Soil Quality Survey of Community Supported Agriculture Designated Farms of Southeastern Wisconsin

By

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Abstract

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In a time of growing environmental concerns farming practices have been under intense scrutiny. Consumers have become increasingly concerned about the quality of their foods and from concern Community Supported Agriculture (CSA) has grown in popularity. A common conception of CSA farms is that they are all the same. More specifically they are all organic resulting in soil quality being the same. A survey of soil quality was done to test this conception. Abiotic and biotic components alike were tested including; soil moisture, soil texture, nitrogen levels, invertebrate macrofauna diversity, and organic matter. Farms were also ranked based on organic practices. Farms tended to split in results based on farming methods used. Farms with an organic designation tended to have higher levels of components of soil health then farms without the designation. This study reflects the importance of consumer knowledge of the farm they choose based on individual wants.
Literature Review

As human populations have grown throughout the decades farming has become increasingly important. As long as there are people to feed there will be farmers to grow the food to feed them. For much of the later part of the 19th century and the beginning of the 20th century, farms were widely diverse. The most common feature on these farms was horses; every farm needed them for work, and the horses were followed by cattle, chickens and corn. Many farms also had hogs, apples, hay oats, potatoes, and cherries; some even grew wheat, plums, grapes, and pears. Higher diversity on the farm normally resulted in higher soil quality and lower dependency on feed distributors (Pollan, 2006). However, as times changed so did the philosophies on agriculture. Many people believed that agriculture needed to be modernized, industrialized (Fitzgerald, 2003).

By far, large industrial spreads are the most common type of farm found throughout the Wisconsin. These farms produce large cash crops such as corn and soybeans. These crops are grown over generally one to two hundreds acres of land and are normally rotated between the two or more crops by growing season. Most often industrial farms use high doses of chemical fertilizers, pesticides, water and genetically altered seeds in order to achieve higher yields.

Industrial farming is not limited only to corn and soybeans (a crop commonly rotated with corn to replace nitrogen in the soil); animal confinements are also popular throughout the United States. The most common confinements house cattle, hogs, or chickens. Confinements, commonly referred to as CAFO’s (concentrated animal feeding operations), generally consist of large buildings housing hundreds of animals (EPA, 2003).
Both industrialized plant crops and animal operations have the benefit of high yields, but in recent years industrial agriculture has been under intense scrutiny by environmentalists. The sewage lagoons of CAFO’s have leaked into water supplies in the past making it undrinkable. Monocultures (planting only one type of crop at a time) have been accused of stripping soil of its nutrients and by leaving the soil bare in the winter months, layers of topsoil have blown away during the decades of farming (Pollan, 2006). Due to this intense environmental scrutiny and other social aspects, alternative farming practices have grown in popularity. Consumers are looking for fresh produce coming from sustainable farming practices. Community supported agriculture is one such place that these needs can be fulfilled.

**Community Supported Agriculture**

Community supported agriculture (CSA) provides an agreement between farmers and their consumers, otherwise known as shareholders or subscribers. Subscribers agree to purchase a share of specific crops at the beginning of the season. Subscribers buy shares of any of the crops the farmer is planting and shares vary in size based on the needs of the consumer. The farmers then plan on production based on the amount of shares they sell. Farmers may plant a larger harvest in order to sell the over production elsewhere. However, farmers must be careful with planting more then they have sold because there is no guarantee that the over production will be sold. In this system the risks of farming are shared by the subscribers and the farmers; if there is an insufficient harvest the loss is mutual. Conversely, if the harvest is successful subscribers reap the benefits as well as the farmers. The estimated costs of input, labor and the standard living of the farmer are all taken into account when the cost of the share is determined.
(Adams, 2003). Shareholders also receive other various responsibilities, such as helping plant, harvest, or delivering produce. These responsibilities may be part of the contract drawn up between farmer and shareholder, or they may be solely on a volunteer basis.

**CSA History**

Community Supported Agriculture had its beginnings in Japan in the 1970’s and was first called the Telkei system. The Telkei system was created by a group of Japanese women that were concerned about foods being contaminated with pesticides and imported and processed foods. It broadly translates to “food with the farmer’s face on it” (Henderson, 1999). The goals of the Telkei system were to develop understanding between consumers and producers, create an alternative system of distributing local produce, and finding a better way of life through consumer supported farming, in terms of interaction and cooperation with producers (Henderson, 1999).

These goals struck a cord with Robert Steiner, an Austrian philosopher in the 1920’s, who believed that the farm should be treated as one interconnected entity rather than individual parts (this concept is called biodynamic farming). The popularity of community supported agriculture spread through Europe then made its way over to the United States in the 1980’s. In 1986 two CSA farms developed independently, Indian Line Farm in Massachusetts and Temple-Wilton community farm in New Hampshire. Since the opening of these two farms the number of CSA’s has grown to over 1,700 farms throughout the United States (McFadden, 2005).

CSA’s are also developing networking systems and associations to connect themselves. A network system such as this serves to exchange information and ideas, educate new members, and support new or struggling farms. This system of
communication is the tool used by Community Supported Agriculture to compete with large industrial farms and consists of farmers in the same region and may possibly include local agriculture extension offices (McFadden, 2005).

Community supported agriculture in Wisconsin specifically has grown drastically since its introduction to the United States twenty years ago. The first CSA projects in the state developed in Milwaukee in 1988. Since then there are more than 65 CSA farms that supply produce for an estimated 3,000 homes annually (Henderson, 1999).

**CSA Benefits**

Community supported agriculture serves many different purposes for both farmer and subscribers. The relationship between farmer and shareholder results in better economic viability for the farmer and by selling shares of their crops, farmers take pressure off of themselves to produce a large yield. Farmers are also able to find another market for their crops if they are not able to compete in the traditional market (Henderson, 1999).

Another purpose of community supported agriculture is to familiarize consumers with the process of farming. An understanding of how farms are operated and the risk involved is also gained by shareholders. Limitations such as weather and possible food production based on region are also recognized (Henderson, 1999). Many CSA subscribers have inadequate experience with farming and as a result possess a limited understanding of the process. Many subscribers are drawn to the idea of being a part of the process.

By being in direct contact with farmers, consumers are able to know the source of their produce. Instead of wondering what part of the country their food comes from,
consumers are able to pinpoint where and how their food is grown. Many subscribers also claim the ability to taste a difference between the produce they receive from their CSA and what they may buy at the supermarket. This is significant because it is what often keeps members renewing their subscription year after year.

The largest draw for many subscribers is that a CSA also gives something to the shareholders that industrial farming does not; an alluring ideal that focuses on community “oneness”. A large portion of shareholders subscribe to a CSA because of the feeling it gives them. “People are being drawn to it for both philosophical and pragmatic reasons, and the conjunction of food, farm, and community is felt by many to constitute the real genius of the CSA” (Adams, 2003). Consumers buy into the idea that a relationship of mutual respect and appreciation will develop between farmer and subscriber and this is one of the largest selling points of community sponsored agriculture. These goals and ideals have helped CSA expand over the last twenty years.

Farmers and shareholders alike are attracted to CSA because of the environmentally friendly farming practices that are sometimes used, such as organic, biodynamic, or some other practices that limits the use of pesticides, herbicides, and artificial fertilizers. A majority of CSA farms forego the above mentioned chemical treatments in favor of biological treatments.

A large percentage of CSA’s also support crop diversity rather than monocultures as most industrial farms do. Rather than planting only one crop continuously, farmers plant a variety of crops or polycultures. This means that one farm may have multiple crops at one time, such as tomatoes, pumpkins, celery, carrots, herbs, and many more. All of the previously mentioned crops are often found on CSA designated farms. Planting only
one crop season after season works to deplete soil nutrients; by planting a variety of crops farmers are replenishing as well as using nutrients. Monocultures are also more susceptible to diseases and pests while diverse crops serve as pest and disease controllers (Henderson, 1999).

Soil

Different farming practices can have drastically different effects on soil quality. It is a highly dynamic entity with many components. Each of these components is interconnected and must function and balance together in order for the soil to be healthy and successful for growing plants.

Soil quality is defined by soil scientists as the extent that the soil can (1) promote biological activity (plant, animal, and microbial), (2) mediate water flow through the environment, (3) retain environmental quality by acting as a buffer that assimilates and reduces contaminants (Coleman et al, 2004). One such factor is the amount of macrofauna found in the soil including earthworms, ants, beetles, termites, spiders, etc. These are all thought to be signs of soil health. These soil macrofauna mix and redistribute organic matter, neutralize soil pH, increase availability of many nutrients, stimulate microbial populations, and enhance soil physical properties (Lavelle et al. 2006).

Soil moisture is the amount of water held in place between soil particles. This is an important factor to examine because soil moisture helps to determine how well crops may grow. Too much soil moisture may “drown” root or causes then to grow as fungus that is fatal to the plant. Conversely, too little soil moisture will result in the plant withering and dying (Arnold, 1999). A leading detail in soil science is that certain
physical and chemical relationships in all biospheres, including soil, are mediated by water. Water is one of the most vital and limiting factors of life, especially in many plant species (Coleman et al, 2004).

Nitrogen is a critical nutrient needed for plant production. Most non-legume plants need extra nitrogen added to the soil in the form of organic or non-organic fertilizers in order to thrive. Crops that lack sufficient amounts of nitrogen yield plants that are “yellow and stunted with smaller then usual flowers and fruits” (Berry et al. 2002).

Organic matter within soil is also an important indicator of soil quality. Organic matter is formed from plant material following the death of the plant top or roots. The plant falls to the ground and is decomposed by soil microbes as well as heat and moisture. Soil macrofauna serve to churn up soil and move the organic matter further down. The organic matter serves important functions within the soil, such as holding nutrients and holding the structure of the soil (Shepard et al. 2002).

Each of these soil elements is vital to the success of a crop. If one element is out of balance the entire crop may fail. A large problem faces farmers when determining how to maintain this balance. There have been many different approaches taken by farmers over time. Traditionally farmers have used chemical fertilizers and pesticides to keep soil “healthy” enough to produce large yields. However, over the last twenty years some farmers have chosen to take a different approach and have used organic fertilizers instead in an attempt to be ecologically friendly. Organic practices are thought to hold soil properties with higher success then traditional farming practices. Many people value soil health that can occur as a result of organic farming.
Consumers then assume that all CSA farms are also organic, which may or may not be the case. While thinking of community supported agriculture, a general consensus by consumers is that these farms are solely organic. Organic practices hold soil properties with higher success than traditional farming methods. In a 1994 study of CSA’s, Rochelle Kelvin found that many members were joining for organic produce (Kelvin, 1994). If the general consensus is true that all CSA farms are organic and if organic practices are indeed better for the soil then we expect CSA designated farms to have a higher quality soil based on soil macrofauna, nitrogen, organic matter, and soil moisture, and each of the CSA’s sampled to have similar results throughout.

**Methodology**

Five farms throughout southeastern Wisconsin were chosen for sampling based on CSA designation and farming methods retrieved through discussion with farmers. With permission of the farmers soils were collected, tested, and recorded. The first two farms were chosen for their organic designation. They were Springdale Farms in Fredonia (figure 1.5) and Wellspring Inc. in West Bend (figure 1.2). The last three farms were chosen because they were not certified organic. They were Nature Creek Farm in Belgium (figure 1.3), Pinehold Gardens in Oak Creek (figure 1.4), and Full Harvest in Hartford (figure 1.1).

**Site Description**

Nature Creek is not an organically certified farm. However, it uses mainly environmentally friendly farming practices. A green manure is used to fertilize crops. Green manure is a crop grown to add nutrients and organic matter to the soil. Nature
Creek rotates Sudan grass, buckwheat, and soybeans as their green manure/cover crop. This crop is then plowed under and incorporated into the soil. Cover crops not only serve to add nutrients into the soil, but they also help prevent erosion. Organically certified fish fertilizers and organic pesticides are also used in substitution of traditional harsh chemicals.

Pinehold Gardens, like Nature Creek, is not a certified organic farm. This farm uses organic methods as well. Cover crops are used on a three year rotation. Crops used are spring oats, field peas, ryan vetch, red clover, and sweet clover. Pinehold Gardens also uses compost as a fertilizer applying it twice a year.

Full Harvest is similar to Pinehold and Nature Creek as well; in terms of not being organically certified yet using environmentally friendly practices. Full Harvest uses a cover crop of barley and, at planting of the crop, a mixture of soybean meal, calcium sulfate, potassium sulfate, and boron to insure plants receiving all of the vital nutrients. This farm also uses an organically certified pesticide.

Wellspring Inc. is an organically certified farm. This farm uses compost and cover crops consisting of winter rye and legumes; it also uses mulch, companion plants, and harvests all crops by hand. Certified organic pesticides are used as well as homemade pesticides made of pepper spray and garlic.

Springdale is also an organically certified farm. Cover crops are used consisting mainly of legumes. Rotational cropping as well as mulching, and companion planting are all used. Generally no pesticide is used, if any pesticide is used it is homemade and meets all organic regulations. This farm harvests tomatoes by hand.
Farms were awarded points based on organic practices and then ranked according to amount of points. Nature Creek, Pinehold, and Full Harvest all received the same amount of points at 5 while Wellspring and Springdale were awarded 9 points each.

<table>
<thead>
<tr>
<th>Ranking of Farms based on Organic Practices</th>
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<tbody>
<tr>
<td>Nature Creek 1</td>
</tr>
<tr>
<td>-Organic fish fertilizer</td>
</tr>
<tr>
<td>-Green manure</td>
</tr>
<tr>
<td>-Organic certified pesticide</td>
</tr>
<tr>
<td>-Rotational cropping</td>
</tr>
<tr>
<td>-Harvest by hand</td>
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<td></td>
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<td>5 points</td>
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Table 1.1

**Sampling Methods**

Each tomato field was divided up into five sections approximately 40’x 40’ and three samples were taken from each section with a soil core approximately 12 centimeters in depth. Soil cores had a diameter of 10 cm per sample. Each field had a total of five samples consisting of three separate soil cores and the three cores in a given section were mixed to create one representative sample that was then placed in a Ziploc bag.
To assess moisture, after all samples were collected, samples were brought back to the lab and placed into a pre-weighed drying container. Each sample was measured out to 15 grams. After the weight was recorded each sample was placed in a drying oven set at 55°C until soil was dry, approximately 48 hours. Samples were left to cool approximately 24 hours and each sample was then reweighed and recorded. Soil moisture was calculated by subtracting the weight of the dry sample from the weight of the wet sample. That amount was then divided by the weight of the dry soil in order to the percentage of moisture in the soil (Robertson et al, 1999). Farms were also assigned points based on amount of organic practices and ranked accordingly. Rankings were used within linear regression portion of analysis of soil moisture.

Soil texture was also measured. Soil samples were dried at 55°C for 48 hours. Sub-samples from each site were mixed together to produce one large sample for each site. Dried samples were then mixed together using a pestle to gently break apart large chunks and then separated with a soil sieve. Soil was separated in to the following categories: gravel, fine gravel, very coarse sand, coarse sand, medium sand, very fine sand, and silt. Each category was then weighed and recorded. Total weight was found and each individual weight was then divided into total weight to find percentage of each category.

Sub-samples were also combined to find nitrogen levels. A standard Rapi test was used to find nitrogen levels in each of the sites. Dried soil samples from each farm were measured out to 1 Tbs. and placed in a mason jar. This was then mixed with 5 parts water for every 1 part soil. A lid was place on the jar and the mixture was shaken for 1
minute. The mixture was then allowed to sit for 24 hours in order to let the sediment to settle to the bottom.

Part of the water was then removed using a sterile pipette and placed in the Rapidtest apparatus. A capsule containing nitrogen indicating powder was carefully broken into the water. This mixture was then shaken for 1 minute and let sit for 10 minutes. Nitrogen levels were determined based on a color matching system.

To find organic matter within soil samples two grams of soil from each sample was measured out. Samples were then placed in a muffle furnace at 450˚C for 3 hours. Samples were then left to cool for 24 hours and reweighed. To calculate organic matter the weight of the baked sample was subtracted from the weight of the original sample. This total was then divided by the weight of the original.

In order to quantify macrofauna in the soil, a Berlese-Tullgren funnel was used for extraction. The soil sample was placed in a funnel with a jar of alcohol beneath it. A light source was placed above the sample to dry it out slowly from top to bottom. Samples were left in the funnels for approximately 24 hours. As the soil dried out the organisms moved downward and into the container of alcohol. These organisms were then identified, counted, and recorded. This procedure was repeated for each section of each farm (Robertson et al, 1999).

Results

Soil moisture at Wellspring and Springdale were similar with Wellspring at 32% soil moisture (±2.2) and Springdale at 26% soil moisture (±5.6) (figure 2.1). These two farms were also the two farms tested that were organically certified and ranked the
highest in organic practices. Wellspring and Springdale were also similar in soil composition having the highest percentages of coarse sand and lowest percentages of gravel out of the five farms sampled. Nitrogen tests at Wellspring displayed a rating of N2 adequate while Springdale was N1 deficient (table 1.2).

Wellspring and Springdale also had the highest amount of organic matter at 5.3% and 5.1% respectively (figure 2.2). When testing for macrofauna at these two farms organisms were found only at Springdale which included 3 mites and 1 beetle total. No invertebrate macrofauna were found at Wellspring.

Tests preformed on Full Harvest, Nature Creek, and Pinehold farms all resulted in similar results. Soil moisture at Full Harvest was at 20% (±1.0), Nature Creek soil moisture was at 21% (±1.4), and soil moisture at Pinehold was 21% (±1.4) (figure 2.1). These three farms were also the farms tested that were not certified organic and ranked evenly in terms of organic practices (table 1.1). Nitrogen testing revealed differences in the soils sampled. Full Harvest tested at a N4 surplus ranking, Nature Creek tested at a N2 adequate ranking, and Pinehold tested at an N1 deficient ranking (table 1.2).

Organic matter at these three farms was similar. Nature Creek, Full Harvest, and Pinehold all had 3.2% organic matter in the soil samples taken (figure 2.2). No invertebrate macrofauna were found in any of the samples from these three farms.

<table>
<thead>
<tr>
<th>Farms</th>
<th>Springdale</th>
<th>Pinehold</th>
<th>Nature Creek</th>
<th>Wellspring</th>
<th>Full Harvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen Levels</td>
<td>N1 Deficient</td>
<td>N1 Deficient</td>
<td>N2 Adequate</td>
<td>N2 Adequate</td>
<td>N4 Surplus</td>
</tr>
</tbody>
</table>

Table 1.2: Nitrogen levels of five farms sampled.
Discussion

The five farms sampled tended to separate out into two distinct groups once the tests were performed. The two farms with the highest ranking according to organic practices (also the two that were certified organic) tended to have similar results, while the other three that ranked similarly yet below the other two ended with similar results within the five tests performed.

Wellspring and Springdale tested the highest in soil organic matter and soil moisture. This may be attributed to the high number of organic practices used on these farms. The high use of biotic materials rather then chemicals contributed to the higher percentages of organic matter which in turn assists in retaining soil moisture.

The soil composition at these farms also plays a key role in the amount of soil moisture found there. The relatively low amounts of gravel in the soil and higher amounts of sands at Wellspring and Springdale also contribute to soil moisture percentage. Lower levels of gravel means water cannot drain through the soil at a high rate. The loamy quality of the soils at these two farms is important for holding nutrients as well as the water.

Full Harvest, Nature Creek, and Pinehold all received rankings below those of Wellspring and Springdale. These three farms were also the three that were not certified organic; however, environmentally sound practices were used at all three farms.

Organic matter percentages were lower at these three farms in comparison to the certified organic farms, by only approximately 2%. This may be because while cover crops were used at each of these farms; Springdale and Wellspring also used mulch as well as companion planting to add biotic material to the soil.
The high levels of gravel in the soils at Nature Creek, Full Harvest, and Pinehold are most likely partially responsible for the lower levels of soil moisture. As stated early higher levels of gravel in soil aids in the draining of water from the soil. Pinehold had the highest percentage of gravel at 77% which can be an explanation as to why it had low soil moisture at 20%; as opposed to Wellspring which had the lowest percentage of gravel at 9% and the highest soil moisture at 32%.

The data shows that there is indeed a difference between farms that are certified organic and not certified organic. The differences may not be large but they are present. Because the differences are fairly small it may not mean a lot for crops within these five farms; however, the greater the soil health the better a crop will thrive.

Each of the methods used in this study are standard for a soil survey; however, some adjustment may be made in order to obtain larger amounts of data which in turn will solidify conclusions made.

The largest constraint on this study was the amount of time allotted. In order to obtain a better representation of soil properties of each of the farms tested samples should be taken periodically throughout the course of a year. Particularly before planting, during growing and after harvesting to gain a better understanding of how those three things can affect the soil.

A researcher would also benefit from taking larger samples then what was taken for this study. The lack of macrofauna found in this study could be attributed to the small amount of soil taken for each sample; a larger sample size may contain a greater biodiversity. A greater number of samples could be taken as well to have an improved
representation of the field as a whole. Also testing more then one field may be beneficial to understanding the farm as a whole.

Finally conducting a wider array of soil nutrient tests would be valuable to gain a better understanding of soil quality. This includes potassium and phosphorus as well as nitrogen. Further testing beyond a Rapi test for nitrogen is recommended as well. All of these suggestions would lead to further understanding of the dynamics of soil health within these farms.

Based on the results of the tests conducted it is clear that there are trends in the components of soil quality within the certified organic farms and trends within the farms that are not certified organic. Consumers need to be aware that there are differences between CSA farms. Not all are certified organic and put into practice methods that are required for organic certification. Based on the individual needs of the consumer it is important to find out as much as possible about a CSA of interest and how they are run. However, it is not recommended to group CSA’s into categories of organic and non-organic because while farms within these groups show similarities; it is important to remember that each individual farm is unique.
Appendix A: Arial Photos of Farms Sampled

Figure 1.1: Arial Photograph of Full Harvest

Figure 1.2: Arial Photograph of Wellspring Inc.
Figure 1.3: Arial Photograph of Nature Creek

Figure 1.4: Arial Photograph of Pinehold Gardens
Figure 1.5: Arial Photograph of Springdale Farms

Figure 1.6: Map of Southeastern Wisconsin
Appendix B: Soil test result figures

Figure 2.1: Linear Regression of Soil Moisture of Five Farms Sampled

Figure 2.2: Linear Regression of Soil Organic Matter of Five Farms Sampled
Figure 2.3: Soil texture percentages Nature Creek.

Figure 2.4: Soil texture percentages Pinehold.
Figure 2.5: Soil texture percentages Full Harvest

Figure 2.6: Soil texture percentage Wellspring.
Figure 2.7: Soil texture percentages Springdale.
Bibliography


