, such as local, or low carbon procurement. Reports by the New England state governments and the Massachusetts College and University system (Church, 2014; Holmes, Wiltshire, Wynn, & Lancaster, 2010) determined a variety of barriers to increased institutional local or low carbon procurement. Barriers exist from both ends of the issue: both in supplying low carbon and regional foodstuffs as well as the institutional demand and ability to purchase such products. Many barriers are especially difficult for small to medium size suppliers to overcome and therefore can have difficulty fulfilling the needs of large scale procurers. For instance, reliability of quantity and quality, and seasonality of products, as well as red tape issues including liability insurance, food certification issues, and the commonality of multi-year contracts among large institutions can be especially high hurdles for small or medium producers.

Large suppliers can reliably provide various quantities of a vast array of products. Furthermore within a given product the purchaser can expect a high level of homogeneity which large scale purchasers need. This overall ease of sourcing has helped to strengthen relationships between institutions and large suppliers (Church, 2014). Furthermore, when institutions can purchase from large vendors they can reduce the number of suppliers they deal with. This reduces the institution's overall managerial effort and therefore cost. Smaller farming operations that possess more flexibility to produce low carbon foods often also have a more difficult time maintaining a supply of product. In addition to the production capacity difficulties small and medium farms might encounter, they are likely to be more susceptible to system perturbations such as weather events or price fluctuations than larger entities. Granted institutions could defer these risks by sourcing from a larger geographical area or by tapping more farms, however this again increases the management cost for the institution, and is generally not preferred. A food aggregator can quell these challenges. A food hub, cooperative, or other aggregator is a person or institution that "aggregates food and facilitates sales to wholesale customers or individual consumers" (Johnson & Aussenberg, 2013; Sanger & Zenz, 2004). Aggregation serves to reduce marketing costs for producers and increase reliability for purchasers in addition to providing a single convenient contact point for procurement for institutions.

Distinctly separate from reliability, seasonality can be easily predicted and prepared for. The Midwestern temperate climate cannot grow all possible foods during all parts of the year. For instance fresh apples are available in the Midwest from July-November. Apples the rest of the year must either be regional apples capable of long term storage, or grown and shipped other regions, often in the southern hemisphere (Blanke & Burdick, 2005). With proper planning and greenhouses the seasons of some foods can be extended, but simply put, certain fresh foods are not locally available throughout the entire year. Unfortunately, the harvest seasons of most foods in the Midwest do not coincide well with the school year. Institutions can plan to consume a more diverse array of seasonal produce to still provide fresh foods, or invest in food preservation methods; potentially a service offered by an aggregator. Furthermore, mindsets can shift to view seasonality as a positive. In season produce can be abundant and affordable. A "Vegetable/Product of the Month" program could help to celebrate and highlight seasonal, regionally available products (Church, 2014).

After production issues, other logistical problems such as insurance and certification can deter small producers (Chris Henning UIUC Dining Services, personal communication, 3/13/14; Church, 2014; Hurley, Murner, & Russell, 2010; Sanger & Zenz, 2004). Some large purchasers require minimum insurance coverage or certifications that can be costly to smaller farms. For instance, the University of Illinois requires all contracted vendors possess $100,000 commercial general and automobile liability insurance (Chris Henning UIUC Dining Services, personal communication, 3/13/14). Dining Services (DS) also requires Hazard Analysis and Critical Control Point (HACCP) plans of all vendors and any produce suppliers must be GAP (Good Agricultural Practices) certified. Contract terms and renewals vary by product and vendor. Single year contracts are standard. Long term contracts are up for renewal every 2-3 years (Chris Henning UIUC Dining Services, personal communication, 3/13/14). Other certification standards can be required of potential producers, either at the state, institutional, or even vendor level.

Programs offered at the state or institutional level can help facilitate farmer entrance into local markets. Suggestions include certification programs specifically for small producers, such as 'GAP Lite', since small growers face different food safety threats than large producers(Church, 2014). Additionally, farm policy and programs to provide small farmers with materials and assistance on certification can help them to obtain and maintain proper certifications, such as a program at UMass Amherst (Church, 2014; Johnson & Aussenberg, 2013).

On the purchasing side of the arrangement issues range from a perception of higher costs, contract specifications, and consumer apathy from lack of awareness (Church, 2014; Hurley et al., 2010; Sanger & Zenz, 2004). At times local production may be more costly, but when dealing directly with a farmer or aggregator the lack of middle men should create a competitive pricing (Johnson & Aussenberg, 2013). Often the price of local foods increases when funneled through by larger suppliers which charge a markup. This markup comes from the inherent cost of the infrastructure the vendor employs and vendors can markup local foods in order to capitalize on the growing demand. Additionally, the increased tax revenue generated from the expenditures and regional jobs should be factored against increased expense (Masi et al., 2010).

Further, large institutional contracts and the specific language used can create difficulties for vendors. For instance, a change in wording from "in state" to "regional" or "in state or within 30 miles of the border" can greatly increase the radius vendors can select from. *New England Food Vision* authors advocate that if Massachusetts expanded their local buying to include New Hampshire producers, both states would benefit (Donahue et al., 2013). Institutions can mandate that vendors obtain some of their products regionally. By setting low thresholds, such as requiring 5% regional foods in all contracts, vendors can be encouraged to slowly begin local purchasing. Admittedly 5% is well below the iCAP goal of 30% local food, but this can be starting point that vendors can easily meet. From there the requirement can be gradually increased, reducing growing pains for both vendors and farmers by allowing for gradual scaling of purchasing and production. Other contract mandates offer opportunities for institutions, such as naming a few specific products that must be purchased regionally, or requiring production and processing facilities within a specified region or distance(Church, 2014; Sanger & Zenz, 2004). For instance, eggs, dairy, corn chips, or other products that require minimal processing and have an eager regional supply would provide a manageable starting point. Produce is a common regional product and a logical choice for local purchasing due to its freshness; choosing to specifically limit a contract to common regional horticultural products can allow smaller vendors to compete. Further advantage can be gained if smaller producers can work with small suppliers that serve as an aggregator for those products. UIUC contracts produce in this fashion through Central Illinois Produce, which is a locally based supplier that can source local zucchini, cucurbits, cabbage, and tomatoes from a nearby Amish community when such crops are in season (John Peters Central Illinois Produce, personal communication, 9/11/14). Larger suppliers satisfying larger contracts made through the bid system can have difficulty managing decentralized local sources (Church, 2014; Sanger & Zenz, 2004). The language used to set contracts can favor or discourage purchasing of products from large scale suppliers. Some products can also be unnecessarily precluded by contract language. A change in wording from "large white eggs" to "white or brown, large or medium eggs" can immensely increase the purchasing options for a vendor, making it significantly easier to procure regionally (Church, 2014).

SUMMARY

While a general consensus exists regarding the qualitative benefits of local foods, there have been few studies quantifying the foodprint of a university, or the impact a shift in purchasing could have on the foodprint or regional economy. UIUC and other institutions have begun implementing plans to reduce GHG footprints and promote local foods both for environmental and economic benefits. Interest in campus sustainability efforts has increased over the past 25 years, and the ACUPCC emerged to encourage colleges and universities to quantify GHG reductions. The ACUPCC recommended tool does not require inclusion of foodprint, and therefore little research has been conducted to quantify impacts of food carbon. Many campuses do have sustainability plans, whether or not they are ACUPCC signatories. Some address goals for food procurement and consumption. Previously, limited tools to quantify foodprint gave rise to projects like RFC which have qualified food sustainability considering social, economic, and environmental impacts despite not quantifying carbon emissions. Research suggests social, economic, and environmental benefits of local/sustainable foods but despite this consensus a shift of purchasing habits of anchor institutions has been slow due to a multitude of barriers on both the supply and demand side of the situation. Given the growing interest in quantifying and reducing institutional emissions, this project will conduct a life-cycle analysis that helps begin to quantify the potential environmental and economic benefits of local food purchasing practices for UIUC. It will also serve as a model for other organizations, companies, or municipalities that might be interested in adopting similar food based purchasing behaviors. The end goal of this work is to: 1.) determine the baseline foodprint for UIUC; 2.) estimate the local economic benefit of a shift toward regional spending using an LM2 model; 3.) elucidate GHG and economic impacts of regional food purchasing through the development of food purchasing scenarios and use results from these to 4.) provide recommendations on decreasing the institutional foodprint.

REFERENCES

2009 Cornell Climate Action Plan. (2009).

2015 Illinois Climate Action Plan. (2015).

A Climate Action Plan for the University of Illinois at Urbana-Champaign. (2010).

ACUPCC. (n.d.). ACUPCC Greenhouse Gas Inventory Brief, 1–8.

ACUPCC. (2006). Presidents' Climate Commitment.

Bahlai, C. a., Xue, Y., McCreary, C. M., Schaafsma, A. W., & Hallett, R. H. (2010). Choosing organic pesticides over synthetic pesticides may not effectively mitigate environmental risk in soybeans. *PLoS ONE*, *5*(6). doi:10.1371/journal.pone.0011250

Barclay, C. (2012). *Food Miles-House of Commons Standard Note*.

Barker T., I. Bashmakov, L. Bernstein, J. E. Bogner, P. R. Bosch, R. Dave, O. R. Davidson, B. S. Fisher, S. Gupta, K. Halsnæs, G.J. Heij, S. Kahn Ribeiro, S. Kobayashi, M. D. Levine, D. L. Martino, O. Masera, B. Metz, L. A. Meyer, G.-J. Nabuurs, A. Najam, D. Z. (2007). Technical summary. *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, 23–78. doi:10.1103/PhysRevD.70.106002

Barnett, R., Battcher, P., Boggs, A., Cotton, S., Curtin, M., Dietz, K., … Payne, R. (2010). *University of Louisville Climate Action Plan*.

Barot, S. (2012). *Climate Action Planning: An Analysis of University of Illinois Climate Action Planning*.

Bassil, K. L., Vakil, C., Sanborn, M., Cole, D. C., Kaur, J. S., Kerr, K. J., & Sanin, L. H. (2007). Cancer health effects of pesticides. *Canadian Family Physician*, *53*(10), 1704–1711. Retrieved from http://www.hubmed.org/display.cgi?uids=17934034

Blanke, M. M., & Burdick, B. (2005). Food (miles) for Thought: Energy balance for locally-grown versus imported apple fruit. *Environmental Science and Pollution Research*, *12*(3), 125–127.

Boston University Sustainability. (2010). *Boston University*. Retrieved June 5, 2015, from http://www.bu.edu/sustainability/

Canning, P. (2011). *A Revised and Expanded Food Dollar Series A Better Understanding of Our Food Costs*.

Carlsson-Kanyama, A. (1998). Food Consumption Patterns and their Influence on Climate Change. *Ambio*, *27*(7), 528–534.

Church, S. (2014). *Local and Sustainable Food Procurement by New England State Governments : Barriers and Recommendations*.

Collins, A. J., & Fairchild, R. (2007). Sustainable Food Consumption at a sub-national level: an ecological footprint, nutritional and economic analysis. *Journal of Environmental Policy and Planning*, *9*(1), 5–30. doi:10.1080/15239080701254875

Correia, F., Howard, M., Hawkins, B., Pye, A., & Lamming, R. (2013). Low carbon procurement: An emerging agenda. *Journal of Purchasing and Supply Management*, *19*(1), 58–64. doi:10.1016/j.pursup.2012.11.004

Davis, A. S., Hill, J. D., Chase, C. a, Johanns, A. M., & Liebman, M. (2012a). Increasing cropping system diversity balances productivity, profitability and environmental health. *PloS One*, *7*(10), e47149. doi:10.1371/journal.pone.0047149

Davis, A. S., Hill, J. D., Chase, C. a, Johanns, A. M., & Liebman, M. (2012b). *Table S2 Increasing cropping system diversity balances productivity, profitability and environmental health.*

Democracy Collaborative. (2010). *Policy Brief Stimulating Economic Growth through Local Purchasing By directing their massive purchasing power locally , anchor institutions encourage local business improvements and , ultimately , economic growth and stability Making it Work Best Practice*.

Donahue, B., Burke, J., Anderson, M., Beal, A., Kelly, T., Lapping, M., … Berlin, L. (2013). *A New England Food Vision*.

Dubb, B. S., & Howard, T. (2012). Job Creation : Entrepreneurship Approach Leveraging Anchor Institutions for Local Job Creation and Wealth Building, (Cms 2011), 1–31.

Dunning, R. (2011). *Summary of Key Points: Evidence-based Support for Local Food Systems, Proposed Research, and the Role of Extension Summary of Key Points*.

Edwards-Jones, G., Milà i Canals, L., Hounsome, N., Truninger, M., Koerber, G., Hounsome, B., … Jones, D. L. (2008). Testing the assertion that “local food is best”: the challenges of an evidence-based approach. *Trends in Food Science & Technology*, *19*(5), 265–274. doi:10.1016/j.tifs.2008.01.008

Enderton, A., & Bregendahl, C. (2015). Food Hub Development in Iowa Lessons learned from a.

FAO. (2006). *Livestock’s long shadow*.

Food Skills Initiative. (2015). *Cornell Sustainable Campus*. Retrieved May 6, 2015, from http://www.sustainablecampus.cornell.edu/initiatives/food-skills

Gammon, D. W., Aldous, C. N., Carr, W. C., Sanborn, J. R., & Pfeifer, K. F. (2005). A risk assessment of atrazine use in California: Human health and ecological aspects. *Pest Management Science*, *61*(4), 331–355. doi:10.1002/ps.1000

Gunders, D. (2012). Wasted: How America is losing up to 40 percent of its food from farm to fork to landfill. *NRDC Issue Paper*, (August), 1–26. Retrieved from http://www.nrdc.org/food/files/wasted-food-IP.pdf?mkt_tok=3RkMMJWWfF9wsRonuqjPZKXonjHpfsX56+woXaS1lMI/0ER3fOvrPUfGjI4ATMphI/qLAzICFpZo2FFUH+GbbIFU8g==

Hall, K. D., Guo, J., Dore, M., & Chow, C. C. (2009). The progressive increase of food waste in America and its environmental impact. *PLoS ONE*, *4*(11), 9–14. doi:10.1371/journal.pone.0007940

Hamerschlag, K., & Venkat, K. (2011). *LIFECYCLE ASSESMENTS : METHODOLOGY & RESULTS Meat Eaters Guide : Methodology Table of Contents*.

Harwell, B. (2005). The Validity of Food Miles as an Indicator of Sustainable Development Final Report produced for DEFRA - Executive Summary, (7).

Hatanaka, M., Konefal, J., & Constance, D. H. (2012). A tripartite standards regime analysis of the contested development of a sustainable agriculture standard, 65–78. doi:10.1007/s10460-011-9329-7

Holmes, M., Wiltshire, J., Wynn, S., & Lancaster, D. (2010). *PAS2050 Informing Low Carbon Procurement : Pilot Study - Food*.

Hurley, D., Murner, D., & Russell, A. (2010). *Public College and University Procurement*.

INCPEN. (1996). *Impact of Packaging in the UK Food Supply System*.

INCPEN. (2009). *Table for one the energy cost to feed one person*.

Indiana University Office of Sustainability 2020 Vision. (2010).

Inflation Calculator. (2013). *Bureau of Labor Statistics*. Retrieved May 2, 2015, from http://www.bls.gov/data/inflation_calculator.htm

IPCC. (2006). *2006 IPCC GUIDELINES FOR NATIONAL GREENHOUSE GAS INVENTORIES - Overview*.

IPCC. (2007). *Direct Global Warming Potentials*. Retrieved from http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html

Johnson, R., & Aussenberg, R. A. (2013). The Role of Local Food Systems in U . S . Farm Policy.

Kim, B., Houser, L. P., Rosenthal, A., & Neff, R. (2008). Literature Review of Methods and Tools for Quantifying the Indirect Environmental Impacts of Food Procurement, 1–65.

LCI Methodology and Data Sources. (2011). *CleanMetrics*. Retrieved September 6, 2015, from www.cleanmetrics.com/html/lci_methodology.htm

Low Carbon Diet. (2015). *Bon Appetit Management Company*. Retrieved May 6, 2015, from http://www.bamco.com/timeline/low-carbon-diet/

Low, S. A., Adalja, A., Beaulieu, E., Key, N., Martinez, S., Melton, A., … Jablonski, B. B. R. (2015). *Trends in U . S . Local and Regional Food Systems Report to Congress*.

Masi, B. B., Schaller, L., & Shuman, M. H. (2010). *THE 25 % SHIFT The Benefits of Food Localization for Northeast Ohio & How to Realize Them*.

Michigan State University Sustainability. (2015). *Michigan State University*. Retrieved from http://sustainability.msu.edu/

Miller, W. P. (1992). Economic Multipliers: How Communities Can Use Them for Planning. *Community & Economic Development*, 1–4. Retrieved from http://www.uaex.edu/Other_Areas/publications/PDF/FSCED6.pdf.

Moretti, E. (2010). Local multipliers. *American Economic Review*, *100*(May), 373–377. doi:10.1257/aer.100.2.373

New Economics Foundation. (2002). Plugging the Leaks: Making the most of every pound that enters your, *50*(September), 126. doi:10.1093/itnow/bwp027

Newcomb, M., & Rosett, M. (2009). Campus Carbon Foodprint UNC ' s Carbon Foodprint : The Carbon Dioxide Equivalent Emissions of Carolina Dining Services by Rupert Campbell , Jonathan Carr , Madeline Gwyn , 1–41.

Pimentel, D., Hepperly, P., Hanson, J., Douds, D., & Seidel, R. (2005). Environmental, Energetic, and Economic Comparisons of Organic and Conventional Farming Systems. *BioScience*, *55*(7), 573. doi:10.1641/0006-3568(2005)055[0573:EEAECO]2.0.CO;2

Pirog, R., Van Pelt, T., Enshayan, K., & Cook, E. (2001). Food, Fuel, and Freeways, (June).

Pomona College Action Plan - Food and Agriculture. (2015).

Pomona College Climate Action Plan. (2009).

President's Sustainability Steering Committee University of Texas at Austin Natural Resource

Conservation Plan. (2012).

Pretty, J. N., Ball, a. S., Lang, T., & Morison, J. I. L. (2005). Farm costs and food miles: An assessment of the full cost of the UK weekly food basket. *Food Policy*, *30*(1), 1–19. doi:10.1016/j.foodpol.2005.02.001

ProBas Prozessorientierte Basisdaten für Umweltmanagementsysteme. (2015). *Umwelt Bundesamt*. Retrieved February 5, 2015, from www.probas.umweltbundesamt.de/

Purdue University Sustainability Strategic Plan. (2010).

Quinn, G. P. (2009). *Local Food , Farms & Jobs : Growing the Illinois Economy Table of Contents*.

RFC. (2015). Real Food Challenge. *Real Food Challenge*. Retrieved May 2, 2015, from www.realfoodchallenge.org

Röös, E., & Karlsson, H. (2013). Effect of eating seasonal on the carbon footprint of Swedish vegetable consumption. *Journal of Cleaner Production*, *59*, 63–72. doi:10.1016/j.jclepro.2013.06.035

Routledge. (2004). *UC Sustainable Practices Policy*. doi:10.4324/9780203071052

Roy, P., Nei, D., Orikasa, T., Xu, Q., Okadome, H., Nakamura, N., & Shiina, T. (2009). A review of life cycle assessment (LCA) on some food products. *Journal of Food Engineering*, *90*(1), 1–10. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-48549096872&partnerID=40&md5=0ec582cb2c43eb091acb8553ea214b88

Sacks, J. (2002). *The Money Trail - Measuring your impact on the local economy using LM3* (Vol. 128). doi:10.1016/j.ajodo.2005.06.015

Sanger, K., & Zenz, L. (2004). *Farm to Cafeteria connections: marketing opportunities for small farms in Washingon State*.

Santa Cruz Climate Action Plan. (2011).

Saunders, C., Barber, A., & Taylor, G. (2006). *Food Miles – Comparative Energy / Emissions Performance of New Zealand ' s Agriculture Industry*. *Research Report*.

Shuman, M. H. (2010). *The Competitiveness of Local Living Economies*.

Silvenius, B. F., Grönman, K., Katajajuuri, J., Soukka, R., Koivupuro, H., & Virtanen, Y. (2014). The Role of Household Food Waste in Comparing Environmental Impacts of Packaging Alternatives, (June 2013), 277–292. doi:10.1002/pts

Small, E. (2012). *UMass Amherst Climate Action Plan 2.0*.

Smith College - Sustainability and Climate Action Management Plan (SCAMP). (2010).

Sonntag, V. (2008). *Why Local Linkages Matter*.

Spanò, L., Tyler, C. R., Van Aerle, R., Devos, P., Mandiki, S. N. M., Silvestre, F., … Kestemont, P. (2004). Effects of atrazine on sex steroid dynamics, plasma vitellogenin concentration and gonad development in adult goldfish (Carassius auratus). *Aquatic Toxicology*, *66*(4), 369–379. doi:10.1016/j.aquatox.2003.10.009

Stagner, J., & Ahmed, F. (2009). *Stanford Energy & Climate Plan*.

Stanford University Energy and Climate Plan. (2013).

Student Sustainability Committee Projects. (2015). *Student Sustainability Committee*. Retrieved May 6, 2015, from http://ssc.union.illinois.edu/projects.aspx

Sustainability Master Plan for Texas A&M University. (2010).

Swenson, D. (2009). *Investigating the Potential Economic Impacts of Local Foods for Southeast Iowa Analyzed by Dave Swenson Department of Economics , Iowa State University*.

Thatcher, J. (2004). *THE CORNWALL FOOD PROGRAMME - Evaluating the economic impoact of local procurement in the NHS*.

The NC 10% Campaign. (2015). *Center for Environmental Farming Systems*. Retrieved May 2, 2015, from http://www.cefs.ncsu.edu/whatwedo/foodsystems/10percent.html

The University of Montana Climate Action Plan. (2010).

U.S. Dairy Sustainability Report. (2012).

UC Berkeley Climate Action Plan. (2009).

UC Davis Climate Action Plan. (2010).

UC Riverside Climate Action Plan. (2010).

UMass Permaculture. (2014). *UMass Dining*. Retrieved May 6, 2015, from http://www.umassdining.com/sustainability/permaculture

United States Department of State. (2010). U.S. Climate Action Report.

United States Environmental Protection Agency. (2001). Apendix A. Sensitivity analysis: How do we know what is important? *Process for Conducting Probabilistic Risk Assessment.*, *3*, 1–37.

University of Florida Climate Action Plan. (2009).

University of Michigan - Ann Arbor Sustainability Goal Reporting Guidelines. (2014).

University of Missouri Climate Action Plan. (2011).

University of North Carolina Climate Action Plan. (2009).

UW Madison Office of Sustainability. (2012). *UW Madison*. Retrieved June 5, 2015, from http://sustainability.wisc.edu/

Venkat, K. (2012). Comparison of Twelve Organic and Conventional Farming Systems: A Life Cycle Greenhouse Gas Emissions Perspective. *Journal of Sustainable Agriculture*, *36*(6), 620–649. doi:10.1080/10440046.2012.672378

Vo, H. (2008). *Food Systems Awareness and Consumption Choice*.

Webb, J., Williams, A. G., Hope, E., Evans, D., & Moorhouse, E. (2013). Do foods imported into the UK have a greater environmental impact than the same foods produced within the UK? *The International Journal of Life Cycle Assessment*, *18*(7), 1325–1343. doi:10.1007/s11367-013-0576-2

Weber, C. L., & Matthews, H. S. (2008). Food-miles and the relative climate impacts of food choices in the United States. *Environmental Science & Technology*, *42*(10), 3508–13. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/18546681

WildCAP : The University of New Hampshire ' s Climate Action Plan. (2009).

WRI, & WBCSD. (2000). *The Greenhouse Gas Protocol*.

TABLES

Table 1.1 Sustainability Efforts at U.S. Educational Institutions

Institution*	Action:			Year Adopted	Agriculture	Food	Food waste	Local purchasing	Local Definition	Institution Size
Campus	CAP	RFC	Other							
Texas A & M	no	no	Sustainability Master Plan	2010	no	X	4	20%	ND	62,185
University of Florida	x	no		2009	no	No	no	no	no	49,042
University of Illinois	x	no		2010	x	X	x	30%	100 miles 250 miles*	44,520
University of Michigan Ann Arbor	no	no	Office of Campus Sustainability	2011	no	1	4*	20% **	250 miles**	43,625
UW Madison	no	no	Sustainability Council	2012	4*	4*	4*	no	ND	43,275
Purdue University	no	no	Purdue University Sustainability Strategic Plan	2010	no	X	x	x	Indiana or adjacent state	38,770

Table 1.1 (continued)

University of Texas Austin	no	no	Natural Resource Management and Conservation Strategic Plan	2011	no	No	no	no	ND	38,463
Michigan State University	no	no	Climate Outreach Team	2011	4	4	no	no	ND	37,454
UC Berkley	x	x	UC Sustainable Practices Policy	2009	no	No	no	no	2	36,204
University of Missouri	x	no		2011	4	4	no	no	ND	35,441
UC Davis	x	x	UC Sustainable Practices Policy	2010	no	No	no	no	2	35,41 5
Indiana University	no	x	2020 Vision	ND	no	X	no	20%	2	32,371
UMASS Amherst	x	x		2010	x	X	x	100%	3	27,269
Cornell University	x	no		2009	x	X	x	x	ND	20,939

Table 1.1 (continued)

UC Santa Barbara	x	x	UC Sustainable Practices Policy	2012	no	No	no	no	2	18,977
UC Riverside	x	x	UC Sustainable Practices Policy	2010	no	X	x	30%	2	18,539
University of North Carolina Chapel Hill	x	x		2009	no	No	no	25% current*	250 miles*	18,503
Boston University	no	x	GHG reduction goals in place*	ND	no	+*	+*	+*	ND	18,306
UC Santa Cruz	x	x	UC Sustainable Practices Policy	2011	no	No	no	no	2	15,978
University of Louisville	x	x		2010	no	+	+	15%*	250 miles*	15,727
University of Montana	x	x		2010	no	no	no	no	2	14,946
University of New Hampshire	x	no	Food Solutions New England	2009	no	no	no	no	Regional = New England	12,811

Table 1.1 (continued)

Stanford	no	1	Energy and Climate Plan	2009/2013	no	no	no	no	ND	7,063
Smith College	x	x		2010	no	x	x	RFC goals	150 miles	2,664
Pomona College	x	x	Action Plan- Food and Agriculture	2009	*	+	+	RFC goals*	200 miles*	1,607

1-No formal RFC affiliation, but similar goals
2-Institution offers no explicit local definition. Presumably using RFC's 150 mile definition
3-UMass Amherst has a goal to define "local" as a distance that allows best support of the local economy and communities, achieve carbon neutrality, and improve environmental quality.
4-Makes note of keyword, has some symbolic actions, but outlines no clear goals.
x-Quantifiable goal; + - Qualitative goal
* - Item was found on website, not in a CAP/sustainability plan
** UM Ann Arbor considers local as being in Michigan, or a processing facility within 250 miles of the Ann Arbor campus, with at least 50% of ingredients being sourced within 250 miles of the processing facility. This also excludes products of Concentrated Animal Feeding Operations, products of minimal nutritional value such as soda and many candies, as well as items composed primarily of water.
ND- Not Defined

(*Sustainability Master Plan for Texas A&M University*, 2010)(*University of Florida Climate Action Plan*, 2009)(*A Climate Action Plan for the University of Illinois at Urbana-Champaign*, 2010)(*University of Michigan - Ann Arbor Sustainability Goal Reporting Guidelines*, 2014)("UW Madison Office of Sustainability," 2012)(*Purdue University Sustainability Strategic Plan*, 2010)(*President's Sustainability Steering Committee University of Texas at Austin Natural Resource Conservation Plan*, 2012)("Michigan State University Sustainability," 2015)(*UC Berkeley Climate Action Plan*, 2009)(*University of Missouri Climate Action Plan*, 2011)(*UC Davis Climate Action Plan*, 2010)(*Indiana University Office of Sustainability 2020 Vision*, 2010)(Small, 2012; "UMass Permaculture," 2014)(*2009 Cornell Climate Action Plan*, 2009, "Food Skills Initiative," 2015)(Routledge, 2004)(*UC Riverside Climate Action Plan*, 2010)("Pomona College Action Plan - Food and Agriculture," 2015)(*UC Riverside Climate Action Plan*, 2010)(*University of North Carolina Climate Action Plan*, 2009)("Boston University Sustainability," 2010)(*Santa Cruz Climate Action Plan*, 2011)(Barnett et al., 2010)(*The University of Montana Climate Action Plan*, 2010)(*WildCAP : The University of New Hampshire ' s Climate Action Plan*, 2009)(Stagner

& Ahmed, 2009; *Stanford University Energy and Climate Plan*, 2013)(*Smith College - Sustainability and Climate Action Management Plan (SCAMP)*, 2010)(*Pomona College Climate Action Plan*, 2009).

Table 1.2 Real Food Calculator Assessment Tool

Local/Community Based	Fair	Ecologically Sound	Humane
local=produced, processed, and distributed within 150 miles	living wage, right to benefits, days or rest, overtime pay, etc.	Biodynamic Certified, Food Alliance Certified, USDA Organic Certified, Protected Harvest Certification, Rainforest Alliance Certified	Animal Welfare Approved, Biodynamic Certified, Global Animal Partnership steps 4-5+, Certified Humane

(RFC, 2015)

Table 1.3 Local Food Multiplier by Sector

Local Food Sector:	LM2 Range (1<LM2<2):	LM2 Average:	Expenses: (Food/Total)
Grocers	1.48 – 1.72	1.6	55-70 %
Restaurants and Food Service	1.67 – 1.88	1.78	27-36%
Distributors	1.16	1.16	87%
Manufacture and Processing	1.37 – 1.7	1.54	33-37%
Farms and Ranches	1.75 – 1.93	1.84	0-34%
All Local Food Economy	1.16-1.93	1.55	0-70%

Source: (Sonntag, 2008); Central Puget Sound Local Food Economy Survey(2005)

FIGURES

Figure 1.1 Sustainability Interest

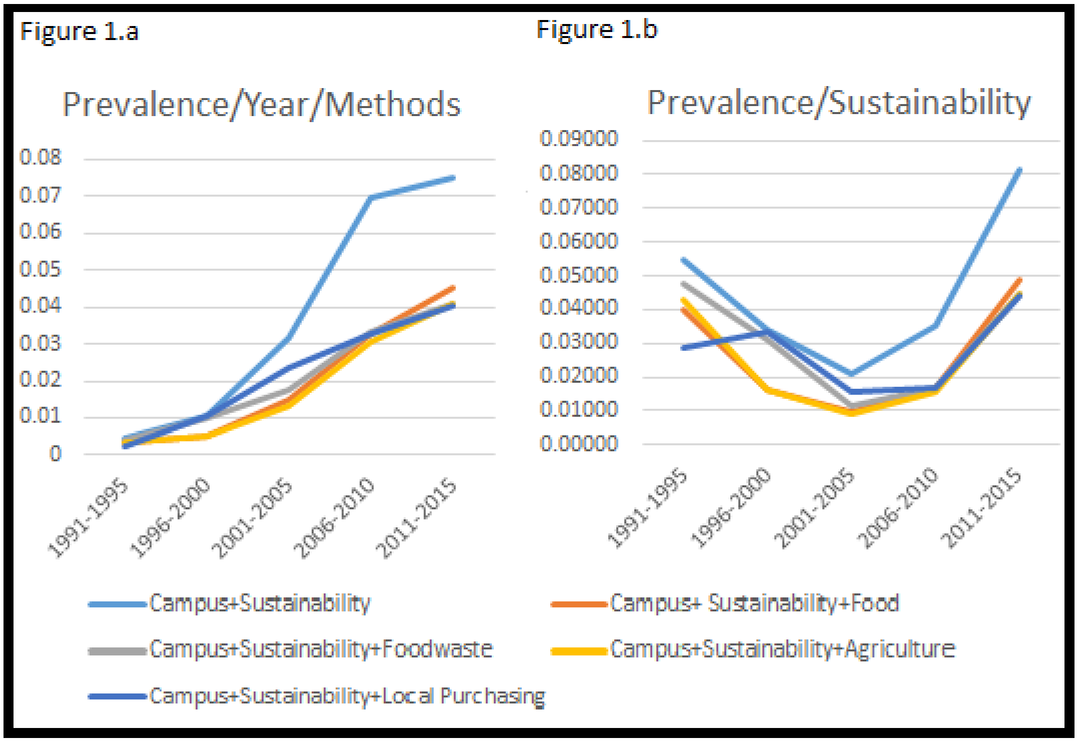

Figure 1.a depicts the prevalence of terms using Google Scholar after normalizing against the search term, 'Methods'. Figure 1.b shows that campus sustainability search results have increased as a proportion of overall sustainability results.

CHAPTER 2: UNIVERSITY OF ILLINOIS URBANA CHAMPAIGN FOODPRINT

ABSTRACT

To comply with the American College and University Presidents' Climate Commitment (ACUPCC), signatory campuses agree to conduct Greenhouse Gas (GHG) emission inventories every other year. While the inventory requires inclusion of on-site agricultural emission sources, it does not require the inclusion of purchased food in emissions estimates. Despite that fact, the University of Illinois at Urbana Champaign (UIUC)'s climate action plan (iCAP) makes reference to food procurement as a means of emissions reduction. To establish a campus baseline, this report conducted a life cycle assessment of the food items purchased by the University of Illinois Dining Services (DS) at the Urbana Champaign campus (UIUC) by constructing 1kg food models to reflect the mixed nature of food products in CleanMetric's FoodCarbonScope™. Packaging and transportation were also added to the estimate and Crystal Ball was used to perform a Monte Carlo style sensitivity analysis which was then used to estimate uncertainty. Finally, both the economic and emissions implications of shifting campus spending were explored through increased local purchasing and alternative protein consumption scenarios. In FY13, purchased food items composed 2.15% of the total university footprint. Using food pyramid groupings, meat accounted for around 50% of the foodprint, with beef comprising over 50% of that. Dairy contributes nearly 15%, with 'Staples' and Beverages constituting over 12% and 9% respectively. Convenience food, Baked Goods, and Produce follow in at over 5%, 4%, and 3% apiece. After on campus food storage, preparation, and serving are accounted for, food accounts for over 5% of UIUC's GHG footprint. Those numbers do not include estimates of emissions from food preparation because storage and preparation are already included in the campus inventory as energy expenses of dormitories and dining halls. Accounting for these would increase the GHG footprint by about 50%, and comprise about 1/3 of the total emissions from cradle to consumption. Transportation of food items turned out to be less impactful than expected, comprising approximately 4% of emissions for purchased food, and less than 0.1% of the total university footprint. Packaging averaged about 9% of the foodprint and is generally credited with preventing food loss which would increase the production emissions. Three different 'local' definitions were used to evaluate the a Local Multiplier (LM2) to explore the hypothesis that decreasing transportation of food items through local purchasing policies may do more by stimulating the regional economy by recirculating money spent within the area instead of exporting capital. The LM2 value for the three definitions of local ranged from 1.632 to 1.066 depending on if the product was grown, processed, and distributed within 100 miles or merely distributed somewhere in state. Additionally, those varying definitions show that UIUC's local purchases range from composing <1% under the 2010 iCAP definition

to 38% of food under the broadest definition. In FY13, DS purchased $27,361 of local food according to iCAP's definition, which is 'A', and the associated LM2 estimated over $17,000 of economic return to the community in second round recirculation. Thus, benefits derived from regional spending, and potential job creation from local production, processing, and distribution arguably outweigh GHG reductions of local food. Based on these findings, recommendations for reducing UIUC's foodprint, include: reducing meat, especially beef consumption possibly by having a weekly meatless day, or a voluntary vegetarian meal program, which could pass along the savings to the student. Additionally, it recommends that Local be defined to include an intermediate distance (≈600k) based on regional distribution opportunities because LM2 models show that the inclusion of production and processing steps are more crucial than exact distance in the definition. Given the regional capacity for grain, legume, and oil crop production, as well as the environmental, economic, and health benefits of a plant centered regional food system; this report recommends future research into specialty grain and bean crops and development of processing facilities to handle food quality specialty grains, legumes, and oils for regional consumption.

INTRODUCTION

2008 Baseline

In 2008 the University of Illinois, Urbana-Champaign (UIUC) signed the American College and University Presidents' Climate Commitment (ACUPCC) and established a baseline to gauge the overall impact of emission sources related to climate change and allow campus to track progress towards emissions reduction goals. The initial 2008 UIUC greenhouse gas (GHG) emissions inventory used Clean Air-Cool Planet's Excel based the Campus Carbon Calculator (CCC) which calculates emissions by multiplying emission factors for different practices with institution specific user inputted numbers that reflect campus energy consumption and travel by assessing purchased electricity, purchased steam, energy generation, commuting, air travel, fertilizer use, animal waste, and solid waste. The CCC is available free online and is recommended for use by the ACUPCC. To establish an inventory of key GHGs (Carbon Dioxide, Methane, Nitrous Oxide, and Fluorinated Compounds) UIUC defined its emissions boundary in accordance with ACUPCC guidelines which rely on the IPCC and the CCC to delineate what emission sources are included in our inventory (IPCC, 2006). UIUC accounting scopes define the operational boundaries in relation to direct and indirect GHG emissions; where, direct emissions are derived from entities owned or controlled by the institution and indirect emissions are derived from institutional activities that rely on outside entities and occur offsite. Scope 1 activities include all direct emissions; scope 2 includes indirect emissions derived from consumption of purchased electricity, heat, and steam and, scope 3 emissions involve other indirect emissions derived from campus activities supplied through purchased services including travel, procurement and waste disposal (WRI & WBCSD, 2000). UIUC's initial GHG inventory from 2008 revealed emissions of 570,000 Metric Ton Equivalents (MTE) of CO_2eq. Coal and natural gas combustion for heating, cooling, and other electricity generation accounted for 85% of the baseline, 10% of estimated emissions came from transportation/travel, 2% came from solid waste, and roughly 1% were derived from agricultural activities carried out on research farms(*A Climate Action Plan for the University of Illinois at Urbana-Champaign*, 2010). As is true for other ACUPCC signatories, the majority of foodstuffs served by campus Dining Services (DS) are considered scope 3, and so are not accounted for by the campus carbon calculator and have been left out of UIUC's inventory since its 2008 inception.

2010 iCAP

In 2010, campus released the first Illinois Climate Action Plan (iCAP) to outline a path to achieving carbon neutrality by 2050. Drawing on a 2010 analysis of UIUC's south farm emissions from 1860 ha (4600 ac) of cropland, pasture, and other agriculturally-focused facilities that was conducted by Dr. David Kovacic and students using the Illinois Farm Sustainability Calculator (Barrot, 2012), the iCAP estimated 7,130 MTE of CO_2 equivalents were derived from agriculture. This was estimated to account for about 1.4% of UIUC's overall footprint. The single largest source of farm emissions come in the form of methane and nitrous oxide derived from livestock and manure, which accounted for 44% of the agriculture-based footprint. Nitrous oxide derived from fertilizer application accounted for another 22% (Barot, 2012). Agricultural iCAP targets called for a 50% reduction in agriculturally-associated emissions by 2020, and called for campus to exceed state local food procurement standards by obtaining more than 30% of food purchases from local sources by 2015. The 2010 iCAP defined local food as that being produced within 100 miles of campus. Other strategies that were proposed to reduce campus emissions included the installation of a methane digester, which was thought to have the potential to decrease agriculture's footprint by 90% by harvesting methane and reusing more manure as potential fertilizer (*A Climate Action Plan for the University of Illinois at Urbana-Champaign*, 2010). Additional strategies called for incentives to promote use of organic and sustainable production practices on lands owned or leased by campus, the implementation of a biofuels initiative to use agricultural wastes as energy sources, composting of food wastes, investigation of biochar as a contributor to climate mitigation, the promotion of a 'local food network' and, the incorporation of carbon costs into food products sold on campus. Although the GHG impact of purchased food was unmeasured, the iCAP estimated that the transportation of food alone might account for 1.8% and 3.5% of total campus emissions (*A Climate Action Plan for the University of Illinois at Urbana-Champaign*, 2010).

2015 iCAP

The 2015 plan claims a larger physical footprint 2570ha (6368 acres) than used in 2010 for campus' agricultural-emissions reductions and reported these to have fallen by 24% from 8177 MTE CO_{2e} in 2008, to 6173 MTE CO_{2e} in 2014(*2015 Illinois Climate Action Plan*, 2015). The 2015 plan calls for the establishment of a baseline agricultural emissions derived from direct (managed lands) and indirect (food purchases) sources, noting that the emissions derived from our six residence halls which serve approximately 25,000 meals daily during the academic year, might be substantial. It calls for evaluation of food-service carbon foot print of Dining services and other vendors and advocates for increasing local procurement to 40% by 2025. Additionally, the document calls outlines unique goals such as increasing carbon sequestration of campus soils, converting at least 50 acres of UIUC farmland to agroforestry by 2020, and the also seeks to reduce agricultural nitrates in runoff and subsurface drainage by 50% by 2022. Calls for the establishment of a baseline for direct (land-based) and indirect (derived from food purchases) emissions appear in the 2015 iCAP draft which was released for public comment May 8, 2015.

Even though purchase of local-foods was one of two explicit targets set by the first iCAP, no analysis of the carbon footprint of campus food (foodprint) has been performed. This study used the CleanMetric's FoodCarbonScope™ (FCS) for LCA. Initially, iCAP identified food transportation as an area of concern. However, research shows GHG emissions derived from food-transportation typically comprise just 2-4% of the food-print of a particular product, and that emissions vary more with food type and production practices used (Collins & Fairchild, 2007; Harwell, 2005; Pretty, Ball, Lang, & Morison, 2005; Saunders et al., 2006; Webb et al., 2013; Weber & Matthews, 2008). Food grown in more southerly regions and shipped north have longer growing seasons, and therefore less heating costs for extended season production(Edwards-Jones et al., 2008). Therefore there is reason to believe that gains to the local economy might be more substantial than reductions to foodprint GHG emissions, (Quinn, 2009; Sonntag, 2008) so a Local Multiplier model was used to estimate regional recirculation of capital. The objective of this work was to quantify baseline emissions derived from food purchases, and estimate the GHG reductions and economic returns to the region that might be achieved from local food procurement for UIUC. Consequently, both the emissions and economic implications of shifting campus spending were explored through increased local purchasing and alternative protein consumption scenarios.

METHODS

Life Cycle Analysis Scope

The foodprint was constructed using Life Cycle Analysis (LCA) of the individual products purchased by UIUC Dining Services (DS) for the 2012-2013 fiscal year. This LCA used a project boundary of "cradle to delivery" which tracks the emissions involved in the production, transport, processing, and distribution of food items. The LCA for this study used the CleanMetric's FoodCarbonScope™ (FCS), which is an online tool available for a subscription which models food product GHG emissions and other resource use for all life cycle stages from cradle to grave. FCS accounts for farm level energy and water use in agricultural production scenarios considering inputs such as fertilizer, pesticides, irrigation, energy, and transport, as well as farm level waste management, and soil related emissions. Processing level emissions include cooking, packaging, and transportation options that can be broken into multiple stages to account for varied modes and distances. FCS was selected because it uses the largest life cycle inventory database for North American food production and processing, and complies with international standards ISO14040 and PAS 2050. FCS uses the US Life-Cycle Inventory Database and the IPCC guidelines for emissions factors, the EPA eGRID and IEA Energy Statistics for electricity, the Greenhouse Gas Protocol and DOE Transportation Energy Data Book for transportation, EPA Energy Star for refrigeration. Cleanmetrics cites many sources for materials as well as food and agriculture inventory information ("LCI Methodology and Data Sources," 2011). CleanMetrics did not offer quantified uncertainty or variance of their LCA. Cleanmetrics validated their findings by comparing to LCA studies cited in Environmental Working Group's Meat Eater's Guide: Methodology (Hamerschlag & Venkat, 2011). They report their results were within a 2-50% range of the other studies listed for meat and dairy products.

UIUC DS provided purchasing information in digital format for five of their largest vendors and the sustainable student farm which raises produce on campus (Chris Henning UIUC Dining Services, personal communication, 9/18/13). The data included over 4000 products, the dollar amount spent on each item and, the quantity of the item purchased. Many of the units were not natively listed as weights so conversions and clarification of ambiguous labels was necessary. In some instances the # symbol meant pounds of a product while in other cases, such as number ten sized cans, the #10 did not necessarily imply weight of the purchase unit. Additionally, the quantity and amount of containers included within 'cases' was explored to determine true product weights. After making the best assumptions possible and double checking questionable units with DS, a listing of kg purchased for over 4000 items was completed. The complete list is available in digital archive, titled "Total Purchases". Product quantities were converted into weights using the purchase units provided by DS to construct 1 kg food models. 1 kg models were used for each individual product that can then be scaled to reflect the actual purchase quantity, although some error may be associated with rounding by FCS for 1kg models. The LCA contained simple and mixed models to describe different types of foodstuffs. Simple models were composed of a single constituent that matched a product listed in the FCS database. For instance, potatoes are composed of no other ingredients and the FCS database has data for multiple production scenarios, varying by production location and/or method. Where possible, the most likely/appropriate source and production method were selected based on generalizations of production locations, food chain knowledge, and supplier information when available. Not all products had multiple production scenarios to choose from. As a rule of thumb, scenarios based in the western United States, especially California had higher embodied water values; while, production scenarios farther east, in more humid regions of North America, have less need for irrigation and therefore have less embodied water. If a product did not have a direct match in the database then it was assigned to a product deemed to be most similar for its model. For instance, FCS had only had data for sugar cookies. Therefore cookies of all types used the sugar cookie model. Mixed models needed to be created to represent food items of greater complexity. This was done by taking up to three of most abundant components of a product and weighting results from appropriate simple model estimates to represent appropriate proportions of the item. For instance, the model for egg sausage and cheese breakfast burritos was defined as being composed of eggs, cheese, and wheat bread, with weighting of 50%, 25%, and 25%, respectively. Some estimations were based on interpretation of a label (if available) and others were averaged based on best estimates. We note, some error will be associated with the construction and relative weight assigned to the complex models. For instance, the omission of sausage in the above example, is somewhat balanced by the increased proportion of egg and cheese.

Additional sensitivity analyses conducted using Oracle's Crystal Ball software (United States Environmental Protection Agency, 2001) were used to determine the impact of different product types, especially with concern for mixed models which are known approximations of food product composition. The sensitivity analysis applied a generic (+/-20%) variance assumption with a uniform distribution for a Monte Carlo style simulation (10,000 iterations) to all the food items in UIUC's foodprint to determine the largest sources of variation in the data set. Not surprisingly, the most expensive items were the largest emitters. Of the four largest sources of uncertainty, three were beef and one cheese. Since a few meat and dairy items accounted for the most uncertainty, the results from UIUC's foodprint were added as a data point to the LCA studies listed in Meat Eater's guide (Hamerschlag & Venkat, 2011) for beef, lamb, pork, chicken, milk, and cheese. This helped to calculate a standard deviation for beef, lamb, pork, chicken, milk, and cheese GHG estimates. The standard deviation for the food groups in question was then applied using Crystal Ball again to estimate a 95.6% confidence interval.

Transportation

Transportation, which affects Embodied Carbon (EC) as well as Embodied Energy, was omitted from the original FCS models so that variable transportation scenarios could be modeled separately. Many uncertainties exist when estimating the transportation distances for a vast array of products. This is complicated by the fact that products can be sourced from different locations at different times of the year, based on varying availability. Even though numerous email and phone attempts were made to retrieve transportation mileage from campus suppliers, only a small number of vendors provided transportation information needed to make refined estimates. Distances for all products are compiled in Table 2.3. Transportation scenarios listed on Table 2.3 include: the standard 1640km informed by Weber and Mathews (2008), 591km for Prairie Farms, 'South Pacific' models a scenario to account for products from New Zealand as a comparison for unseasonal foods, 100 km for some produce purchased from CIP, and 3km for produce grown on the sustainable farm (SSF). A literature review was then used to develop assumptions about the average transportation distances for the majority of foodstuffs. I contacted Rich Pirog, author of the widely cited 2001 report by the Leopold Center for Sustainable Agriculture that estimated some conventionally sourced food items travel 1,546 miles (km) to Iowan consumers (Pirog, Van Pelt, Enshayan, & Cook, 2001), He recommend against using that generic 1,500 food mile assumption based on his expertise and familiarity with the region. After consult, I selected the smaller average US transportation value reported by Weber and Matthews (2008) who cite a typical distance of 1640 km (1019 miles) for final delivery, out of a total supply chain of 6760km for all inputs. This was applied for products that did not have supplier informed transportation distances provided. Errors in assumptions about transportation distance are not too worrisome as the 1640km delivery portion only accounts for about 4% of a typical foodprint. This estimate is similar to Table for One's estimate that 3.5% of emissions are due to average energy expenditures for food delivery (INCPEN, 2009). Both studies agree that food production is a far greater contributor to the total foodprint than transportation(INCPEN, 2009; Weber & Matthews, 2008).

Dairy scenarios were informed by input from Prairie Farms (PF), which is a local distributor that provided information about the locations of processing plants, distribution centers, and reported that the majority of products they distributed locally were processed at either Peoria or Olney facilities, in Illinois and that dairy products are sourced from their respective regions (Ken Barenthin Prairie Farms, personal communication, 7/17/14). Additionally, the 2012 Dairy Sustainability Report cited the average dairy is 443km (275 mi) from the processing plant (*U.S. Dairy Sustainability Report*, 2012). Therefore the PF transportation model included 443km on refrigerated semi-trailer and 148km on a refrigerated single unit truck, a total of 591km which added .06 kg CO_2eq/kg food. Alpha Baking Company did not provide locations but did state that while the foods were processed in Illinois, the flour for most breads included hard spring and winter wheat varieties which are traditionally grown in the Great Plains rather than the soft winter wheat typically grown in Illinois (Tim Lotesto Alpha Baking Company, personal communication, 10/15/14). Given this, a bread item with an improbably direct supply chain from the center of South Dakota, processed in Chicago, and then shipped to Urbana would have 1416km of transportation. Since this estimate is undoubtedly on the low side, and it is near the 1640km assumption, products from the Alpha Baking group were assigned the typical 1640km value. Produce from the UIUC Sustainable Student Farm (SSF) was known to travel 3 km from the farm to an average dining hall. Other produce purchased from Central Illinois Produce (CIP) did not have as straightforward of a path. CIP acknowledged that while they purchase some items from nearby producers during the growing season, they source items from locations ranging from California, Arizona, Michigan, Florida, Idaho, Texas, and Chile all depending on the item and the season (John Peters Central Illinois Produce, personal Communication, 9/11/14). Since no quantified estimate was provided, and the majority of the school year is during winter months when local production is largely unavailable, CIP produce was assigned the average 1640km assumption with the understanding that it is certainly an overestimate of some products and conversely an underestimate of many as well. The majority of products were assumed to travel the standard 1640 km assumption.

Packaging

Product models were created without regard for packaging materials. The FCS food LCA asks for packaging information in terms of type and kg of material per kg of food. Since this data was unavailable for the DS dataset, and even more difficult to obtain than transportation data, packaging was added to the foodprint post FCS modeling. The Industry Council for Research on Packaging and the Environment (INCPEN) documented the energy expended at each stage of the supply chain for various food products after adjusting packaging as a percent of production, processing, and distribution to reflect the stage at which it was applied in this study (INCPEN, 2009). These packaging percentages correspond to the percentage of total energy it takes to get a product from farm to fork. In this case, the percentage of energy expended on packaging was used as a surrogate for the percentage of carbon produced for the sake of the food item. While Table for One considers the energy from farm to fork, the initial scope of this foodprint does not include retail, home storage, or cooking. Therefore energy percentages were adjusted to reflect the cradle to delivery scope used for the LCA, and the stage at which the packaging assumptions were applied. For this study, individually packaged items were classified as snacks, regardless of food type. Ice creams are classified as milk since density of 1.5 gallons of milk make 1 gallon of ice cream is closer to milk density than 10:1 for cheese. Individually packaged ice cream items however are classified as snacks. Items primarily sugar that are not individually packed are classified as sugar, such as corn syrup, jelly, and marshmallow cream. Nuts and beans were classified both as vegetables for the sake of this report.

Weighting/Post Distribution

Since the itemized list of purchases obtained from DS contained only about 2/3 of the total food expenditures that year, the calculations needed to be scaled to represent the full quantity of purchases. Not all categories were represented equally in the initial listing. Since US Foods supplies much of UIUC's meat, the initial listing contained 97% of the meat protein purchases. Scaling of the products relied on CO_2/$ spent for each of the food categories with values multiplied by the actual expenditure per category that was based on a separate purchase summary supplied by DS (Kit Smith UIUC Dining Services, personal communication, 2/9/2015). Not all the categories reported by the DS purchase summary aligned with the food pyramid style classification used in this report and therefore required some manipulation. The product groupings Dairy, Meat Protein, Produce, and Baked Goods aligned well, but DS designated categories Beverages, Convenience Food, and Staples did not. Items listed as Staples that did not match any one of the food pyramid groupings, or that contained little to no meat products, were considered a mix of carbohydrates and fats. Thusly those categories were averaged for a common CO_2/$ value based on products they contained to generate multipliers for Staples, Convenience Food, and Beverages. The value used for Beverages, Convenience Food, and Staples is the average from Fat and Carbohydrates. Additionally, the amount of categorized dairy purchased is larger than the amount reported in the DS report. Some of the dairy items were categorized as convenience foods in the DS report. While this method clearly results in an estimation, the expected footprints should be relatively close, and are not expected to contribute to significant error as these products are non-meat products with foodprints below 3 kg CO_2/kg food (Table 2.1).

This report used FCS to calculate the GHG emission of food being delivered to UIUC, but this is not the end of the story. Those food items must be stored and prepared on campus. The energy for storage and preparation was already included in the initial inventory as building energy expenses and therefore was added separately to avoid double counting as part of the foodprint. Using generic estimations, we asked 'what would be the overall footprint of the food served in DS?' Based on Table for One's (2009) energy allotment breakdown, the average food product incurs 51% of its footprint at the production stage, 10% from packaging, 3.5% from distribution transport, 3% from retailing, 1.5% consumer transport, 17% for post distribution storage, and 14% for food preparation. Since DS has the food items delivered directly to the point of consumption, the final consumer transportation segments can be excluded. To provide a complete accounting, UIUC's foodprint needs to be increased by another 34% to account for: retail, storage, and cooking. Accordingly, the average footprint post distribution (ready for consumption) was assumed to be 50% of the delivery foodprint.

Local Multiplier

To determine the basic economic recirculation factor, a Local Multiplier (LM) was used. While LM's can be used to show many iterations of spending (Miller, 1992; Sacks, 2002), this report only used an LM2, which factors: A) the initial purchase from a regional business B) the dollars spent by that regional business. Each successive round of spending that is accounted for increases the multiplier. Not all businesses recirculate dollars in the same fashion. This report used values (Table 1.3) cited by Viki Sonntag (2008) based on a Local Food Economy Survey for Central Puget Sound LFE Businesses (2005) which estimated the LM2 recirculation values for different segments of the food sector. The LM2 values for production, processing, and distribution were used with ERS Food Dollar Fraction where, which shows what portion of each food dollar spent goes to each segment of the food system (Canning, 2011). This study considered what portion of food spending returns through the farm, processor, and distributor. For the sake of the food dollar fraction, processing was assumed to include processing, packaging, and transportation, modeled after a medium sized regional business such as Prairie Farms. That portion was then multiplied by the LM2 values according to sector, which resulted in an average LM2 value of 1.63 for regionally produced and processed foods. Since this LM2 does not consider any further spending which would surely ensue to some degree, it is assumed to underestimate true recirculation (Quinn, 2009; Sacks, 2002; Sonntag, 2008). Table 2.6 displays the varying impacts of 'local' for three different definitions; showing the FY13 percentage of each 'local' definition, the LM2 impact, as well as the GHG attributable to the supply chain. Local definitions include: A-iCAP's definition of local, within 100 miles of campus; B-Using UM Ann Arbor's definition of food processed within 250 miles of campus, and produced within 250 miles of processing; C-Any portion of production, processing, or distribution in state. The LM2 multiplier for the products of definition A and B included production, processing, and distribution while the LM2 for products added specifically for definition C only included processing and distribution. The removal of production reduced the LM2 value from 1.632 to 1.066.

Alternative Purchasing Scenarios

Goals for alternative purchasing scenarios included discerning the environmental and economic impact of altering: 1. purchases by food type, 2. food miles, and 3. ramping up regional production of low carbon foods. Scenarios for reducing foodprint looked at the highest emitting food items and replaced them with lower emission sources with comparable nutritional value. Scenarios for regional production of low carbon foods were informed by this study (need for protein substituted), as well as knowledge of regional food supply and agronomic capability.

RESULTS AND DISCUSSION

LCA

Assessment of the original dataset revealed it accounted for 9,548±218 MTE CO_2e. Breakdowns by category showed that meat protein incurred the largest foodprint. This was evident in GHG by weight (per kg purchases), GHG per dollar spent, and total footprint (Table 2.1). Not all meat products are created equally, the highest emitting foods come from ruminant livestock, cattle and sheep. Aside from the feed to fatten the animals these livestock produce enteric methane during digestion, which is a potent GHG. Measured as production, processing, and distribution to UIUC, beef's emissions averaged 18.47 kg CO_2e/kg food while chicken and pork came in at 4.96 and 7.52 CO_2e/kg food respectively. Dairy products followed with an average foodprint of 2.74 kg CO_2e/kg food, with carbohydrates and vegetable protein averaged at 1.26 and 1.11 kg CO_2e/kg food, respectively. This shows that even without dramatically reducing meat consumption, GHG reductions can occur from simple consumption shifts. For greater reductions, switching animal protein to plant protein shows the most promise. The most surprising aspect of Figure 2.1 is that plant proteins such as tofu, nuts, and peanut butter cost more than chicken and pork meat. This must be due to some economy of scale factor since the resources to produce 1 kg of plant protein-as reflected by CO_2eq/kg are significantly less than that of meat. Adding the foodprint to the previously existing agriculture LCA more than doubles the impact of agriculture and therefore warrants attention.

Transportation

Depending on product type, transportation accounts for only a small portion of the foodprint, 4% on average but ranging from 2-25% of emissions (Table 2.4). Transportation accounts approximately .09% of the entire UIUC Footprint, at 368 MTE CO_2e. Table 2.2 further depicts the role of transportation in this foodprint. Of all product categories evaluated, transportation constitutes the largest percentage of fruit and vegetable's Embodied Carbon, at 33% (Table 2.4). This is not a result of produce requiring more resources to transport, but of the fact that produce has a smaller production footprint so transportation accounts for a larger percentage of its final emissions. Conversely, transportation accounts for less than 2% of meat foodprint since the production footprint of meat is significantly higher proportionately. Table 2.3 shows transportation scenarios, and the associated footprint of each, and the related LM2 is on Table 2.6. The most common assumption for this report, '1640km standard'(C) adds .14 kg CO_2e/kg food, PF (B) adds .06 kg CO_2e/kg food, CIP(A) incurs .02 kg CO_2e/kg food. FCS modeled the transport of food 3km from the Sustainable Student Farm as negligible. A 'South Pacific' scenario was also modeled to estimate emissions from food shipped from Australia or New Zealand, and showed to incur .29 kg CO_2e/kg food. Granted, these GHG differences seem significant, especially since scenario C has over twice the footprint of definition B, but this difference is small compared to the production footprint (Table 2.1). The PF model comes to approximately 590km (367 mi), which is outside many definitions of 'local' (Table 2.3), but congruent with definition B from Table 2.6. The initial estimate from the 2010 iCAP proposed food transportation alone accounted for between 1.8-3.5% of the total campus GHG emissions, which would be between 10,260-19,950 MTE CO_2e of the 570,000 MTE CO_2e in the 2008 inventory (*A Climate Action Plan for the University of Illinois at Urbana-Champaign*, 2010). The value calculated by this report is significantly lower than the initial iCAP estimate. Reducing food miles, while beneficial, is not the most efficient way of reducing GHG emissions, as further demonstrated in alternative purchasing scenarios.

Packaging

The proportion of packaging in this foodprint ranges from 9% on average, and up to 24% of lighter items (Table 2.4). Packaging is often considered extraneous waste in the food chain when in reality it protects the investment of energy expended in producing, processing, and transport does not go to waste by allowing foods to spoil (INCPEN, 1996). After all, the energy used to produce, protect, store, and prepare food requires 5 times more energy than the caloric value of the consumed food(INCPEN, 2009). In reality, estimates of packaging significance place it between 1-10% of the overall environmental impact for food products, which is relatively low compared to the loss of food waste (INCPEN, 2009; Silvenius et al., 2014). Additionally, single serving packages are often singled out as being particularly wasteful. A Finnish study found some environmentally conscious consumers purchased larger package sizes which use less packaging per unit of food, however this can lead to food waste from spoiled food which actually has the opposite of the intended effect (Silvenius et al., 2014).

Weighting/Post Distribution

The final, weighted foodprint at 11,010±251 MTE for food produced and delivered, 21,178±483 MTE for the same food prepared and served on campus. This weighted value better reflects the proportion of meat, baked goods, produce, etc., purchased by DS as compared to the initial dataset. Post distribution adjustment accounted for on campus storage, preparation, and presentation. This increased the total impact by 51% of the delivered foodprint to 21,178±483 MTE CO_2e, which comes to 5.46% of UIUC's total footprint. Purchased and prepared food account for over 2.15% and 5.46% of the total UIUC footprint, respectively (Table 2.2). Since the energy of on campus food storage and preparation is already included in campus energy consumption, this means that the additional 10,169 MTE is already included as a portion of the campus' overall carbon footprint. However, the size of the post distribution foodprint, at 5.46%, is smaller than expected since the IPCC estimates agriculture as producing 13.5% of anthropogenic emissions (Barker et al. 2007). Considering enteric emissions as well as deforestation for pasture and feedstock production, the United Nations Food and Agriculture Organization reports that global livestock production alone represents 18% of total anthropogenic emissions (FAO, 2006) including land use change such as deforestation that comes with feeding livestock. The EPA estimates that agriculture contributes 8% of our national footprint, however this number does not account for food processing, transport, or land use change, merely production(United States Department of State, 2010). UIUC's lower than expected foodprint is likely due to the UIUC inventory considering only food served on campus by UIUC DS, and does not extend to private dorms, or students and faculty that live off campus. Additionally, students that do live on campus and are served by DS do not obtain 100% of their food from DS. For instance, UIUC DS serves 25,000 meals per day (2015 Illinois Climate Action Plan, 2015) for around 40,000 students, most of whom are obtaining food elsewhere. Meanwhile, since UIUC does pay for electricity, heating, and other emissions sources incurred by both dorm residents and rest of the UIUC student and employee population, the perceived importance of foodprint per capita is diminished.

Post distribution costs vary by product, and affect the relative proportion of other aspects of a foodprint. For instance, the percent of emissions assigned to packaging of snacks seemed especially high initially, but after scaling the scope of Table for One with the scope of this study it became apparent that the relatively high values for packaging were due to the lack of energy used in home storage or preparation, as most snack foods come ready to eat. When comparing snack foods to potatoes for instance, which require approximately five times as much energy to cook than to grow and therefore packaging switched from 5% to 22% of the foodprint when post distribution stages were excluded.

Local Multiplier

The LM2 calculations show that a switch from zero to 100% regional food purchasing would result in over 9 Million dollars recirculating in the regional economy on top of the $15M of initial spending. UIUC DS currently does purchase some regional products, so while this number is an overestimate, it shows the potential of local recirculation. Determining the economic recirculation from local food depends first and foremost on the definition of local food since definitions can vary widely (Table 1.1). US Foods, UIUC DS's largest supplier, provided a list of local food that accounts for approximately 1/3 of all food purchases. The only definition accompanying the list was that they were "Illinois produced items". Presumably, the foods on the list have some portion of their supply chain in the state of Illinois. Three different LM2 values are used in this report to reflect varying 'local' definitions (Table 2.6). The LM2 multiplier was altered to remove production from the scope of those products, reducing it from 1.632 to 1.066. Using definition C does give the largest LM effect, $757,621, however the actual impact of its LM2 value is the lowest at 1.066. Farms and ranches have a higher LM than either processors or distributors, and would benefit the regional economy more than importing food to process in state(Sonntag, 2008). Using the more refined definition, B, the LM2 value increases to 1.632. Note, that this is a conservative estimate as real dollars will likely recirculate more than twice in a region, which is unaccounted for here. A common perception is that local foods are inherently more expensive than traditional suppliers, except for brief periods of seasonality. Higher prices would diminish the purchasing power of food dollars, increase the expense for consumers, and affect the LM2. However, the Economic Research Service of the USDA recently concluded that prices at direct to consumer outlets are on average lower in all seasons than retail stores (Low et al., 2015). Also, costs are likely to compare favorably to current protein substitutes like tofu or nuts that are now bought at a premium.

CONCLUSION

How much progress has been made toward the 2010 iCAP agricultural goals?

The iCAP set out two agricultural targets (*A Climate Action Plan for the University of Illinois at Urbana-Champaign*, 2010):

1) Reduce directly related agricultural emissions by 50 percent by 2020.
2) Exceed the State local food procurement standards by making more than 30 percent of food purchases from local sources (within 100 miles) by 2015.

The iCAP seeks to reduce all agricultural emissions by 50%, therefore the food portion of agriculture should look to cut its emissions proportionately between food purchasing and food production. However, until now the GHG emissions associated with purchased food had not been inventoried.

While public and institutional interest in reducing GHG emissions is increasing (Figure 1.1), no educational institutions had yet considered their foodprint in a carbon inventory. Granted the ACUPCC does not require inclusion of purchased food in the scope 3 emissions for signatories (ACUPCC, n.d.), but according to the Greenhouse Gas Protocol, scope three includes all other indirect emissions, and therefore should include purchased food (WRI & WBCSD, 2000). Gauging from the significance to the UIUC footprint, this seems like an oversight that should be considered by institutions alongside other emission reducing strategies as campuses look at all avenues for GHG reduction. With increasing interest in GHG reduction, greater adoption of low carbon procurement requires more in depth analysis and better understanding of life cycle analysis (LCA) in order to best guide purchasing toward these goals (Correia, Howard, Hawkins, Pye, & Lamming, 2013(Church, 2014; Dubb & Howard, 2012; Holmes et al., 2010; Kim et al., 2008). More in depth LCA understanding of production and processing practices can continue to reduce food related emissions.

Since the GHG emissions from purchased foods had not previously been inventoried, there has not yet been any reduction to meet the 50% reduction target, but this work may serve as a baseline for future comparison. To the second goal of local purchasing, under the broadest definition UIUC is already exceeding this goal (Table 2.6). Varying definitions of local show that UIUC's local purchases range from composing <1% under the 2010 iCAP definition to 38% of food under the broadest definition. This report endorses an intermediate distance definition as regional definition A is especially limiting and would take significant infrastructure to realize, definition C is too broad and does not provide the same benefits as locally grown and processed food. While increasing the portion of locally grown food can help reduce the foodprint by reducing food miles, transportation should not be the primary concern for cutting emissions. Food transportation accounts for 4% of the UIUC foodprint, and less than .1% of the overall UIUC Footprint (Table 2.2). However economic factors provide incentive to support local and regional economies(Masi et al., 2010; Quinn, 2009; Shuman, 2010; Sonntag, 2008; Swenson, 2009; Thatcher, 2004). The simple LM2 used in this report suggests more consideration should be focused on the economics of local purchasing than the GHG reduction aspect. This groundwork may serve as a future baseline for marking progress toward sustainability goals.

SCENARIOS AND RECOMMENDATIONS

The information from this report informed the GHG and economic impacts of alternative purchasing scenarios to meet iCAP goals by increasing vegetable protein and local procurement. Table 2.7 shows ten scenarios varying in purchase type and transportation distances, along with their implications for the UIUC foodprint. Table 2.7 shows considers reduction in transportation GHG if the scenario used a similar definition. PF refers to a regional definition similar to that of a regional company, Prairie Farms, (Similar to Scenario B from Table 2.6) which this report recommends adopting by UIUC. CIP refers to the transportation scenario similar with production and processing occurring within 100 miles of campus (Similar to Scenario A from Table 2.6). See also Table 2.1 for more transportation scenario definitions. The greatest reduction comes from reducing meat, particularly beef purchase. The drastic move of replacing all meat with regionally produced vegetable proteins would cut the UIUC foodprint by nearly 50%, but other options also offer benefits. One opportunity to reduce meat consumption with a carrot instead of a stick might be to offer a vegetarian meal plan that could pass on the monetary savings to students that opted for such a plan, although this may mean separate preparation and/or serving stations. Given the regional capacity for grain, legume, and oil production, and both the environmental and economic benefits of a plant centered regional food system, this report recommends future research into specialty grain and bean crops and development of processing facilities to handle food quality specialty grains, legumes, and oils. This report made no estimate of the GHG footprint of locally produced and processed grains, and plant proteins compared to those grown in other regions. An in depth LCA would be required in order to detect differences in production region or practices. Using FY13 purchasing information, approximately 100 acres could supply the flour, bread, and other baked goods for campus, less than 20 acres could supply dry beans, and around 300 acres could support the canola and soybean oil consumption of UIUC, a tremendous growth opportunity for the institution. Hurdles to increasing local grain and oil crop products include potentially needing specialty varieties, local milling and baking, or oil pressing. These hurdles double as an example of how buying local can benefit the regional economy through job creation. The Food Science and Human Nutrition Pilot Processing Plant on campus has begun canning tomatoes grown by the SSF for consumption later in the school year after tomato harvest has declined. The tomato processing operations were not underway in 2013 and therefore not included in this foodprint. With continued coordination from the Sustainable Student Farm, the pilot processing plant can begin to bridge the gap with processing of the grains and oil crops for DS. A model regional food system on campus that utilizes local grains, legumes and oil crops can demonstrate feasibility for future expansion and adoption by the community. It may be that the most feasible transition option for UIUC would be to grow dry beans since they require the least processing equipment, and low acreage could supply a large percentage of purchased dry beans. The combination of increased plant protein, local production, processing, and distribution will move the campus and region toward long term environmental, economic, and social sustainability.

REFERENCES

2009 Cornell Climate Action Plan. (2009).

2015 Illinois Climate Action Plan. (2015).

A Climate Action Plan for the University of Illinois at Urbana-Champaign. (2010).

ACUPCC. (n.d.). ACUPCC Greenhouse Gas Inventory Brief, 1–8.

ACUPCC. (2006). Presidents' Climate Commitment.

Bahlai, C. a., Xue, Y., McCreary, C. M., Schaafsma, A. W., & Hallett, R. H. (2010). Choosing organic pesticides over synthetic pesticides may not effectively mitigate environmental risk in soybeans. *PLoS ONE*, *5*(6). doi:10.1371/journal.pone.0011250

Barclay, C. (2012). *Food Miles-House of Commons Standard Note*.

Barker T., I. Bashmakov, L. Bernstein, J. E. Bogner, P. R. Bosch, R. Dave, O. R. Davidson, B. S. Fisher, S. Gupta, K. Halsnæs, G.J. Heij, S. Kahn Ribeiro, S. Kobayashi, M. D. Levine, D. L. Martino, O. Masera, B. Metz, L. A. Meyer, G.-J. Nabuurs, A. Najam, D. Z. (2007). Technical summary. *Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, 23–78. doi:10.1103/PhysRevD.70.106002

Barnett, R., Battcher, P., Boggs, A., Cotton, S., Curtin, M., Dietz, K., … Payne, R. (2010). *University of Louisville Climate Action Plan*.

Barot, S. (2012). *Climate Action Planning: An Analysis of University of Illinois Climate Action Planning*.

Bassil, K. L., Vakil, C., Sanborn, M., Cole, D. C., Kaur, J. S., Kerr, K. J., & Sanin, L. H. (2007). Cancer health effects of pesticides. *Canadian Family Physician*, *53*(10), 1704–1711. Retrieved from http://www.hubmed.org/display.cgi?uids=17934034

Blanke, M. M., & Burdick, B. (2005). Food (miles) for Thought: Energy balance for locally-grown versus imported apple fruit. *Environmental Science and Pollution Research*, *12*(3), 125–127.

Boston University Sustainability. (2010). *Boston University*. Retrieved June 5, 2015, from http://www.bu.edu/sustainability/

Canning, P. (2011). *A Revised and Expanded Food Dollar Series A Better Understanding of Our Food Costs*.

Carlsson-Kanyama, A. (1998). Food Consumption Patterns and their Influence on Climate Change. *Ambio*, *27*(7), 528–534.

Church, S. (2014). *Local and Sustainable Food Procurement by New England State Governments : Barriers and Recommendations*.

Collins, A. J., & Fairchild, R. (2007). Sustainable Food Consumption at a sub-national level: an ecological footprint, nutritional and economic analysis. *Journal of Environmental Policy and Planning*, *9*(1), 5–30. doi:10.1080/15239080701254875

Correia, F., Howard, M., Hawkins, B., Pye, A., & Lamming, R. (2013). Low carbon procurement: An emerging agenda. *Journal of Purchasing and Supply Management*, *19*(1), 58–64. doi:10.1016/j.pursup.2012.11.004

Davis, A. S., Hill, J. D., Chase, C. a, Johanns, A. M., & Liebman, M. (2012a). Increasing cropping system diversity balances productivity, profitability and environmental health. *PloS One*, *7*(10), e47149. doi:10.1371/journal.pone.0047149

Davis, A. S., Hill, J. D., Chase, C. a, Johanns, A. M., & Liebman, M. (2012b). *Table S2 Increasing cropping system diversity balances productivity, profitability and environmental health.*

Democracy Collaborative. (2010). *Policy Brief Stimulating Economic Growth through Local Purchasing By directing their massive purchasing power locally , anchor institutions encourage local business improvements and , ultimately , economic growth and stability Making it Work Best Practice*.

Donahue, B., Burke, J., Anderson, M., Beal, A., Kelly, T., Lapping, M., … Berlin, L. (2013). *A New England Food Vision*.

Dubb, B. S., & Howard, T. (2012). Job Creation : Entrepreneurship Approach Leveraging Anchor Institutions for Local Job Creation and Wealth Building, (Cms 2011), 1–31.

Dunning, R. (2011). *Summary of Key Points: Evidence-based Support for Local Food Systems, Proposed Research, and the Role of Extension Summary of Key Points*.

Edwards-Jones, G., Milà i Canals, L., Hounsome, N., Truninger, M., Koerber, G., Hounsome, B., … Jones, D. L. (2008). Testing the assertion that “local food is best”: the challenges of an evidence-based approach. *Trends in Food Science & Technology*, *19*(5), 265–274. doi:10.1016/j.tifs.2008.01.008

Enderton, A., & Bregendahl, C. (2015). Food Hub Development in Iowa Lessons learned from a.

FAO. (2006). *Livestock’s long shadow*.

Food Skills Initiative. (2015). *Cornell Sustainable Campus*. Retrieved May 6, 2015, from http://www.sustainablecampus.cornell.edu/initiatives/food-skills

Gammon, D. W., Aldous, C. N., Carr, W. C., Sanborn, J. R., & Pfeifer, K. F. (2005). A risk assessment of atrazine use in California: Human health and ecological aspects. *Pest Management Science*, *61*(4), 331–355. doi:10.1002/ps.1000

Gunders, D. (2012). Wasted: How America is losing up to 40 percent of its food from farm to fork to landfill. *NRDC Issue Paper*, (August), 1–26. Retrieved from http://www.nrdc.org/food/files/wasted-food-IP.pdf?mkt_tok=3RkMMJWWfF9wsRonuqjPZKXonjHpfsX56+woXaS1lMI/0ER3fOvrPUfGjI4ATMphI/qLAzICFpZo2FFUH+GbbIFU8g==

Hall, K. D., Guo, J., Dore, M., & Chow, C. C. (2009). The progressive increase of food waste in America and its environmental impact. *PLoS ONE*, *4*(11), 9–14. doi:10.1371/journal.pone.0007940

Hamerschlag, K., & Venkat, K. (2011). *LIFECYCLE ASSESMENTS : METHODOLOGY & RESULTS Meat Eaters Guide : Methodology Table of Contents*.

Harwell, B. (2005). The Validity of Food Miles as an Indicator of Sustainable Development Final Report produced for DEFRA - Executive Summary, (7).

Hatanaka, M., Konefal, J., & Constance, D. H. (2012). A tripartite standards regime analysis of the contested development of a sustainable agriculture standard, 65–78. doi:10.1007/s10460-011-9329-7

Holmes, M., Wiltshire, J., Wynn, S., & Lancaster, D. (2010). *PAS2050 Informing Low Carbon Procurement : Pilot Study - Food*.

Hurley, D., Murner, D., & Russell, A. (2010). *Public College and University Procurement*.

INCPEN. (1996). *Impact of Packaging in the UK Food Supply System*.

INCPEN. (2009). *Table for one the energy cost to feed one person*.

Indiana University Office of Sustainability 2020 Vision. (2010).

Inflation Calculator. (2013). *Bureau of Labor Statistics*. Retrieved May 2, 2015, from http://www.bls.gov/data/inflation_calculator.htm

IPCC. (2006). *2006 IPCC GUIDELINES FOR NATIONAL GREENHOUSE GAS INVENTORIES - Overview*.

IPCC. (2007). *Direct Global Warming Potentials*. Retrieved from http://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html

Johnson, R., & Aussenberg, R. A. (2013). The Role of Local Food Systems in U . S . Farm Policy.

Kim, B., Houser, L. P., Rosenthal, A., & Neff, R. (2008). Literature Review of Methods and Tools for Quantifying the Indirect Environmental Impacts of Food Procurement, 1–65.

LCI Methodology and Data Sources. (2011). *CleanMetrics*. Retrieved September 6, 2015, from www.cleanmetrics.com/html/lci_methodology.htm

Low Carbon Diet. (2015). *Bon Appetit Management Company*. Retrieved May 6, 2015, from http://www.bamco.com/timeline/low-carbon-diet/

Low, S. A., Adalja, A., Beaulieu, E., Key, N., Martinez, S., Melton, A., … Jablonski, B. B. R. (2015). *Trends in U . S . Local and Regional Food Systems Report to Congress*.

Masi, B. B., Schaller, L., & Shuman, M. H. (2010). *THE 25 % SHIFT The Benefits of Food Localization for Northeast Ohio & How to Realize Them*.

Michigan State University Sustainability. (2015). *Michigan State University*. Retrieved from http://sustainability.msu.edu/

Miller, W. P. (1992). Economic Multipliers: How Communities Can Use Them for Planning. *Community & Economic Development*, 1–4. Retrieved from http://www.uaex.edu/Other_Areas/publications/PDF/FSCED6.pdf.

Moretti, E. (2010). Local multipliers. *American Economic Review*, *100*(May), 373–377. doi:10.1257/aer.100.2.373

New Economics Foundation. (2002). Plugging the Leaks: Making the most of every pound that enters your, *50*(September), 126. doi:10.1093/itnow/bwp027

Newcomb, M., & Rosett, M. (2009). Campus Carbon Foodprint UNC ' s Carbon Foodprint : The Carbon Dioxide Equivalent Emissions of Carolina Dining Services by Rupert Campbell , Jonathan Carr , Madeline Gwyn , 1–41.

Pimentel, D., Hepperly, P., Hanson, J., Douds, D., & Seidel, R. (2005). Environmental, Energetic, and Economic Comparisons of Organic and Conventional Farming Systems. *BioScience*, *55*(7), 573. doi:10.1641/0006-3568(2005)055[0573:EEAECO]2.0.CO;2

Pirog, R., Van Pelt, T., Enshayan, K., & Cook, E. (2001). Food, Fuel, and Freeways, (June).

Pomona College Action Plan - Food and Agriculture. (2015).

Pomona College Climate Action Plan. (2009).

President's Sustainability Steering Committee University of Texas at Austin Natural Resource

Conservation Plan. (2012).

Pretty, J. N., Ball, a. S., Lang, T., & Morison, J. I. L. (2005). Farm costs and food miles: An assessment of the full cost of the UK weekly food basket. *Food Policy*, *30*(1), 1–19. doi:10.1016/j.foodpol.2005.02.001

ProBas Prozessorientierte Basisdaten für Umweltmanagementsysteme. (2015). *Umwelt Bundesamt*. Retrieved February 5, 2015, from www.probas.umweltbundesamt.de/

Purdue University Sustainability Strategic Plan. (2010).

Quinn, G. P. (2009). *Local Food , Farms & Jobs : Growing the Illinois Economy Table of Contents*.

RFC. (2015). Real Food Challenge. *Real Food Challenge*. Retrieved May 2, 2015, from www.realfoodchallenge.org

Röös, E., & Karlsson, H. (2013). Effect of eating seasonal on the carbon footprint of Swedish vegetable consumption. *Journal of Cleaner Production*, *59*, 63–72. doi:10.1016/j.jclepro.2013.06.035

Routledge. (2004). *UC Sustainable Practices Policy*. doi:10.4324/9780203071052

Roy, P., Nei, D., Orikasa, T., Xu, Q., Okadome, H., Nakamura, N., & Shiina, T. (2009). A review of life cycle assessment (LCA) on some food products. *Journal of Food Engineering*, *90*(1), 1–10. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-48549096872&partnerID=40&md5=0ec582cb2c43eb091acb8553ea214b88

Sacks, J. (2002). *The Money Trail - Measuring your impact on the local economy using LM3* (Vol. 128). doi:10.1016/j.ajodo.2005.06.015

Sanger, K., & Zenz, L. (2004). *Farm to Cafeteria connections: marketing opportunities for small farms in Washingon State*.

Santa Cruz Climate Action Plan. (2011).

Saunders, C., Barber, A., & Taylor, G. (2006). *Food Miles – Comparative Energy / Emissions Performance of New Zealand ' s Agriculture Industry*. *Research Report*.

Shuman, M. H. (2010). *The Competitiveness of Local Living Economies*.

Silvenius, B. F., Grönman, K., Katajajuuri, J., Soukka, R., Koivupuro, H., & Virtanen, Y. (2014). The Role of Household Food Waste in Comparing Environmental Impacts of Packaging Alternatives, (June 2013), 277–292. doi:10.1002/pts

Small, E. (2012). *UMass Amherst Climate Action Plan 2.0*.

Smith College - Sustainability and Climate Action Management Plan (SCAMP). (2010).

Sonntag, V. (2008). *Why Local Linkages Matter*.

Spanò, L., Tyler, C. R., Van Aerle, R., Devos, P., Mandiki, S. N. M., Silvestre, F., … Kestemont, P. (2004). Effects of atrazine on sex steroid dynamics, plasma vitellogenin concentration and gonad development in adult goldfish (Carassius auratus). *Aquatic Toxicology*, *66*(4), 369–379. doi:10.1016/j.aquatox.2003.10.009

Stagner, J., & Ahmed, F. (2009). *Stanford Energy & Climate Plan*.

Stanford University Energy and Climate Plan. (2013).

Student Sustainability Committee Projects. (2015). *Student Sustainability Committee*. Retrieved May 6, 2015, from http://ssc.union.illinois.edu/projects.aspx

Sustainability Master Plan for Texas A&M University. (2010).

Swenson, D. (2009). *Investigating the Potential Economic Impacts of Local Foods for Southeast Iowa Analyzed by Dave Swenson Department of Economics , Iowa State University*.

Thatcher, J. (2004). *THE CORNWALL FOOD PROGRAMME - Evaluating the economic impoact of local procurement in the NHS*.

The NC 10% Campaign. (2015). *Center for Environmental Farming Systems*. Retrieved May 2, 2015, from http://www.cefs.ncsu.edu/whatwedo/foodsystems/10percent.html

The University of Montana Climate Action Plan. (2010).

U.S. Dairy Sustainability Report. (2012).

UC Berkeley Climate Action Plan. (2009).

UC Davis Climate Action Plan. (2010).

UC Riverside Climate Action Plan. (2010).

UMass Permaculture. (2014). *UMass Dining*. Retrieved May 6, 2015, from http://www.umassdining.com/sustainability/permaculture

United States Department of State. (2010). U.S. Climate Action Report.

United States Environmental Protection Agency. (2001). Apendix A. Sensitivity analysis: How do we know what is important? *Process for Conducting Probabilistic Risk Assessment.*, *3*, 1–37.

University of Florida Climate Action Plan. (2009).

University of Michigan - Ann Arbor Sustainability Goal Reporting Guidelines. (2014).

University of Missouri Climate Action Plan. (2011).

University of North Carolina Climate Action Plan. (2009).

UW Madison Office of Sustainability. (2012). *UW Madison*. Retrieved June 5, 2015, from http://sustainability.wisc.edu/

Venkat, K. (2012). Comparison of Twelve Organic and Conventional Farming Systems: A Life Cycle Greenhouse Gas Emissions Perspective. *Journal of Sustainable Agriculture*, *36*(6), 620–649. doi:10.1080/10440046.2012.672378

Vo, H. (2008). *Food Systems Awareness and Consumption Choice*.

Webb, J., Williams, A. G., Hope, E., Evans, D., & Moorhouse, E. (2013). Do foods imported into the UK have a greater environmental impact than the same foods produced within the UK? *The International Journal of Life Cycle Assessment*, *18*(7), 1325–1343. doi:10.1007/s11367-013-0576-2

Weber, C. L., & Matthews, H. S. (2008). Food-miles and the relative climate impacts of food choices in the United States. *Environmental Science & Technology*, *42*(10), 3508–13. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/18546681

WildCAP : The University of New Hampshire ' s Climate Action Plan. (2009).

WRI, & WBCSD. (2000). *The Greenhouse Gas Protocol*.

TABLES

Table 2.1 UIUC Foodprint by Category

This table show weight purchased (kg), amount purchased ($), total kg CO_2eq (CO_2eq), kg CO_2eq/kg food (CO_2eq /kg), and the amount spent per kg of purchased food ($/kg) for each food type. Meat, Dairy, and Veg Protein show the totals and averages for their associated groups (*italics*). Taken from the original dataset provided by Dining Services.

Food Type	kg	$	CO2e	CO2e/kg	$/kg
Eggs	76,858	180,954	185,788	2.42	2.35
Meat Products	38,292	403,865	220,093±**5,800**	5.75	10.55
Meat	**594,901**	**4,047,392**	**4,998,000±240,000**	**8.40**	**6.80**
Beef	145,026	1,263,089	2,678,502	18.47	8.71
Chicken	259,805	1,289,179	895,365	3.45	4.96
Turkey	32,039	241,073	148,125	4.62	7.52
Pork	114,088	664,095	867,099	7.60	5.82
Lamb	5,132	67,269	134,868	26.28	13.11
Seafood	38,811	522,687	274,055	7.06	13.47
Dairy	**600,603**	**1,415,529**	**1,644,506±63,800**	**2.74**	**2.36**
Yogurt	45,752	137,229	54,462	1.19	3.00
Milk/Cream	418,011	472,615	402,256	0.96	1.13
Butter/Cheese	136,839	805,685	1,187,787	8.68	5.89
Veg Protein	**63,367**	**304,761**	**70,340±35,000**	**1.11**	**4.81**
Tofu	19,925	148,616	17,928	0.90	7.46
Beans	32,061	77,180	36,281	1.13	2.41
Nuts	6,904	52,976	8,221	1.19	7.67
Peanut Butter	4,478	25,988	7,909	1.77	5.80
Fats	**246,767**	**1,049,888**	**596,670±20,200**	**2.42**	**4.25**
Carbohydrates	**557,766**	**1,954,605**	**1,307,094±23,600**	**1.26**	**3.50**
Produce	**674,461**	**1,340,651**	**325,695±632,000**	**0.64**	**1.99**

Table 2.2 UIUC Footprint Statistics

UIUC foodprint and Non-Food agriculture as total MTE and proportion of total footprint, as calculated by the Office of Sustainability.

FY13	MTE CO2e	% Total
UIUC Inventory	501,780	97.9%
Non Food Ag Footprint	7,408	1.4%
UIUC Foodprint	11,010±251	2.1%
Total Ag Footprint	18,418±251	3.6%
Ag Footprint + Post Delivery Food	28,586±483	5.6%
GHG from Transportation	440	0.1%
GHG from Packaging	991	0.2%
Total UIUC Inventory	512,790	100.0%

Table 2.3 Transportation Models

Transportation models vary for this study, 1640km was the standard assumption used for all food products without a documented supply chain. GHG emissions calculated in CleanMetric's FoodCarbonScope (FCS). TC= the kg CO_2eq for transportation per kg food. CIP= Central Illinois Produce; SSF=Sustainable Student Farm

Title	Total km	Leg 1 (km)	Leg 1 type	Leg 2	Leg 2 type	Leg 3	Leg 3 type	Mode	GHG (kg)
1640 Standard	1640	1530	Semi Trailer	110	Single unit Truck	n/a	n/a	Standard	0.14
Prairie Farms	591	443	Semi Trailer	148	Single unit Truck	n/a	n/a	Refrigerated	0.06
SSF	3	3	Single unit Truck	n/a	n/a	n/a	n/a	Standard	<.01
CIP Local	120	120	Single unit Truck	n/a	n/a	n/a	n/a	Standard	0.02
South Pacific	15025	12000	Ocean, large tanker	2800	Semi-Trailer	225	Single-Unit Truck	Standard	0.29

Table 2.4 Proportion of Transportation and Packaging Emissions as part of total UIUC Foodprint

Transportation here is considered from farm to delivery to UIUC.

Food Category	Delivered			Prepared		
	kg CO2e/ kg food	Transportation % Total Foodprint	Packaging % Total Foodprint	kg CO2e/ kg food	Transportation % Total Foodprint	Packaging % Total Foodprint
Fat	2.42	5.64%	15.48%	2.64	5.16%	14.17%
Dairy	2.72	3.17%	8.67%	3.68	2.34%	6.41%
Protein-Meat	8.40	1.67%	6.48%	12.06	1.16%	4.51%
Meat Products	5.75	2.44%	8.24%	7.60	1.85%	6.24%
Protein-Veg	1.11	12.61%	13.46%	1.91	7.32%	7.81%
Carbohydrates	2.34	5.99%	12.62%	6.78	2.07%	4.36%
Produce	0.48	33.22%	13.15%	0.81	19.87%	7.87%
Average	3.27	4.00%	8.67%	5.24	2.50%	5.41%

Table 2.5 Post Distribution Multiplier by Food Type

These values were derived from Table For One (INCPEN, 2009) and used to account for presentation, storage, and cooking as a post-delivery multiplier. The UIUC column shows the approximation for GHG emissions assumed to be added at the university level. Home use post-delivery also includes consumer transportation of food items.

	Storage	Cooking	Presentation	Consumer Travel	UIUC	Home Use
Product	% of Total Supply Chain				Post Delivery Multiplier	
Total/Average	17	14	3	1	1.521	1.55
Bread	38	8	1	2	1.903	1.935
Cereals	0	26	2	2	1.396	1.422
Cheese	8	0	3	2	1.127	1.145
Eggs	12	29	2	2	1.759	1.793
Fats/Oils	11	0	5	1	1.192	1.205
Fish	12	4	2	1	1.225	1.232
Fruit (fresh)	0	0	6	6	1.063	1.125
Fruit (produce)	17	0	5	3	1.295	1.341
Potatoes	16	55	4	3	4.340	4.463
Meat	14	13	3	1	1.448	1.455
Milk	38	0	5	2	1.785	1.818
Alcohol	13	0	1	3	1.172	1.203
Soft Drinks	18	0	2	4	1.250	1.295
Tea/Coffee	0	51	0	0	2.030	2.03
Snacks	0	0	0	2	1.000	1.024
Sugar	3	0	3	3	1.029	1.029
Vegetables (fresh)	5	28	2	2	1.561	1.596
Vegetables (other)	25	21	3	1	2.000	2.030

Table 2.6 Local Multiplier Impact of Various Local Definitions

Three different definitions of local, corresponding supply chains that represent each and the impacts on GHG emissions and local economic recirculation. Definitions A and B include production and processing in the Local Multiplier value while C only requires in state distribution.

Local	Transport	Total	CO_2e	Locally Purchased		LM2	
Definition	Model	Kilometers	Food Purchased	%	$	Multiplier	$ Recirculated
A	CIP Local	120	0.02	0.18%	27,361	1.632	17,300
B	Prairie Farms	591	0.06	4.45%	666,320	1.632	421,320
C	1640 Standard	1640	0.14	38.41%	5,741,000	1.066	757,620

Table 2.7 Alternative Purchasing Scenarios

Alternative purchasing scenarios highlight the impact of purchasing shifts on GHG emissions and economic recirculation. All transportation reduction applies only to effect of new purchases. Similarly, all diversion and $ recirculation only reflects the amount diverted. 'PF' and 'CIP Local' reflect transportation scenarios B, and A from Table 2.6, respectively.

Scenario	GHG Reduction		$			Transportation Reduction				Comments
	MTE	%	DS Savings	Diverted Locally	Recirculated	PF MTE	PF %	CIP MTE	CIP %	
Current	1101	-	$14971626.38	-	-	-	-	-	-	*FY13 Baseline
Replace 25% beef with vegetable protein	629	6.5	$140,000.00	$190,000.00	$280,000.00	2.9	0.03	4.3	0.04	
Replace 50% beef with equal amounts tofu/beans	1265	13.1	$273,000	$357,000	$580,000	5.8	0.06	8.7	0.09	
Replace all meat and meat products with vegetable protein	4,515	46.8	$1,406,000	$3,045,300	$4,963,800	55.7	0.51	83.5	0.76	Dairy and Eggs unchanged
Replace 1/5 meat with veg protein	810	8.4	$221,770	$534,890	$871,880	8.9	0.08	13.3	0.12	Simulate 'Meatless Monday' scenario
Reduce meat by 1/5 (all from beef)	1,930	20.0	$433,750	$534,890	$871,880	8.9	0.08	13.3	0.12	Meatless Monday, but all reduction from beef
No purchasing change, 100% regional supply	0	0.0	$0	$9,282,100	$15,130,000	181.0	1.64	270.0	2.45	Produced and Processed regionally. Dairy not included since already regional
Replace flour only with local flour	0	0.0	$0	$18,699	$30,480	1.4	0.01	2.0	0.02	These scenarios assume a regional food system based on grains, legumes, and oil crops, that could be initially modeled on campus.
Replace flour and baked goods with local	0	0.0	$0	$499,570	$814,300	12.7	0.11	19.1	0.17	
Replace vegetable oils (soy and canola) with local	0	0.0	$0	$238,780	$389,220	8.6	0.08	12.9	0.12	
Replace flour, baked goods, and vegetable oils with local	0	0.0	$0	$738,350	$1,203,500	21.3	0.19	32.0	0.29	

FIGURES

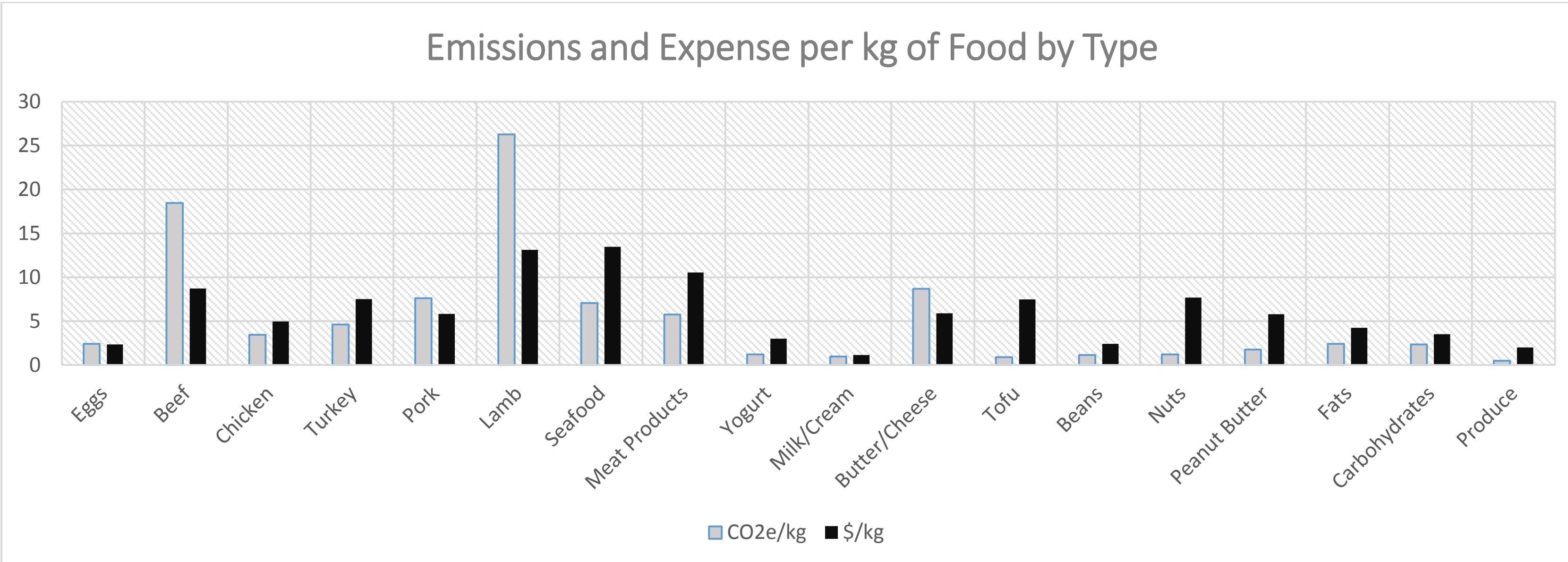

Figure 2.1 Emissions and Expenditures by UIUC Dining Services by Food Type

Data found in Table 2.1

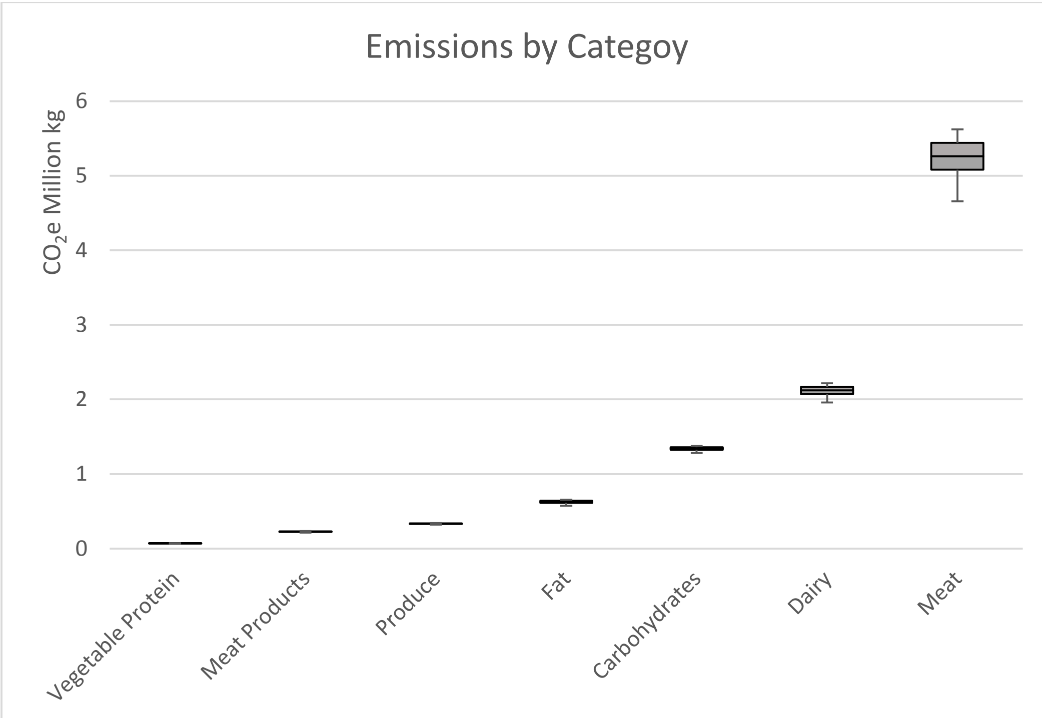

Figure 2.2 Emissions by Category with Confidence Intervals

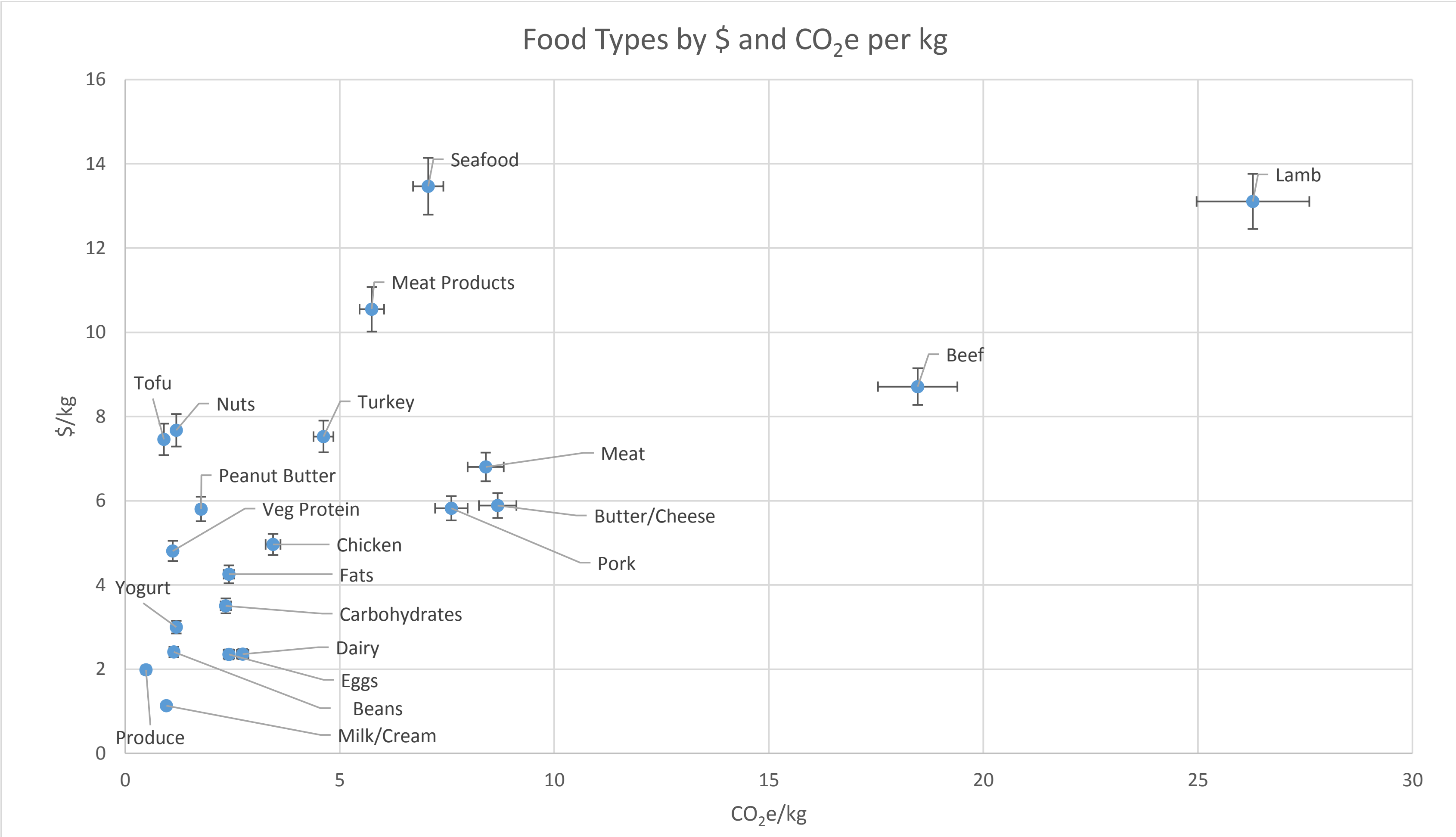

Figure 2.3 Food Types by $/kg and CO_2e/kg

Cost ($) and emissions ($CO_2e$) per kg of food by category

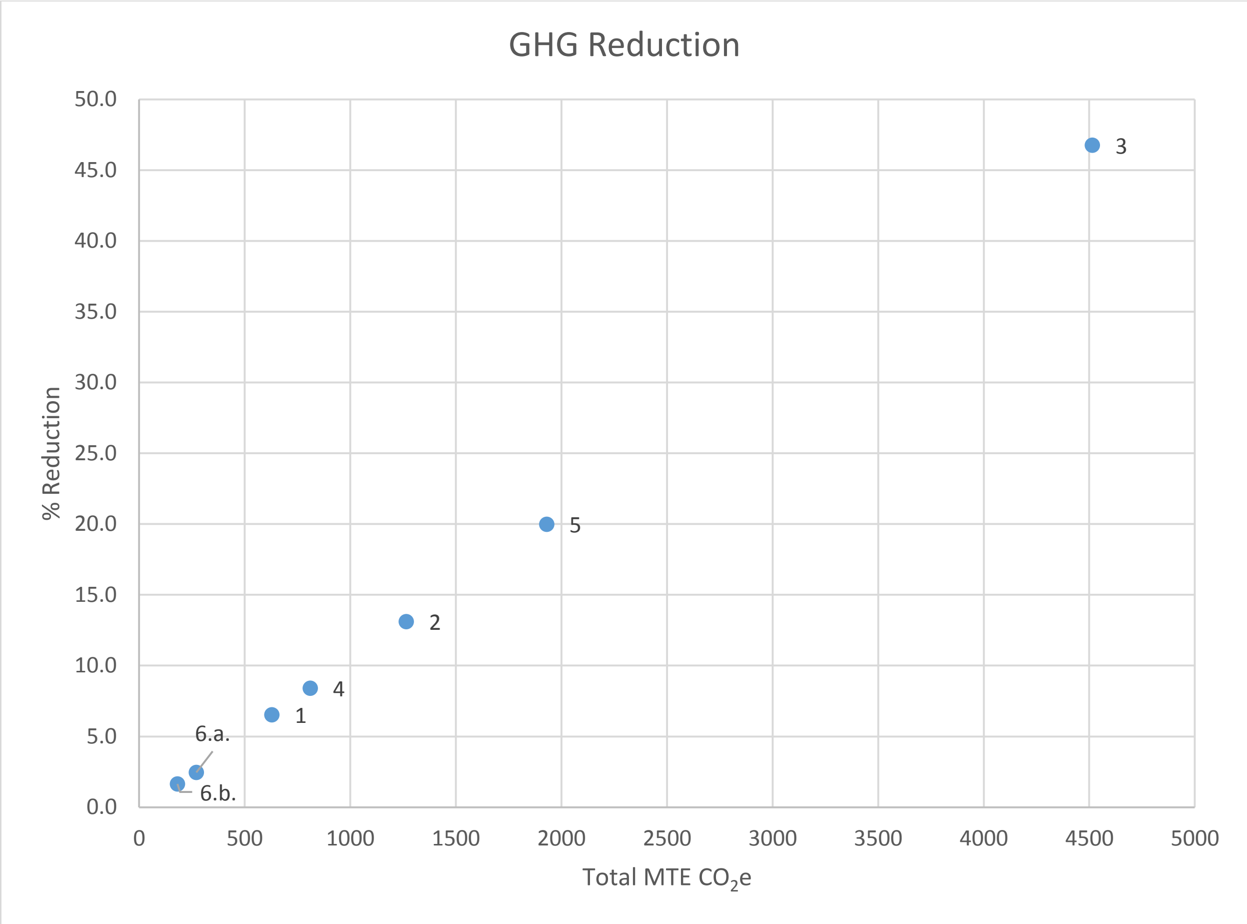

Figure 2.4 Purchasing Scenario GHG Reduction

Figure illustrates GHG reductions through alternative purchasing scenarios depicted in Table 2.7.

1. Replace 25% beef with vegetable protein

2. Replace 50% beef with equal amounts tofu/beans

3. Replace all meat and meat products with vegetable protein

4. Replace 1/5 meat with veg protein

5. Replace meat by 1/5 (all from beef)

6.a. No purchasing change, 100% supplied within 100 miles (Local definition A)

6.b. No purchasing change, 100% supplied within 500 miles (Local definition B)

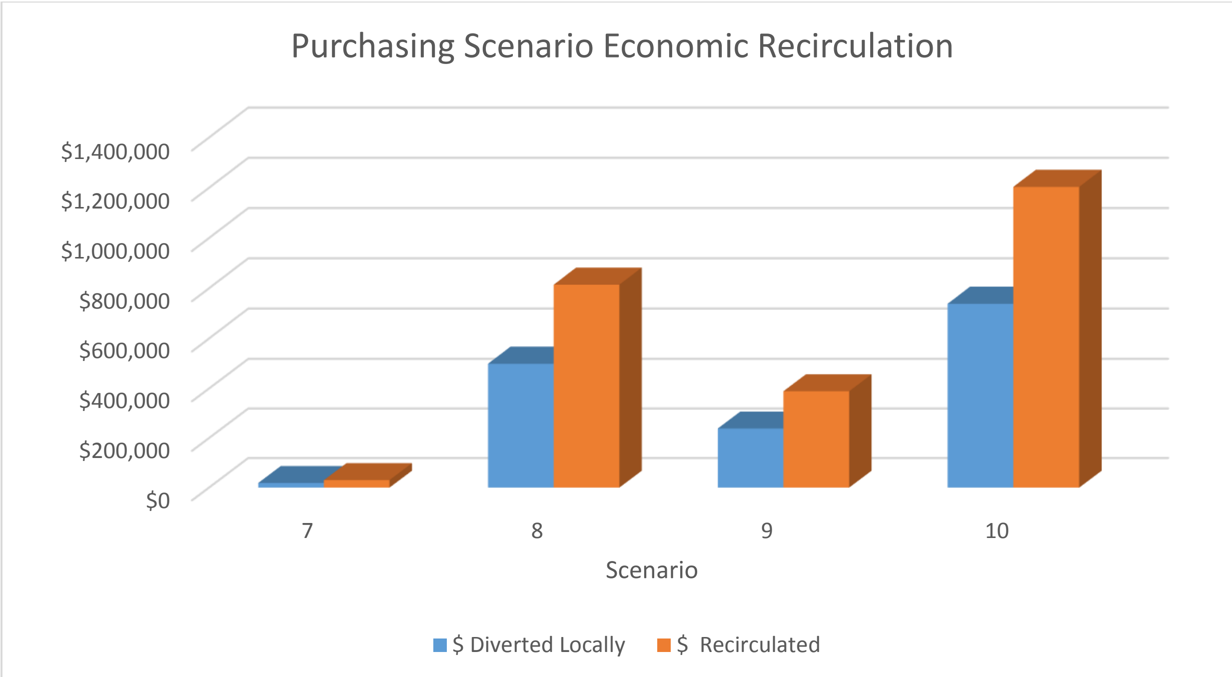

Figure 2.5 Purchasing Scenario Economic Recirculation

Figure illustrates economic diversion and recirculation using LM2 through alternative purchasing scenarios depicted in Table 2.7.

7. Replace flour only with local flour

8. Replace flour and baked goods with local

9. Replace vegetable oils (soy and canola) with local

10. Replace flour, baked goods, and vegetable oils with local

CHAPTER 3: SUMMARY

Interest in sustainability has increased on the campuses of colleges and universities across the nation in recent decades. Educational institutions have increased attention to reducing carbon emissions and the American College and University Presidents' Climate Commitment has emerged as a guide, requiring institutions perform baseline carbon inventories and publish climate action plans with emissions reduction targets. Very little progress has been made toward assessing and reducing the Greenhouse Gas (GHG) emissions from our food supply; while Scope 1 agricultural emissions are accounted for, the Climate Action Plans are not required to account for, or address scope 3 emissions related to food despite estimates that agriculture accounts for around 15% of all anthropogenic emissions. Additionally, local foods are often touted as better for reducing emissions related to food miles, including in the 2010 Illinois Climate Action Plan. This report estimates that in FY13, purchased food items accounted for 2.15% of the total UIUC GHG footprint. Including emissions related to on campus food storage and preparation and other agricultural activities on the south farms means that agriculture and food consumption are responsible for 5.6% of UIUC's total footprint.

Meat products accounted for around 50% of the foodprint, with beef comprising over 50% of that. Dairy accounted for about 15%. Packaging composed approximately 9% of an average product's footprint. Transportation miles only composed 4% of the foodprint, so while reducing mileage does not offer the same GHG saving potential as altering consumption and production practices, Local Multiplier (LM2) models show economic benefits to the region derived from increasing local production and processing. Varying definitions of local show that UIUC's local purchases range from composing $<1\%$ under the 2010 iCAP definition to 38% of food under the broadest definition. More narrow definitions that require production and processing to also be local improve the local multiplier.

Results from this work suggest purchasing and consumption scenarios that focus on regional food production and processing, reducing meat consumption, and capitalize on the region's capacity for grain, legume, and oil crop production will best support a local, environmentally and economically sustainable food system.