A Cost Benefit and Life Cycle Analysis of Distant and Local Farming Systems

By

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Abstract:

As the population of the world continues to exponentially increase, so have the demands for food and America's agricultural production has transformed in order to meet these needs. Today's conventional methods have shifted to systems of heavy synthetic chemical use, large farm size, and mass transportation, causing degrading effects on the environment and human health. An alternative, more sustainable method of production is becoming increasingly important. A life cycle analysis was done in this study to assess the environmental impact of Local and Distant farms with respect to Conventional and Organic systems and determined which of the four systems contributes a greater impact. A cost benefit analysis for local and super markets was done to compare the economic cost of each system. The results showed that distant conventional farms have a higher impact compared to the other farming types, with local organic showing the least impact. In the CBA, price was not found to have a correlation by the distance traveled. These results suggest that the most conventional method of farming is contributing to environmental degradation, and that this impact is not being accounted for in the price or produce but is actually making it cheaper for the consumers to buy.

1. Introduction

As the population of the world continues to exponentially increase, so have the demands for food and America's agricultural production has transformed in order to meet these needs. Before the concern of world hunger became a global issue, America's farming world was dominated by family farms that were living and working together in smaller scale communities, compared to today's society. These production methods included natural fertilizer applications that came from the farm animals such as cow manure, crop rotation throughout a single growing season where one crop may take out certain nutrients and another crop grown in the same spot would replenish those back into the soil, and the size of land that was farmed on was only a couple acres. Most importantly, the amount of man power needed to run these farms required multiple laborers where work was very labor intensive in order to produce and protect crop yields. This not only provided healthy fresh food to the community and a primary food source for the family, but it also passed on knowledge to younger generations in a world where being a farmer was a popular occupation. In the past 100 years however, traditional farming methods have changed with an increase technology that has made it possible to increase the farm size while also decreasing the number of operators who run that farm (Heller and Keoleian 2002).

1.1 A Change in Agriculture

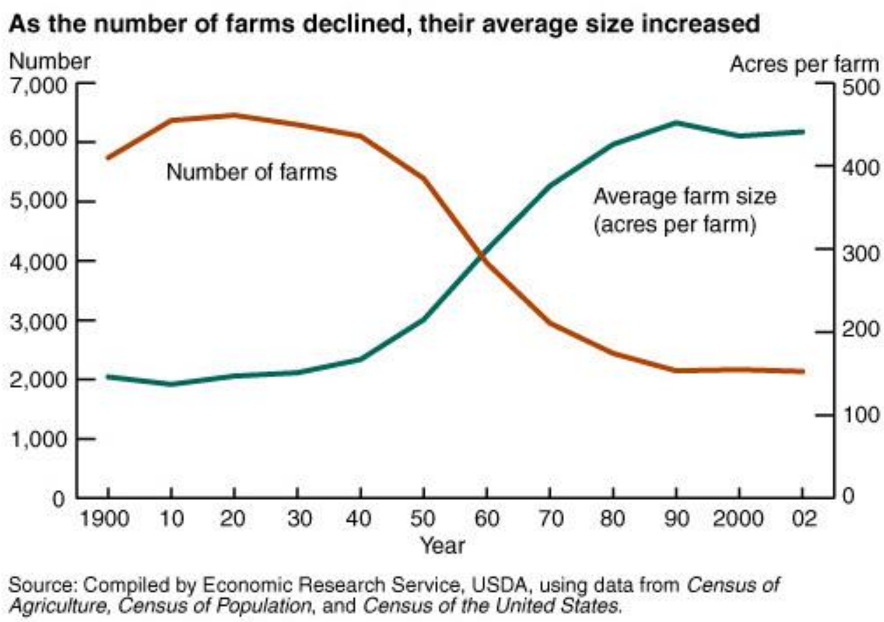

Figure 1. Illustrated data that has been compiled through census data by the Economic Research Service where in the past 50-60 years

After the rise of the Green Revolution, in a post-World War II society, a transformation occurred in agriculture that can define today's conventional methods of production. One significant change in production was the use of natural fertilizers, such as manure, to synthetically produced fertilizers using the high energy input to carry out the Haber-Bosch process. This technological advancement, along with synthetic pesticide production, was thought to be the answer for solving world hunger by promoting and protecting higher crop yields that could be distributed around the globe. Land usage has also significantly increased in this new conventional farming world where it went from more farms producing on a couple acres of land and has transformed to a fewer number of farms using hundreds or thousands of acres for crop yields (Figure 1). The increased technology has made today's agriculture more efficient in processes like tilling, planting and harvesting that are done by machinery, reducing the amount of manpower needed in production. The use of these machines also requires high energy input of fossil fuels, which also increases as the size of the land being used increases.

The rise of these technologically advance methods have become more popular in the markets by supplying "fresh" cheap produce to consumers at large national and regional chains of grocery stores. With sustainability becoming an important factor to measure within these systems, life cycle analysis comparing different methods of production have also been on the rise (Heller and Keoleian 2002) and comparison studies that have been done define conventional methods as reliant on intensive chemical use.

In the United States today, conventional agriculture production relies on heavy commercial fertilizers and pesticide to promote and protect crop yields. As corporate supermarkets have become popular places for convenient shopping, conventional farms have increased in size and have also increased the transportation of their goods to national and regional corporate chains of grocery stores. Farmers, a once important occupation in pre-industrialized society now makes up about 1% of the population, but yet the demands for food has been met by conventional agriculture production (Heller and Keoleian 2003). These methods seem to be economically beneficial as crop yields increase and prices lower in the market.

1.2 Why is it a Problem?

The environmental degradation of today's conventional farming system is at the cost of natural ecosystems as well as human health, which has become more prevalent in today's society.

1.2.1 Synthetic Fertilizers

Synthetic fertilizers are a defining aspect of the changing practices for conventional farming, these chemicals are beneficial for replacing important nutrients back into the soil and are efficiently able to apply to a larger scale than there typically was in before the industrialization of the Haber process. Although these can be efficient for supply of demand in the market, harmful consequences have come of it within the natural environment. The main available nutrients, nitrogen, phosphorus, and potassium, all required higher energy inputs per hectare when compared to a farm that used organic fertilizer methods such as manure and legumes (Pimentel and Berardi 1983).

The production of fertilizers alone accounts for 30% of the total US energy (Pimentel et al 1983), not including the transportation and application to and on the farms. In the early 1900's, two scientist by the name of Fritz Haber and Carl Bosh figured out how to fix atmospheric nitrogen at an industrialized scale, known as the Haber-Bosch Process. Since the invention and large scale production, the world's population went from 1.6 billion to todays 7 billion, this boom was seen after the mass production of synthetic fertilizers providing more food to a starving, and Haber was awarded 1918 Nobel Prize (Erisman et al 2008) for this discovery. Although this process helped to feed a world in hunger, the process itself requires high fossil fuel inputs in order to compress and generate heat for these reactions occur and their applications also have detrimental effects on the environment including imbalance in the nitrogen cycle because of the increased rate of nitrogen coming out of the atmosphere and being put back into the soil. This also in turn has a negative effect on the soil organisms and organic matter content by altering these communities that are important for soil health. Indirect effects on aquatic ecosystems can also be seen by the dead zones occurring in lakes and oceans from fertilizer runoff that deplete the system of oxygen and result in dead zones (Townsend and Palm 2009).

Coastal dead zones are a result of fertilizer runoff that cause a degrading impact on the environment. Dead zones come from decreased oxygen availability, when excess nutrients enter the system algae are able to uptake these as primary nutrients as well as the oxygen in the water. This creates a hypoxic zone because of the decrease in oxygen concentration of a system and less is available to other organisms in higher trophic guilds causing fish kill. Fertilizer runoff that is from the corn belt of the Midwest, runs into the Mississippi River and is responsible for the algal dead zone in the Gulf of Mexico (Pimentel et. al 2005). The Gulf of Mexico, near the mouth of the Mississippi river is an important source shrimp, oyster, and fish harvesting for the United States (Potash and Phosphate Institutes of the U.S. and Canada, 1999 via Gulf of Mexico Dead Zone). The continued use of these synthetic fertilizers and the agricultural runoff will keep causing greater impacts as they continue to harm and accumulate in the United States food chain.

1.2.2 Synthetic Pesticides

Inputs of other groups of synthetic chemicals are different pesticides that include popular productions insecticides and herbicides as well as other products targeted towards a variety of environmental threats to crops. With the increasing farm sizes in the recent years, synthetic Pesticide production and application have become popular methods or production because they are able to protect high yield crop fields and increase revenue. The benefits of pesticide use was measured at an economic aspect where there was an annual gain of $10,900 million from an investment of $2800 million by Pimentel and Andow et. al (1993). Different cost benefits analyses of pesticides on the environment have been measured by looking at economic gains and losses. By measuring and discussing the production, use, and impact of these synthetic pesticides in economic benefits, they seem efficient for use in agricultural systems.

Gains can be measured as revenue from crop production and losses can be measured as the money spent dealing with the effects on the environment from pesticide use. Studies have shown a total of $10 billion spent on different societal and environmental factors, human health effects can be looked at as a societal impact with 1 million human poisonings and around 200,000 deaths measured around the world annually in a study by World Health Organization and United Nations Environmental Programme (WHO/UNEP 1989 via Pimental et al1992). Other factors that can contribute to the sum include the increased application needed because of resistant of different pests like insects, plant pathogens, and weeds (Pimental et al 1992)., The declining bird populations and ground water contamination (Pimentel 2005) are examples of degrading environmental impacts that can be measured as a result of pesticide use. Persistence of pesticides in ground water sources used for human consumption can also contribute to societal costs of health effects and management. Although pesticides have shown to be beneficial on an economic scale, the environmental costs are important to consider when weighing the risks of continuing the use of these synthetic chemicals in the agricultural industry.

1.2.3 Fossil Fuel Input and Emissions

Fossil fuel inputs are a required resource throughout the life cycle of conventional systems. Production of crop growing requires machinery that are efficient for planting, applying, and tilling large scale farms. The production of synthetic chemicals alone requires a high demand of fossil fuel energy that can also be economically demanding and having a greater impact on the environment, compared to the energy needed for running the machinery. Mass transportation is a very high energy requirement later in the life cycle analysis, transporting these produce items from a few farms spread throughout the country to the same supermarkets around a region or the whole nation. This can also make the market prices fluctuate throughout the year causing consumers to pay higher produce prices due to rise in fuel costs.

The benefits of mass producing and transporting produce items to large supermarkets are their high yields that are sold at affordable prices, more abundant in the market, and more frequently available. Economic and societal impacts can be positively displayed in these aspects, but climate change has become an accelerated impact from increased concentrations of fossil fuel emissions in the atmosphere after industrialization. The negative impacts on the environment as well as the scarcity of the nonrenewable (in our lifetime) natural resources has made the search of an alternative source for fuel energy has become increasingly important and measured data must provide a net energy gain in order to be considered as a viable option. Two different biofuel options include ethanol that is produced from corn and biodiesel that is produced from soybeans, these also happen to be crops that are produced in conventional agriculture for uses in a variety of industries. Ethanol was found to have a gain of 25% more energy compared to the amount put into its production, biodiesel was measured to be even more productive with a net gain of 93% (Hill et. Al 2006). Even though these seem like great alternatives, the growing of these crop resources will still require similar inputs that were discussed earlier, creating an intensive energy system.

Air quality measures are an indicator of fossil fuel concentrations that can negatively affect the environment by contributing to the increase of Green House Gases (GHG's) from fossil fuel emissions. These gases are able to trap in UV rays reflecting off the earth's surface and trap in heat, that can be seen as a result of increased annual temperatures of regional climates across the globe. Other indicators can be studied at the ecology aspect as shift in species distribution can be correlated with climate change impact as habitat alteration becomes an indirect effect. Soot, smog, and acid rain have become more frequent in recent decades due to the industrialization process and burning of fossil fuels (NRDC July 2011). Among these air quality effects, other pollutants that are a product of this combustion are Particulate Matter (PM), Nitrogen and Sulfur Oxides (NO_X/ SO_x), and Volatile Organic Compounds (VOCs) have been linked to the increased effects of different cardiovascular diseases, heart attacks, asthma, premature births and deaths, and birth defects (NRDC July 2011). The negative impact on society and the environment make reducing fossil fuel consumption in agricultural systems crucial in order to practice sustainable methods for conventional production.

1.3 Alternative Methods

When taking in the economic and environmental cost of inputs in today's conventional farming, direct monetary benefits support economic efficiency, however, this does not show to be a sustainable method when weighing the impact on the environment. It has now become more important to start focusing on, researching, and practicing alternative methods to reduce these impacts.

1.3.1 Organic Distant

One alternative to this is Organic farming, this term can be defined as synthetic chemical free farming which provides consumers with the trust that farming is a more secure label that no synthetic chemicals or fertilizers have been applied in the production of these crops (Cooley and Lass 1998). Comparison studies stated that organic farming operations were pesticide free and used natural methods for fertilizing (Pimentel et al 1983). The chemical free production has made this produce become more increasingly popular in the market causing a higher demand for organically grown produce. A study done by Williams and Hammitt in 2000 analyzed the differences between organic and conventional produce buyers in the Boston area, the results have shown that more than 75% rated factors like freshness, taste, nutritional value, appearance, and Labeled 'pesticide-residue free' and 'organic' as most important when making purchasing decisions. These are characteristics of organic production that are associated with the food that is grown this way, what consumers may not realize is that organic produce sold at supermarkets is still massed produced, requiring still intensive energy input for machinery and transportation. The amount of energy input into large scale organic systems and distributors was not significantly less than conventional systems when comparing the two (Pimentel et al 1983). This is why it is important to educate consumers on where their food comes from because when the environmental impacts of organic are compared to conventional, synthetic pesticide and fertilizer applications are the only limiting factors of these two systems.

1.3.3 Conventional Local

Organic produce options are often the better choice when purchasing produce because of the chemical free guarantee that comes along with it. Although this practice is able to reduce the impact on the environment by reducing chemical runoff, mass transportation is still a large contribution to the carbon footprint of this production. Another option to explore is conventional local produce that is grown and then sold at local markets in surrounding communities. These different markets can include Farmer's Markets where a variety of different local farming businesses can go to sell produce to consumers during a growing season. Community Supported Agriculture (CSA) is also economically beneficial market system where financial support given to farmers by consumers guarantees crop share of the total yield that next season. Lastly, on-site farm stands are great local markets to buy your everyday produce from; some have someone collecting money while others go off the trust system for payments. The transportation required to sell this produce to consumers is significantly decreased when the food is traveling in state and typically less than one hundred miles. Although produce sold in these markets are still grown with these synthetic chemicals, the small communal scale makes it possible for the consumer to build a relationship with the farmer as well as their food (Cooley and Lass 1998). Local markets can also be economically efficient by keeping money within the community instead of it be distributed to unknown recipients. Environmental and economic costs of local conventional produce compared to previous mentioned alternatives can have a reduced impact and be beneficial to the local economy.

1.3.2 Organic Local

A final alternative to the chemical intensive conventional systems or mass producing and transporting organic systems is the organic local option of available produce. The process of organic growing provides more sustainable production method of food from chemical free practices, crop rotation, natural fertilizer methods, and natural pest defense strategies. Other benefits include the small scale production level that organic local production is farmed on; these farms tend to be smaller in size because it is a more labor intensive system in order to assure sustainable farm land and healthy crops.

Organically grown local produce is also available in the different local market types; Farmer's Market, CSA's, and On-site stands. Hickory Grove Farms, a local organic business grown and sold in Burlington, WI grows all of their crops on less than an acre of land with an additional half acre of orchard trees (Interview). It is not uncommon for local farmers to describe their produce as uncertified organic which means they have not filled out the required paper work to be considered and labeled organic by the United States Department of Agriculture. This inability to provide certification of the organic practices does not mean that they aren't organic, they instead to choose to sell to a community that entrusts its methods (Schnell 2007).

1.4 Local Food Economies

Economic reasons are also what make supporting local farming so beneficial to the community where the money that is spent by consumers on their food stays in the local economy and is not put towards other areas where the farming productions take place. At the Farmer's Markets, where there are multiple stands of farmers that are selling the in-season produce of the time provides consumers with options on where they would like to buy their food from, as opposed to supermarkets where produce comes from one maybe two different farms. Available research on CSAs is beneficial to consumers because "knowing the farmer may provide members a feeling of trust about food safety and confidence about reduced pesticide exposure and other chemicals" (Cooley and Lass 1998).

Local markets for produce are popping up in more urbanized populations today where the availability of fresh food seems to become scarcer. The establishments of CSA's are recreating local food economies where there is a direct link between the consumer and producers (Schnell 2007). These are important principals for social and economic health within a community.

Table 1.1 and 1.2 Summary and overview of Environmental, Economic, and Social aspects of compared farm types

Fertilizers	**Distant Conventional**	**Distant Organic**
Environmental	Chemical Runoff	Nutrient Runoff
Economic	High Cost	Lower- No Cost
Social	Hazardous to health	Little-No Effect
Pesticides		
Environmental	Chemical Runoff	No impact
Economic	High Cost	none
Social	Hazardous to health	Promotes health quality
Energy		
Environmental	Long transportation	Long Transportation
Economic	Fossil Fuel Costs	Fossil Fuel Costs
Social	Air quality standards	Air Quality Standards

Fertilizers	**Local Conventional**	**Local Organic**
Environmental	Chemical Runoff	Nutrient Runoff
Economic	High Cost	Lower-No Cost
Social	Hazardous to health	Little-No Effect
Pesticides		
Environmental	Chemical Runoff	No impact
Economic	High Cost	none
Social	Hazardous to health	Promotes health quality
Energy		
Environmental	Shorter Transportation	Shorter Transportation
Economic	Reduce Fossil Fuel Cost	Reduce Fossil Fuel Cost
Social	Improves Air Quality	Improves Air Quality

1.5 Goals for this Study

This study was designed to analyze the environmental, economic and social impacts of conventionally and organically grown produce for both distant and local farm. A life cycle analysis was done with the objective to identify which system of farming, Distant Conventional, Distant Organic, Local Conventional, Local Organic creates the most impact on the environment. A cost benefit analysis was conducted to compare which is more economically efficient by comparing miles traveled per dollar with the assumption the more miles per dollar is more efficient compared to lesser miles per dollar. The stated hypotheses address the predicted outcome for each analyses of the experiment:

1. The Life Cycles Analysis of Distant Conventional, Distant Organic, Local Conventional, Local Organic, when compared and analyzed will show that distant farms have a higher environmental impact than local farms and that organic practices of each location type will be the system with the reduced impact.
2. The Cost Benefit Analysis of Local markets compared to Super markets, when statistically comparing the miles traveled per dollar of the produce, the data will show an average miles per dollar traveled is greater in super markets than local markets for each produce of interest.
3. The Consumer Survey was conducted to address the opinions of the consumers at both market types to understand what factors are contributing to people preferring to buy from a particular market type.

The consumer survey in the study will provide the information about where the popular markets to shop and what factors are influencing them to buy that way. Typically, the system that requires synthetic chemical applications, uses more acres of land, and is transported further will have a much higher impact contributing to climate change and environmental degrading impacts. The expected system to have the highest impact is the distant conventional produce that also tends to be cheaper in the market. Organic Local produce has the smallest impact on the environment because they are grown sustainably and sold close to home.

2. Methods

Two different data analyses were done in this study to measure environmental impact and economic benefit. A life cycle analysis was done to interpret the difference in environmental impact for both distant and local farms, each with conventional and organic production methods. A cost benefit analysis was also done to compare if local markets or super markets provide more economic benefits to consumers. A consumer survey was the last experiment done to look at the opinions and influenced factors of shoppers at both market type.

2.1 Field Data Collection

Data was collected from both Local and Super markets in the Kenosha Area. The local markets include: Kenosha Harbor Market, Jerry Smith's Pumpkin Farm, and Griffiths Grounds, an on-site farm stand. The Kenosha Supermarkets include: Wal-Mart, Pick N' Save, and Woodman's. The variables measured at both markets were: Produce Type, State/Country Grown, Market Sold, Price, and Quantity (how it was sold, ex: per pound, pre-bagged, individual, etc.).Geographical variables were also measured by: Address, City, State, and Zip.

A personal interview was also done with the owner of Hickory Grove Farm, a local organic farm located in the town of Burlington in Kenosha County. The data representing consumer opinion was also collected in the field by willing participants in a survey similar questions that were related to each market (Local or Super).

2.2 Statistical Data Collection

The United States Department of Agriculture (USDA) website provides an interactive quick stat query data on the Agricultural Census of 2007. Data used in this study was found by Commodity: AG LAND (Agriculture Land), Category: Area, and selection of various Data Items. The measured data can be sorted on a national, state, or county level. 2007 was the most recent year available for all data sets used in the study, except for data on organic sources where the most recent year available is 2008. The specific statistics of interest that were used for this experiment are discussed as they relate to the study.

2.3 *Life Cycle Analysis*

The life cycle analysis looked at four different systems: Distant Organic, Distant Conventional, Local Organic, and Local Conventional. Three man life cycle variables that were focused on: Natural Resources, Synthetic Chemical/ Natural Fertilizer Use, and Energy all play an important role in the production from beginning to end. The impacts were assessed by measuring different units associated with each variable, with the assumption that the higher the variable is measured to be, the more of a degrading impact it has on the environment. Natural Resources variable was measured in cropland acres to represent the amount of land that is taken up by agriculture practices that make it vulnerable to degradation. Synthetic Chemicals/Manure Fertilizer was also measured in the amount of acres that each fertilizer type was applied to represent the amount of land susceptible to natural and synthetic chemicals. Energy was measured by the number of miles traveled from the state produce was grown to where it was sold; this was done to represent fossil fuel consumption. The data used to measure Natural Resource and Synthetic Chemical/Natural Fertilizer came from the Agricultural Census of 2007 and Energy was measured using google maps. The different measurements recorded determined the rank of impact on the environment; the averages of these impacts for each life cycle variable were calculated based on Local and Distant data.

Table 2. Compiled data of inputs and outputs looked at for each Life Cycle Variable and also corresponding with its degrading impact

Life Cycle Variable	Inputs	Outputs	Environmental Degradation
Energy	Fossil Fuels for transportation	Emissions into the atmosphere	Air quality and Climate Change
Synthetic Chemical	Fertilizers and Pesticides	Application	Social and Aquatic effects
Natural Resources	Land and water use	Runoff and Soil erosion	Soil quality and irrigation

2.3.1 Energy Assessment

Energy was measured in Google maps for both local and distant; the number of miles were recorded from the distance of a major city in the state of interest to Kenosha, Wisconsin (Table 3). In order to quantify the environmental impact of energy, the mileage that was measured in google maps, determined the Rank of that state (Table 3).

State	Major City
California	Sacramento
Idaho	Boise
Illinois	Chicago
Iowa	Des Moines
Michigan	Lansing
Virginia	Richmond
Wisconsin	Madison

Table 3. Major City reference point used to measure transportation distance

2.3.2 Natural Resource Assessment

Farm size was measured by Data Item: Cropland, Harvested-Acres; Domain: Area Harvested. The available information displayed the total number of acres, measured in a range of farm sizes (example: farms ranging from 50-199 acres make up a total of 34,000 acres in a given state). The values given in the data set were compiled together by summarizing total acres into the determined ranks for the study (Table 4). The rank that contained the greatest amount of acres was the number used for that state.

Organic assessment was measured by Data Item: Organic, Cropland-Acres and Organic, Cropland-Number of Operations. The total number of acres was divided by the number of operations to determine an average Organic farm acre size, the calculated number determined the rank measure for the variable.

2.3.3 Synthetic Chemical/Natural Fertilizer Assessment

Synthetic chemical applications were also measured by state using the USDA Quick Stat Query with the selected Data Items: Treated, Measured in Acres and the following Domains: Chemical, Herbicide; Chemical, Insecticide; and Fertilizer. The acreage of application was recorded and then divided by the total number of acres found in the natural resource assessment, to calculate the percent of agricultural land treated with each chemical type.

Manure fertilizer applied per acre data was used to measure fertilizer in organic systems. This number was divided by the total acreage per state to determine the percent of manure applied to acres. Chemical applications were assumed zero. For organic analysis The calculated percentages of manure per acre determined the rank to assess the impact on the environment (Table 4).

Table 4 is a summary defining the measurements for each rank of the three different variable categories, because of the limitations to statistically compare the environmental impact each variable contributes, a general even partitioning was set up for comparison. The Energy assessment was set up by the first rank defining local distances from major towns and cities. Rank 2 was defined by distances within the Midwest area, Rank 3 for distances outside of the Midwest region, and Rank 4 for international sources. Synthetic chemicals and manure were based off land percentage of application, split into four even ranks ranging from 1-100% with the assumption that more land of which they are applied to has a higher impact on the environment. The third variable, Natural Resources, is defined by acreage size of farms, rank 1 represents the smaller family farms, rank 2 is a range with the average farm size in the United States falls within, rank 3 is the range of which farms can be defined as above average, and rank 4 represents the range for the size of most corporate farms.

Rank	**Natural Resources (Acres)**	**Synthetic Chemicals (% Acres Applied)**	**Energy (Miles)**
1	1-100	1-25	1-100
2	100-500	26-50	101-500
3	501-1000	51-75	501-1,000
4	1,000+	76-100	1,000+

Table 4. Measurements of Ranking used to quantify and compare the life cycle analysis for all four practices of interest

2.3.4 Distant Data Assessment

The field data collected at super markets used the measured variable, location grown, to determine the states that were analyzed for statistical data. States of interest for the distant analysis includes California, Idaho, Illinois, Iowa, Michigan, Virginia, and Wisconsin. This was applied to both organic and conventional systems.

2.3.5 Local Data Assessment

The location grown variable was also used from the field data collected at local markets to determine states of interest. The states included for the local analysis include Illinois, Michigan, and Wisconsin. Kenosha and Walworth County in Wisconsin, Lake and McHenry in Illinois were also used from statistical data collected from the USDA quick stat query data.

2.4 Cost Benefit Analysis

The cost benefit analysis portion of this study focused on collected field data variables. An average amount of miles per dollar was calculated to assess which market prices are more efficient by comparing how far each produce will travel before it costs the consumer $1.00. The treatment variable included: Local Markets and Super Markets. Microsoft Excel was used to calculate averages and produce bar graphs to compare and contrast how far produce is travelling for how much you are paying. The overall cost benefit analysis was used to interpret from the data on which market is more economically efficient that would be defined as the produce travelling more miles per dollar.

2.5 Geographical Data Representation

The field data that was collected was also used in ArcGIS to show the distributions of produce count on national scales and average price at markets on a regional scale.

2.5.1 National Maps

Two separate national maps were created to display the data found at Local and Super Markets. The count of produce found in each state was displayed on a color gradient scale to show a visual distribution of where produce items are coming from at both markets.

2.5.2 Regional Map

A single map visually displays the spatial distribution of the selected local and super markets in Kenosha County (Figure 7). Average price of all produce items measured at individual markets were displayed by a point size gradient that can be compared and contrasted through this visual assessment.

2.6 Consumer Survey

A consumer survey was conducted at each market type to understand what factors are influencing the consumers to buy at that particular market type. Appendix A shows the survey given at the local Kenosha Harbor Market and Appendix B was the survey given to consumers at super. The similar questions on each survey were meant to represent the same opinion factors, but each was manipulated to be geared toward the particular market type. The response for questions on the survey are marked as disagree, somewhat disagree, neither, somewhat agree, and agree, ranking from 1-5 respectively in order to produce frequency tables for consumer response.

The responses to the surveys were numerically converted into SPSS and frequency percentages ran to factors influencing consumers to shop at these markets. The source of information question is also categorized numerically and input into SPSS that was used to run statistical tests on frequency of the numerical responses.

3. Results

The life cycle analysis of the experiment comparing the environmental impact of four different farming systems was measured on a scale from 1-12, with 12 being the highest measurement of environmental impact. The data shows distant conventional farming having the highest impact at a 9 (figure 2). Equal impacts of rank 3 for inputs of land, synthetic chemical, and fossil fuel transportation contributed to the highest measured impact out of all four farming systems. Distant organic measured to be the second highest at 7, with land and fossil fuel transportation contributing the most where each variable was measured to be a rank 3. Local conventional was measured to have a similar impact at 6, with land and synthetic chemicals being the highest contributions with ranks of 2 and 3 respectively. Local organic measured to have the lowest impact on the environment at a 3 (figure 2). Equal ranks of land, manure fertilizer, and transportation were found to be 1.

This LCA suggests that distant sources of farming contribute to a higher impact on the environment because of the amount of fossil fuels required to transport these produce items around the nation. This can be explained by distant organic sources showing to have a greater impact compared to local conventional sources that are using synthetic chemicals, but distributing on a much smaller scale, thus showing less of an impact although these chemicals are present.

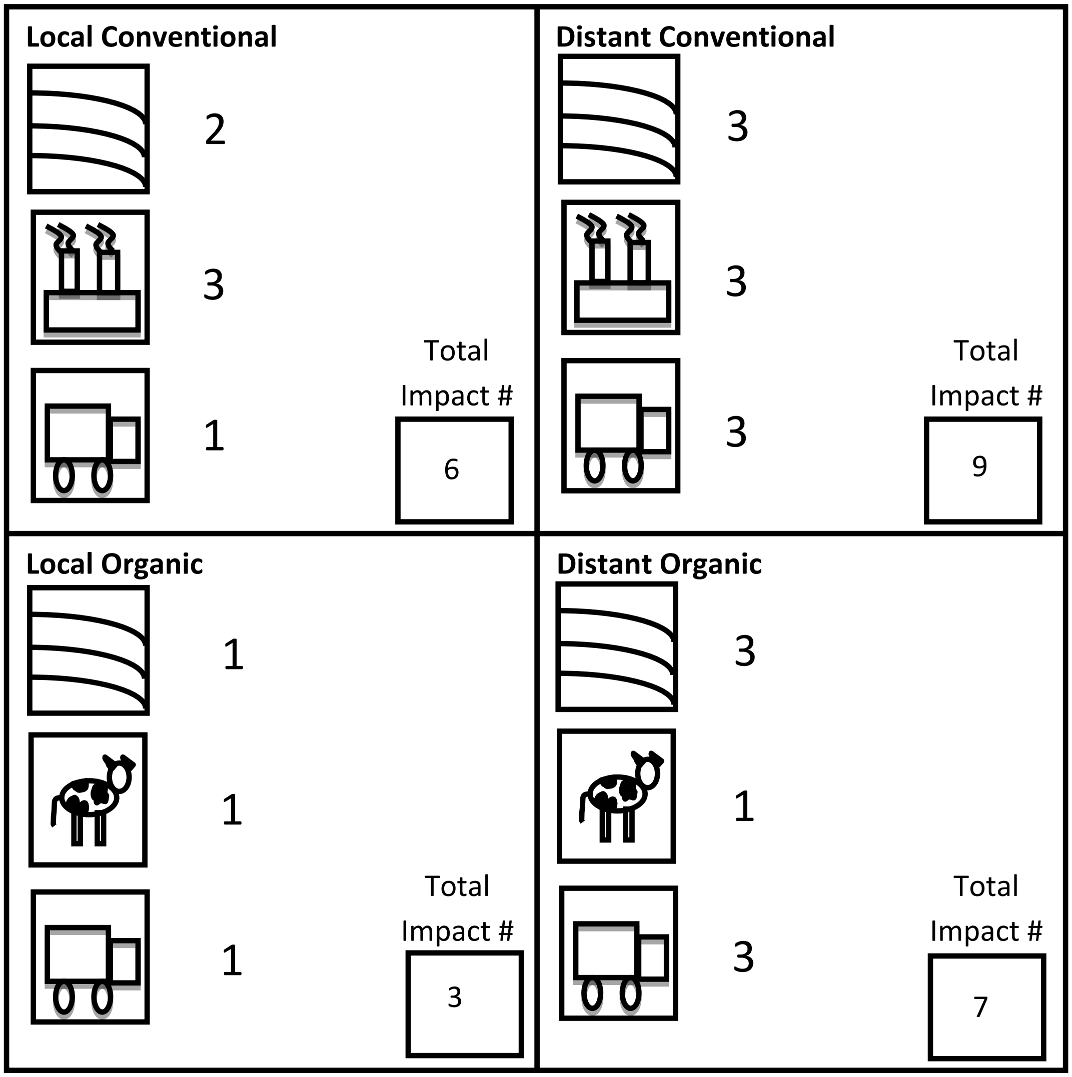

Figure 2. Compiled Life Cycle Analysis Data of Each Studied System, Displayed by Interest Variables. The pictures from top to bottom represent each variable as follows; Naturel resources, Synthetic Chemical (Conventional), Manure (Organic), and Energy.

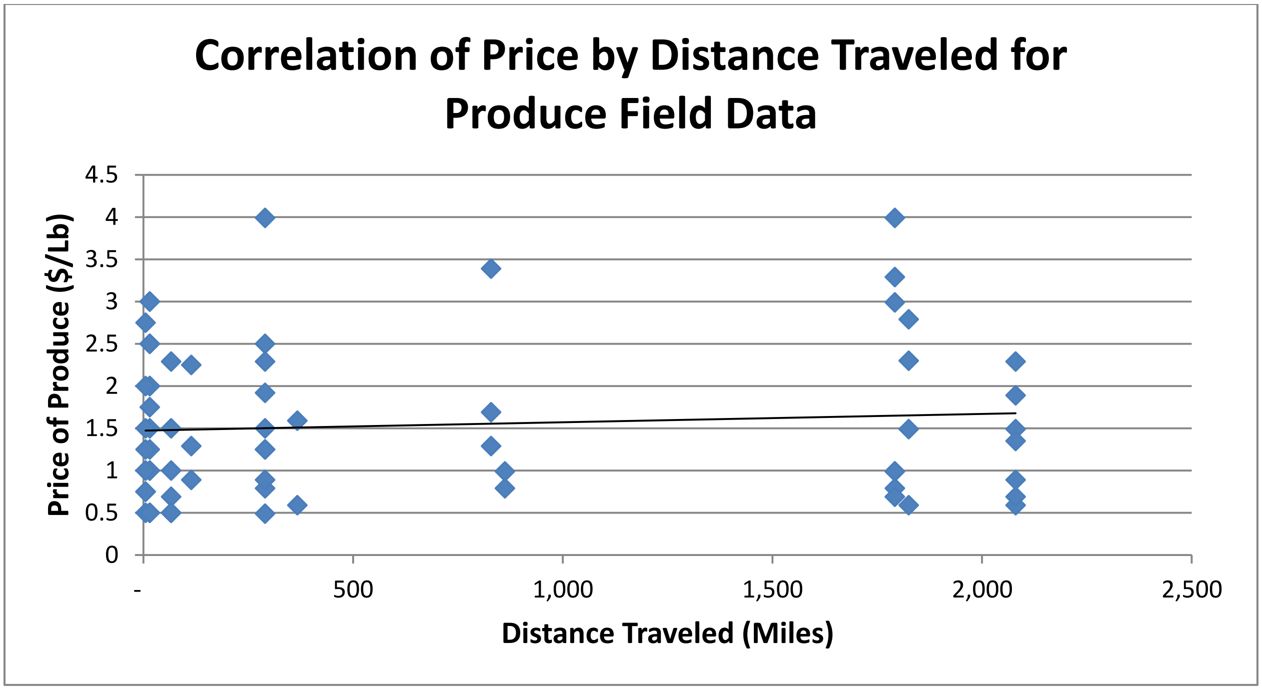

Figure 3. Regression Analysis of relationship between the distance produce travels and the influence on price. p=0.479, R Squared=.008

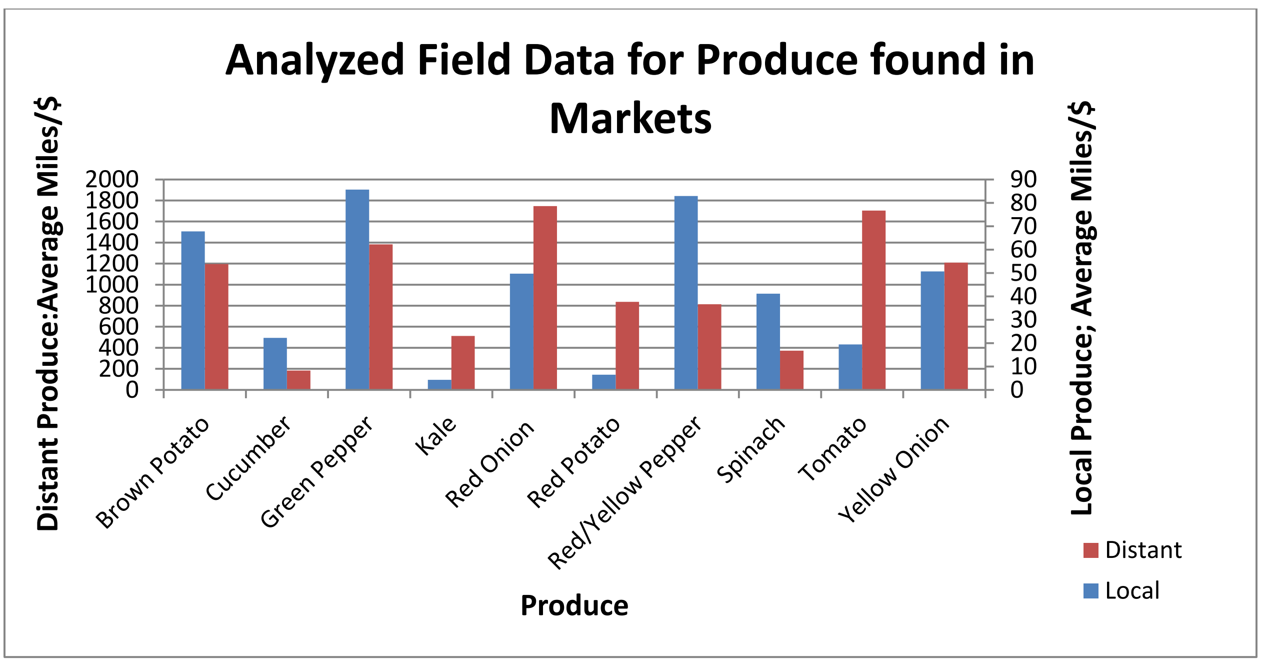

Figure 4. Analyzed field data for individual produce items from local and distant sources

A linear regression determined a p-value of 0.479 and an R Squared Value of 0.008 (figure 4), these values show that there is no statistical correlation between the distance produce travels and the price that consumers are paying for it. When looking at data on the average miles traveled per dollar of individual produce items from local and distant sources, there seems to be no significant comparison between produce at local and distant sources except for the difference in scale for each calculated average (figure 4). The distant scale ranges from 0-2000 Miles/$ and the local scale from 0-90 Miles/$, this means that distant produce is traveling much further for every dollar the consumer pays, which provides less fresh produce to consumers than from a local source where it is traveling much less per every dollar. The differences in these scales can be accounted for by the LCA (figure 2), where the synthetic chemical inputs contribute to higher crop yield, making it possible to sell these produce items for much less than organic sources.

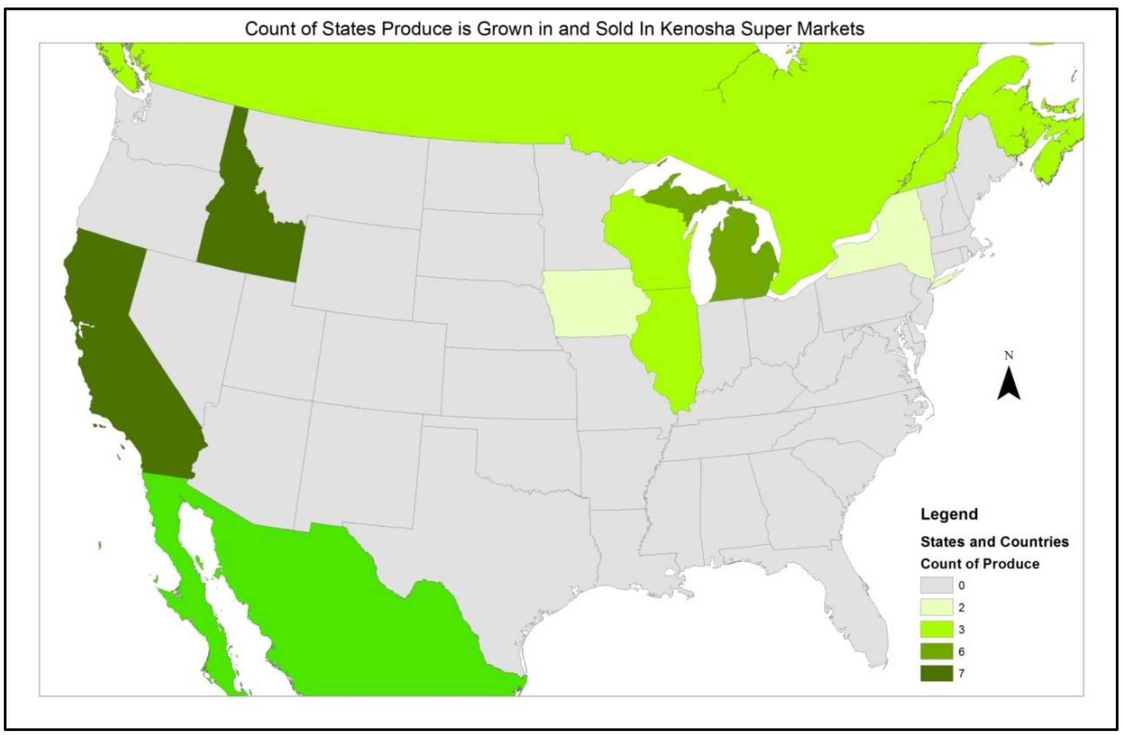

Figure 5. Location of which produce items were found to be grown in from collected data at Supermarkets.

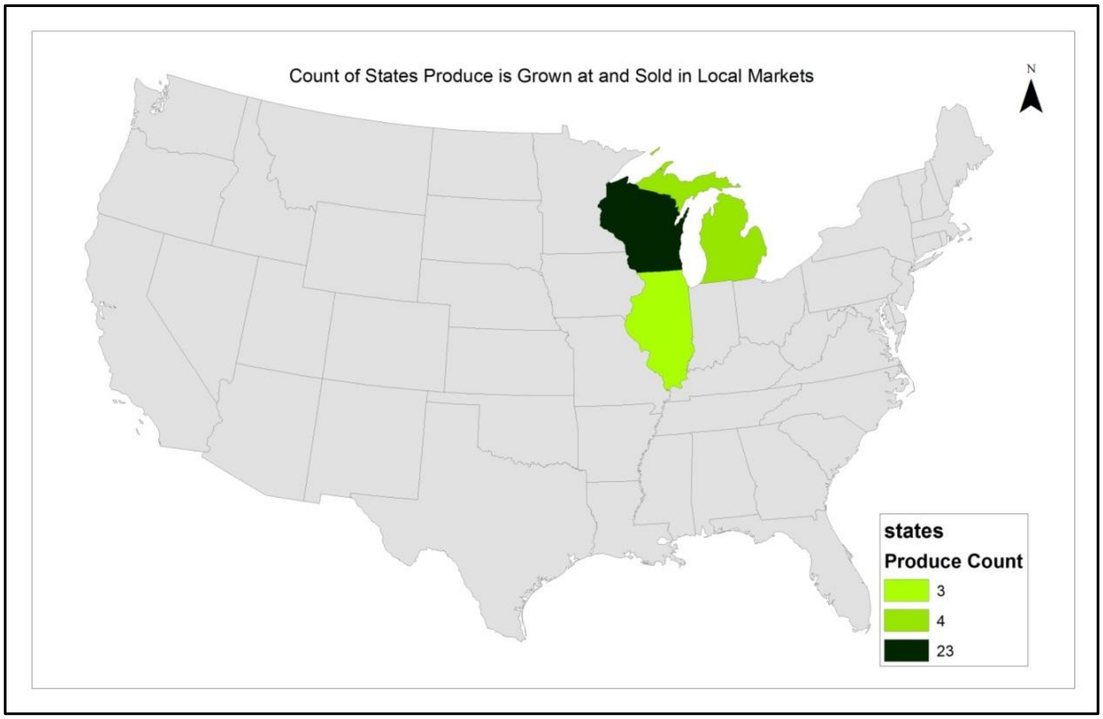

Figure 6. Location of which produce items were found to be grown in from collected data at Local markets

Figures 5 and 6 are maps made from collected field data in GIS representing the states and countries of which produce at both local and super markets were taken. Figure 5 shows majority of produce items that are sold at Super Market coming from more distant sources compared to Figure 6 where the Midwest region is the extant of produce travelling to local markets.

4. Discussion

4.1 Life Cycle Analysis

The data analyzed in the Life Cycle Analysis did support hypothesis #1, that distant and conventional farming systems will show to have a higher environmental impact, where the measured environmental impact was pre-determined and calculated within three different categories. The scale of environmental impact for this experiment was out of 12, Conventional distant was the system with the highest measured impacted totaling 9, Distant organic totaling 7, Local conventional totaling 6, and Local Organic totaling 3 (Figure 2).

Due to the lack of information available on specific farms of where surveyed produce had come from, for distant sources at least, the USDA quick stat query data provided specific information on interest variables that could account for all four farming systems. The statistics used from the Agricultural Census of 2007 were measured in the amount of acres applied for pesticides, herbicides, synthetic and manure fertilizers. Farm size was also measured by acres and cropland information was used because the study focused on produce items. Given this was the information provided, the ranking systems were set up by average farm size for natural resources and percent of acres that chemicals were applied. Energy measured in transportation distance stayed consistent between the Local and Distant systems because of the fixed states and city locations used to measure mileage.

In order to set up a life cycle analysis that could better compare the impact on the environment for each system, starting with the synthetic chemical assessment, more relevant information on pounds of application for chemical types would provide better insight as to how much of these are entering into the environment. These statistics can then be compared to information from literature or actual field testing, on the concentration amount chemicals are found in non-targeted areas, such as aquatic systems. In doing this, that could provide the experiment with how much is actually being applied to farm land and in turn how much of that is ending up in other areas. Using given information about the health and effects on a studied system from literature or from data collected in the field, a stronger correlation to environmental impact could be assessed for the synthetic chemical variable.

Looking at the natural resource variable, broad information on cropland for state and county level does not necessarily represent the farms of which these produce items are grown. Information on actual farms for which produce was found to be grown would make a better comparison on how much land is actually being used to grow these specific produce items, instead of using the average farm size calculated for the whole state which could include farms that aren't even growing the produce items of interest.

The story for the energy assessment variable is similar because specific farm location information was not available, which is why reference cities were used. This method made inaccurate measurements of how far produce traveling, for example, the state of California reference city was the state capital Sacramento but it does not mean the farm of surveyed produce was from this area. If this produce were to have come from a different area in the state, a more accurate measurement on where and how far it traveled would provide better statistical correlation between fossil fuel emissions and environmental impact.

4.1.1 Distant Conventional Assessment

The environmental impact number of this system was measured at 9 out of 12, which shows a relatively high environmental impact compared to other systems. This was equally contributed by each of the variables measured in this experiment, natural resource ranking of 3 determined the highest amount of acres of cropland within a range of 500-1000 acres for each state in which corporate grocery store produce was found to be grown. The synthetic chemical ranking of 3 determined the average application of conventional land acreage measured sprayed 50%-75% of the land in each state. Last, the average distance that produce items travel to these groceries was calculated at a rank of 3 for the range of 501-1000 miles. The summary data found in figure 1 shows that all three of these variables play a significant role on impacting the environment.

4.1.2 Local Conventional Assessment

The environmental impact number for local conventional was measured at a 6. The natural resources ranking was measured to be 2, where the average farm size in acres for Michigan, Wisconsin (Kenosha, Racine, and Walworth Counties), and Illinois (Lake and McHenry County). This determines the average farm size ranged between 100-500 acres. The synthetic chemical rank was measured at 3, where 51-75% of the cropland is sprayed with insecticides, herbicides, and commercial fertilizers. Energy transportation was measured to be a rank of 1 due to the locality and small distribution range of 1-100 miles. Although this system relies on heavy application use that contributes to its high environmental impact number, less transportation cuts down a lot on fossil fuel emissions that is seen in distant systems, even organically grown produce

4.1.3 Distant Organic Assessment

The environmental impact number of 6 was calculated for distant organic systems. The natural resource ranking of 3 determines that the average organic farm size range from 500-1000 acres. Fertilizer ranking was calculated as 1, between 1-25% of organic land was applied with manure fertilizer, insecticide, herbicide, and commercial fertilizers were assumed 0. Energy ranking for distant organic was also 3, the same states and cities were measured for distant both conventional and organic. The lesser impact of distant organic farming can be explained by the fact that there are no synthetic chemicals being applied in the process which reduces effects on multiple ecosystems. However, there is still a large cost both economically and to the environment with fossil fuel demands and consumption. This is why locally grown and sold produce is a more eco-friendly choice. Chemical inputs on local conventional farms are also a risk consumers could take if the farmer or business is not USDA certified organic or uncertified organic.

4.1.4 Local Organic Assessment

The local organic system had the lowest environmental impact number of 3 and each variable measured was calculated with a rank of 1, meaning that natural resource organic farm size average was between 1-100 acres, manure fertilizer cropland application was 1-25%, and energy transportation was 1-100 miles. Due to small amount of land use, fewer fertilizer and no chemical inputs, and small distribution range, local organic systems have a more sustainable impact on the environment compared to the other three systems that require

4.2 Cost Benefit Analysis

Hypothesis #2, that miles per dollar statistics would be higher in super markets when compared to local markets, was supported by the data (figure 4) where the scales differ because of the large distribution of miles that supermarkets (distant) get there produce from compared to the much smaller distribution that local markets do. However, the distance the produce traveled influencing the price did not have a statistical correlation (figure 3). The field data collected on produce at super market is to represent produce that is grown on distant conventional farms. The field data on produce collected at local markets were to represent local conventional farms, information on organic produce items was not taken in the field data for the sake of the cost benefit relationship of price and transportation.

Looking at figure 3 on distant produce, the scale on miles per dollar ranges from 0-2000 compared to a scale of 0-100 miles per dollar on the local produce scale. Although the data did support the hypothesis that distant produce is more economically efficient due to traveling more miles at a cheaper price than local produce travels, the life cycle of these systems also has to be considered in economic terms where the detrimental costs of to the environment from inputs needed leads to management strategies that can be quantified in monetary terms.

Analyzing the data at an economic standpoint, it shows the supply and demand of the food market where local produce is not in as high of a demand, which can explain the higher prices at farmer's markets than grocery stores. Going back to the discussion on the energy assessment variable of which this information was used for the linear regression in the CBA, the consistency in the amount of miles traveled contributed to the lack of correlation on price dependency. Again, if specific locations on farms could be used, it would provide random and comparable data for the cost benefit analysis portion and potentially a more significant correlation.

4.3 Consumer Survey

The goal of the consumer survey was to identify what factors influence consumers towards local or super market types. Each survey was geared toward each market type seen in Appendices A and B. The data collected from each market however was not enough information to draw statistical conclusions about consumer opinion. If this experiment were to be replicated, the method of survey data collecting would have to be more focused on from standing outside of stores and in front of vendors but to provide a table at each where people can come and take the survey.

5. Conclusion

The overall goal of this study was to explain the life cycle for different farming systems of which produce is provided including local and distant, conventional and organic farms. Three important variables were used to measure the impact each of these inputs has on the environment and determine what was more sustainable. A cost benefit analysis comparing produce at market types was done to analyze the relationship between economy and environment of the farming systems to overall discuss which can be seen as more economically efficient and sustainable. Local organic and conventional farming was measured to have the lesser impact to the environment due to less need of fossil fuel emissions. Distant farms however were found to be more economically efficient in that the food travels further but is costing the consumer less. Although these distant systems of farming may seem to be more beneficial in the market for consumer's pockets, the other costs of environmental degradation is more difficult to quantify and compare in a way that would cause a shift in market preference from distant conventional to local organic produce. Along with consumer preference playing a role in market support and prices, other influential factors that is difficult to control can include things such as government subsidies that provides money to farms that practice with synthetic chemicals and fertilizers. The cost alone for the production of insecticides, herbicides, and commercial fertilizers requires a lot of energy and emissions.

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	Strongly Disagree	Somewhat Disagree	No Opinion	Somewhat Agree	Strongly Agree
I like to make the grocery store my primary source for fruits and vegetables					
I like to shop at local grocery stores just as much as Farmer's Markets					
I feel that I pay reasonable prices for produce at the grocery store					
I am aware of seasonal produce selection					
I try to buy in season produce					
The grocery store is open at a convenient time for me					
I know where the food I buy is coming from					

Please number 1-5 with 1 being the most important and 5 being least Important

I buy based on:

Price	
Source	
Organic	
In-Season	
Local	

Gender: Male Female

Age Group: 17 and below 18-25 26-35 36-45 46-55 56-65 66+

Appendix A. Grocery store market survey for customers

	Strongly Disagree	Somewhat Disagree	No Opinion	Somewhat Agree	Strongly Agree
I like to make the Farmer's Market my primary source for fruits and vegetables					
I like to shop at local grocery stores just as much as Farmer's Markets					
I feel that I pay reasonable prices for produce at Farmer's Markets					
I am aware of seasonal produce selection					
I try to buy local in season produce					
The Market is at a convenient time for me					
I know the farmer's I buy food from					

Please number 1-5 with 1 being the most important and 5 being least Important

I buy based on:

Price	
Source	
Organic	
In-Season	
Local	

Gender: Male Female

Age Group: 17 and below 18-25 26-35 36-45 46-55 56-65 66+

Appendix B. Local market survey for customers