The Future of U.S. Alternative Agriculture in a Time of Change

A Collaborative Research Exploration between Common Harvest CSA Farm (Osceola, WI)
&
The Students in Geography 232: People, Agriculture and Environment
Macalester College

Fall 2017

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Prologue and Acknowledgements

The following report represents the collective efforts of 29 students co-investigating a series of critical questions related to Community Supported Agriculture (CSA) in Northwestern Wisconsin and the Twin Cities Metro area of Minnesota. During the September-October 2017 period, students in Geography 232 (People Agriculture and the Environment) engaged in a collaborative research exploration with Common Harvest CSA farm in Osceola, WI. Following on four previous years of collaboration, the course instructor and the co-owners of the farm developed a set of research questions that were of mutual interest. The questions identified were as follows:

1) Given that climate change likely fosters more variable weather patterns, how is the CSA model (which distributes risk to members) holding up in the face of weather extremes in Polk Country, WI, other areas of the Twin Cities metro, and the region more broadly?
2) What are the pros and cons for farms in Polk County, WI of being located relatively close to the Twin Cities Metro Area? How does the mix of pros and cons shift depending on the type of farm in question? What happens when the Metro area essentially gets 'closer' following the construction of the Stillwater bridge?
3) The US has a history of transferring its model of agriculture to other countries. What can the reverse teach us? To be more specific, what farm challenges do you observe in Polk County, WI and what lessons could we take from elsewhere to try to address them?
4) What are the costs and benefits to particular approaches to more sustainable farming in the upper Midwest? What are the chances of some of these practices being incorporated into the forthcoming 2018 farm bill and how might they be implemented more broadly?

The class was divided into six research groups of four to six students. Research questions 2 and 4 were assigned one research group each, whereas questions 1 and 3 each had two groups. In order to prepare for their exploration of these questions, all students in the class read background materials on the region, soil ecology, farming, and the CSA concept. Common Harvest CSA co-owner Dan Guenther visited the class on September 14 to guest lecture about soil ecology, farming practices and the CSA movement. The class spent a full day on the farm on Saturday, September 16, during which time they received a tour of the area and then moved to the farm to learn about farming practices and the logistics of running a CSA. The six groups then spent the following two weeks collecting and analyzing data for their respective research questions. Students working on the first question interviewed some Common Harvest CSA members and reviewed reports from other CSA around the country. Students exploring the second question spoke extensively with the owners of Common Harvest CSA farm as well as some other famers in the area. These working on the third question examined farming challenges in Polk County, WI and then reviewed the literature for relevant practices used in other parts of the world to address similar problems. Last but not least, those addressing the fourth question relied on information collected in the field as well as reports in the academic literature. The students working in each of the research groups penned a report addressing a segment of their questions. These reports are included as sub-chapters, following each research question, in this document. While the quality of the individual reports may vary, together they represent a rich set of insights that were co-produced with the owners of the farm, as well as the various individuals who were interviewed for this project.

None of this would have been possible without the time, energy and intellectual input of the co-owners of Common Harvest CSA farm, Dan Guenther and Margaret Pennings. We are also grateful to the Civic Engagement Center of Macalester College, and especially Paul Schadewald, for providing financial and logistic support for this exercise.

Bill Moseley, Professor of Geography, Macalester College

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*Not all student authors chose to publish their findings in this report. Furthermore, some opted to share their findings anonymously as indicated here.

Chapter 1:
Given that climate change likely fosters more variable weather patterns, how is the CSA model (which distributes risk to members) holding up in the face of weather extremes in Polk Country, WI, other areas of the Twin Cities metro, and the region more broadly?

The Findings of Research Group 1a (Rita Bernardo, Siddhant Singh, Emily Bowler, Anonymous, Carter D'Angelo)

Climate Change and Its Effects on the CSA Shared-Risk Model

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Group 1a

Prof. Moseley - Macalester College

People, Agriculture, and the Environment

October 3, 2017

Introduction

Due to climate change resulting in variable weather patterns, it is important to understand how climate change impacts agriculture. In particular, this paper will explore the effects of climate change on community supported agriculture farms better known as CSAs in the Midwest region of the United States. CSAs have a risk-share model, in which risk is shared between farmers and members regarding the produce that is grown during the season. This model allows for a close, producer-consumer relationship and a comprehensive understanding of the cost and production of fresh food.

Within the shared-risk model of CSAs, CSA farmers seem to bear most of the risk of climate change so how can policy aid farmers in adapting to climate change and influence consumer choices to sustainably support the CSA model? Farmers face many uncertainties and misperceptions of climate change and its impacts on their livelihood in the long-run. To help farmers adapt to climate change, government can provide farmers the necessary tools to sustain a livelihood despite the effects of climate change. Also, there is a consensus among consumers to participate in CSAs; however, membership is not always feasible for everyone, and there are a variety of options to obtaining food. This paper will explore the technologies and policies that show potential to help farmers combat climate change and encourage consumers to support the CSA model.

Method

Information to conduct this paper was gathered via personal communication and extensive online research from academic journals. For the personal communication aspect, five farmers and five members, who are members for at least one season, from CSAs or programs similar to CSAs like cooperatives or co-ops in the Twin Cities metro area, were interviewed via

email or in person. One element of the personal communication aspect was a visit to a CSA farm, Common Harvest in Osceola, Wisconsin, where information was gathered about the owners Dan Guenther and Margaret Pennings' concerns regarding the effects of climate change on their farm and the dynamics of the shared-risk of the CSA model with their members. Then, to get a better understanding of other CSA models within the Midwest region, the other element of personal communication was to gather information via email from three more farmers and five members of CSAs and co-ops. Members were asked these questions:

1. If not CSA, where do you shop for produce?
2. What made you decide to join a CSA? And how did you hear about this particular CSA?
3. What do you like about your CSA?
4. What would you change about your CSA?
5. Is there a minimum amount of produce that would make you drop your CSA?
6. How does the risk of the CSA model as a consumer impact your choice to continue membership?
7. Do you share your CSA produce?
8. If gov't subsidies, for example in the form of SNAP benefits, were available for being a part of the CSA, would this make it more affordable for you to continue membership?
9. What are some ways you think can persuade other consumers to participate in a CSA? Education? Subsidies? Health reasons?
10. There was a hailstorm earlier this year in June that delayed deliveries by two weeks, which must have inconvenienced you. What was your reaction to that?

These questions that were asked of CSA members pertained to how they felt about recent climate change events and if it impacted their choice to continue membership. Information is also gathered regarding the affordability of being a CSA member and what factors could help with this potential barrier. Farmers were asked these questions:

1. How many acres is your farm? How many members do you have on the average year? Does this number fluctuate?
2. On the average year how many of your members return for the next year?
3. How do you attract potential members? Has this changed over time with experience, farm productivity, or political climate?

4. Do you talk to your members about risk(namely the potential for low crop yields)? If so how? And has this changed over time with experience, farm productivity, or political climate?
5. In your personal experience has the past five to ten years experienced an increase in interest in CSA's or a decrease?
6. Have you or your farm been affected by changes in climate or extreme weather events over the past 20 years?
7. What about the CSA farm model appealed to you? What do you think it is about the CSA farm model that appeals to your members?

These questions that were asked of CSA farmers pertained to their concerns with climate change and how that affects their membership retention. Information is also gathered about the reasons why farmers chose to enter the market of CSAs. For the extensive online research of academic journals, 7 articles were reviewed to get a better understanding of the available technologies and policies that can aid farmers to adapt to climate change. These articles were published within the past decade to ensure current relevancy and were obtained via Academic Search Premier, an online research database.

Findings

CSA model

After gathering information from CSA farmers and members, it seems that the burden of the effects of climate change and the shared-risk of the CSA model is borne heavily on the farmers' side. With more options in the market for agriculture, Farmer #1 (2017) stated that "overall more people are probably interested in [CSAs], but there are so many choices than 10 years ago that we are not seeing that increase. And I know most farmers are in the same boat. We talk about it all the time." This is evidence that part of the risk that CSA farmers bear is retention of members to sustain the CSA model and support a livelihood, which is further worsened by the factor of climate change.

The effects of climate change is evident with the recent events that occurred this past harvest season in the Midwest: hailstorm on June 11th and blight in early August, all due to cooler temperatures. Upon interviewing Guenther and Pennings' (2017) concern with these events, they have cited that these were unusual occurrences that have never occurred in the past decade. Pennings expressed that blight has caused damage to the tomatoes, and was resolved that the tomatoes to be grown for the next season would be a different variety that is blight-resistant. This is evident that there are ways that farmers can adapt to climate change without additional support, simply by tweaking the crops they grow during the season. Other farmers who were part of the interviewed set were fortunate to have not sustained significant damage from the recent events, and they were able to recover quickly for the rest of the season.

In contrast, the five members of CSAs and similar programs did not seem to be impacted by the recent climate change events and their choice to continue membership with their respective programs. With the recent hailstorm, Member #1 (2017) claimed that she "kept buying my veggies with my other groceries like I do in the winter." Other members that were interviewed also claimed that they have other alternatives to obtaining food if it was not fulfilled via the CSA share. This is further evidence that farmers bear most of the risk in the CSA model because members often have alternatives; therefore, they are risk-adverse to the impacts of climate change as they can choose to shop elsewhere or potentially terminate CSA membership.

Government Subsidies

Owning a CSA farm can be financially difficult to maintain with the costs necessary to sustain the livelihood of the farmer(s) and their family. At Common Harvest CSA, Guenther and Pennings (2017) have both highlighted that their farm was debt-adverse, and they would not accept government subsidies, in which they do not qualify for because their farm does not meet

the requirements for agriculture subsidies. They have cited that they would not receive subsidies because they often come with conditions and oversight of how their farm is operated. This is understandable as the CSA dynamics does not include a third party role in the producer-consumer relationship.

However, there is a role government can have in helping to sustain CSA models. Government, at the state level, can provide aid that "should be perceived as complementary to the actions taken by the farmers themselves" (Lipińska, 2016). They can provide informational training and other proactive tools to farmers on how to combat climate change. Ultimately, the decision on risk management of climate change would the farmers' decision.

Guenther and Pennings have participated in a few programs to help reduce costs on the farm, particularly a $5,000 grant for smaller family farms to implement solar energy on the farm. This is evidence that there are programs, not directly linked to agriculture, that can aid farmers to combat climate change, and in this case, change the energy source used on agriculture. It supports the idea that government programs can have a role in sustainable agriculture by promoting policies and programs to help sustain farmers' livelihoods and reduce reliance on fossil fuels.

Being able to afford membership in a CSA can be a barrier to sustaining the CSA model, as it can decrease membership retention, especially in the face of climate change. Though the role of government plays middlemen in the relationship dynamic of the farmer and the member, it can provide support to consumers, especially low-income communities, who face financial barriers in accessing quality and locally grown food (Cotter, Texeira, Bontrager, Horton, & Soriano, 2017). Government aid can be in the form of SNAP (Supplemental Nutrition Assistance Program) benefits, in which CSAs can accept by obtaining license approval from the Department

of Agriculture's Food and Nutrition Service. This will help increase membership and sustain the CSA model financially.

In comparison, members who are part of the interviewed set, did not seem to see the share price as a barrier to continuing membership. This is an indication that most members of CSAs are able to afford membership, and members are informed of the benefits and risks that come with membership. When asked in the questions if government subsidies in the form of SNAP benefits were made available in the CSA model, one member indicated "I suspect that most of the people who use our drop site wouldn't qualify, the [socio-economic status] is on the higher end" (Member #1, 2017). This is evidence that there are still barriers in obtaining membership, and one key component is accessibility of CSAs to people of lower income.

Climate Change: Technologies and Uncertainty

In combating climate change, there are available technologies, climate-smart agriculture (CSA) technologies to help farmers adapt. Khatri-Chhetri, Aggarwal, Joshi, and Vyas (2017), explore how farmers prioritize these technologies and incorporate them into their farming practices at a local scale. Climate-smart technologies are defined as helping "to achieve at least one pillar of CSA (either increases productivity or increases resilience or reduces GHG emission)" (Khatri-Chhetri et al., 2017, pg. 184). It was assessed that farmers' preferences of these available technologies depended on their finances and the specific climate change issues that the farmers are facing; therefore, policies "need to emphasize on the crucial role of providing information about available CSA technologies and creating financial resources to enable farmers to adopt various CSA technologies that are relevant for their location" (Khatri-Chhetri et al., 2017, pg. 190).

However, even with the available CSA technologies to combat climate change, upper Midwest farmers still have uncertainty of the impacts of climate change to warrant adoption of new agricultural practices. This uncertainty is linked to four factors: personal experiences of weather events, perception and understanding of climate risks, personal values and beliefs, and social norms that information about climate change cannot be trusted (Morton, Roesch-McNally, & Wilke, 2017). With uncertainty, farmers who do not believe in climate change or perceive that there is not enough information to justify changing one's practices, can continue to contribute to the factors that cause climate change.

Conclusion

To summarize, farmers bear most of the risk in the community supported agriculture (CSA) model, especially in the face of climate change and retaining membership. Consumers, or members, have food alternatives that they cannot otherwise obtain via a CSA share, which generates a low risk-share for members and show potential for termination of membership. Government can provide policies and programs that support both farmers and consumers to sustain the CSA model in the form of climate-smart technologies for farmers and SNAP benefits for consumers. Even with available technologies, many farmers still have uncertainty about climate change to justify adapting new agricultural practices.

A common theme among the information from the literature and interviewed set of farmers and members is the barriers that farmers and members face when adapting to climate change. Money and information or training are the common barriers to both the farmers and members of the CSA model. Farmers have to consider the information and finances that comes with adapting to new farming practices specific to the climate issues in their area, while members have to consider the information and financial risk with CSA membership. Many of the

interviewed members are able to afford membership, but people of lower-income communities face financial barriers and possible lack of information of CSAs, which can also be due to inaccessibility.

To help continually support the CSA model, a policy could be to provide farmers with the proper training and complementary tools specific to the climate issues that they face at the local level to help adaptation to climate change. Another policy would be to have CSAs become more accessible to lower-income communities by approving CSA programs to accept SNAP benefits and to mandate that CSA drop-sites are within the area of these communities.

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Effects Of Climate Change On Agriculture In The Twin Cities Region And Potential Future Impacts

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Introduction

Climate change is upon us, and it threatens to disrupt the quality of life humans have today. Increasingly erratic weather patterns, such as droughts, flood and hail, severely threaten our food production system.

Community Supported Agriculture(CSA) farms are a form of agriculture which cut out middle-men in the process of food production and aim to foster a closer relation between the food producers and the consumers. The chief attractions of CSA farms are knowing where the food you are eating comes from, having healthy vegetables to eat every week, supporting local businesses, and the more environmentally friendly approach CSAs adopt towards farming (Personal Communication, 2017)[1]. CSAs have a shared-risk model of business where the subscribers pay up front for the produce before the beginning of the season.

The research question I worked with was "Over the past few years, how has climate change affected the CSA farms and agriculture in general in the region, and how may this change in the future?". This paper explores some of the impacts of erratic weather on CSAs and agriculture around the Polk County area, and how climate change is likely to affect them in the future. The paper also discusses late blight of tomatoes, and how its pathogen may be getting more suitable conditions for germination with the current trends of climate change. Foresight in such situations is important as it allows sufficient time to formulate policy and take action to limit the repercussions of climate change.

[1] This information was synthesized from interviews conducted with CSA members and CSAs.

Research methods

1. Field trip - On Saturday, 16 September, our class went to the Common Harvest Farm, a CSA farm operated by Dan and Margaret, in Osceola, Polk County, Wisconsin. On the bus ride over, Dan gave us a general tour of the area which consists of many farms, including dairy farms and large conventional farms which grow a lot of soy and corn. In the farm, Dan and Margaret led us through the several intricacies of running the CSA: the soil profile, how they use implements on their farm, how weather affects them, etc. We also had question sessions with them later in the day.
2. Library research - I looked for studies which discussed climate change, how they would influence weather events, and how that would impact agricultural practices. Some of the studies cited are Fujisaka et al.'s "*The impact of climate change on interdependence for microbial genetic resources for agriculture*" and Ye et al.'s "*Rapid decadal convective precipitation increase over Eurasia during the last three decades of the 20th century.*" Fujisaka et al.'s study discusses how occurrence of diseases and pests may increase in crops with climate change. Ye et al.'s study discusses how thunderstorms(heavy, or convective rainfall) are increasing at the expense of showers(steady, or non convective rainfall) because of climate change. S.C. Pryor's book "*Climate change in the midwest : Impacts, risks, vulnerability, and adaptation*" which provided an overview of the midwest's climate history and the possible ramifications of climate change in the region was also helpful.
3. Interviews - The two groups having the same overarching question interviewed subscribers of the Common Harvest Farm and shared their findings with the other groups.

Carter and Emily from our group also interviewed some other CSAs in the area and their subscribers.

Findings, analysis and discussion

Hailstorms

Polk County and neighbouring areas suffered a major hailstorm on June 11 (Barrow, 2017). "It was the first one in 28 years" says Farmer Dan. Their first delivery of the season was delayed by two weeks because of the hailstorm, and the delivery season was cut short from 18 weeks to 16 weeks. "The entire tomato crop was stripped because of the hailstorm. Luckily the kale, onions and swiss chard grew out of it, so we had something to deliver. " mentions Margaret. "I sent all our members a message regarding the hail storm and how it had affected our crop. All of them responded positively with messages of solidarity, 'We're with you through this' ", she continues. She doesn't know how this would affect their retention rate. "This is the first time something like this has happened, and we'll only be able to tell next season." Research on the relation between climate change and hailstorms indicates that while they will occur less frequently with anticipated rise in temperatures, the hail size is expected to increase (Brimelow, Burrows, & Hanesiak, 2017). So while hailstorms themselves may decrease, the damage they cause when they do occur will be far more lasting, especially from the viewpoint of a farmer.

Rainfall

One of the major impacts climate change will have(and to a certain extent, has had) on agriculture would be the change in precipitation patterns. As the earth becomes warmer, the rate of evaporation increases, and this leads to a greater amount of water vapor in the atmosphere.

The increased water vapor in the air induces heavier rains(Intergovernmental Panel on Climate Change [IPCC], 2007)**.** The fact that water vapor is itself a greenhouse gas exacerbates the problem further (National Aeronautics and Space Administration, 2008).

Dan mentions how rainfall has changed since the time he began at Common Harvest Farm. “It used to be 30% thunder, 70% showers but now it’s the other way around - 70% thunder and 30% showers”.

When it rains heavily in a short period of time, the ground is unable to absorb the rainwater as effectively as it would if the amount of water was spaced out over a longer period of time(IPCC, 2007). This leads to runoff, causing significant soil erosion and which could further result in floods. It also leads to the increase in the frequency and severity of droughts.

A study by Ye, Fetzer, Wong, and Lambrigtsen (2017) found that it is possible that convective rainfall (rain falling in short and stilted abrupt bursts, or thunderstorms) occurs at the expense of nonconvective rainfall (steady rainfall over many hours, or the showers). Their research notes that even though the average annual precipitation over Eurasia has not varied significantly over time, annual convective rainfall has grown at an alarmingly fast pace of 18.4 % per degree Celsius. The study claims that with increasing global warming, convective rainfall too would increase, and so would the plethora of problems associated with it, since it found a there is a direct correlation between increase in convective rainfall and increase in temperature. While the author of this paper could not find any documentation on convective and nonconvective rainfall in Wisconsin specifically, Dan’s observations could well be accurate. Anderson(2013) notes that days with high rainfall have increased across the Midwest, and this increase is particularly marked in the last quarter of the 20th century. Thus the results of the

study by Ye et al. could be seen from the perspective of agriculture in Polk County (as well as elsewhere in the US) and the adverse impact it may have in the future.

Late Blight in Tomatoes

This August, the Common Harvest Farm was unable to deliver their choicest tomatoes to their subscribers because of the late blight (the same one that caused the Irish Potato Famine back in 1845). The fungus which causes the blight, *Phytophthora infestans*, affects both potatoes and tomatoes. It is a hard pest to get rid of, and requires all the crops affected by it to be destroyed in order to not affect future plantings. Chemical controls and fungicides such as phenylamides are traditionally used to control their growth(Nowicki, Foolad, Nowakowska, & Kozik, 2011). Organic farms, such as the Common Harvest Farm, however, avoid the use of synthetic fungicides and pesticides, and can often be more susceptible to epidemics.

"We had a colder August this year, and that may be the reason for the blight.", says Dan. Margaret comments "We rarely had any blights when we began. But over the course of the last four seasons, we have had our tomato crops affected by the late blight three times. I can not say with certainty, but I think it is because of climate change.". In an email, Dan remarks "In the end cool wet weather is the primary determining factor as to whether we get it(referring to the late blight) or not. What is hard to adjust to is that in our first 24 seasons we only had late blight once, and now in the past four seasons, we have had it three times. It is very weather dependent", The only tomatoes which didn't contract the blight were the one or two disease-resistant varieties of the crop they had started planting over the past few seasons to combat the blight. "The one issue is that they do not have as good of flavor as the other varieties we prefer [sic]". Another

CSA in Polk County(name withheld), has also had late blight set in on their tomatoes, as have other farms in the area (Personal communication, 2017).

According to Wallin et al. (1950), the fungus *Phytophthora infestans* reproduces most vigorously when the temperatures are between 45° F (7.2° C) and 80° F (26.8° C) and the moisture content is high (as cited in Petzoldt and Seaman, 2006). When the average temperature increases by a degree Celsius, not only are the crops susceptible to the blight for ten to twenty more days than is normal, but the onset of the blight also occurs earlier by four to seven days (Fujisaka, Williams and Halewood, 2009).

An analysis of the graphs of the total rainfall and average temperature in August over the past decade in Amery, a city located 20 miles from Osceola reveals interesting trends(see graphs at page 10). As is clear from the graphs, the temperature over the past decade in August has been in the ambient range for the late blight to occur(graph 2, page 10). Rainfall has varied, but not significantly (graph 1, page 10, and graphs on page 11). However, the way rainfall occurs - whether in short bursts or over long periods of time - has changed, as discussed previously. The fungal spores of *P. infestans* require one to two days of high humidity for them to germinate(Nowicki et al., 2011). Clearly, there has been sufficient moisture in the air over the past few years for the fungal spores to develop. As discussed previously, rising temperatures lead to an increase in the amount of water vapor in the air, and thus can lead to conditions more favorable for the late blight. Whether increase in high intensity, intermittent rainfall also affects the blooming of the late blight is not known. But there may be a correlation which can be explored in future research.

Conclusion

This paper evaluated some of the problems faced by the Common Harvest Farm in the recent past, and how climate change may aggravate such problems around the area in the future. Hailstorms with bigger hail size may occur in the future, severely threatening the growth cycle of crops. Rainfall is increasingly coming in the form of thunderstorms instead of steady showers leading to soil erosion, runoff, and floods. The occurrence of late blight which is a difficult disease to control has increased, and this could be because of changing temperature and precipitation patterns.

Whether this will affect the relationship between CSAs and their members in the near future is suspect. In the interviews, none of the subscribers indicated that financial constraints were a big concern for them while buying from the CSAs. The fact that they knew who was growing their food, and how it was being grown, made it a worthy investment. The delay in delivery due to the hailstorm did not bother the members seriously, and they recognized the fact that they shared the risks of crop failure with their farm. Not enough data is available to comment on how the retention rate of subscribers may be affected post a season in which some deliveries have failed.

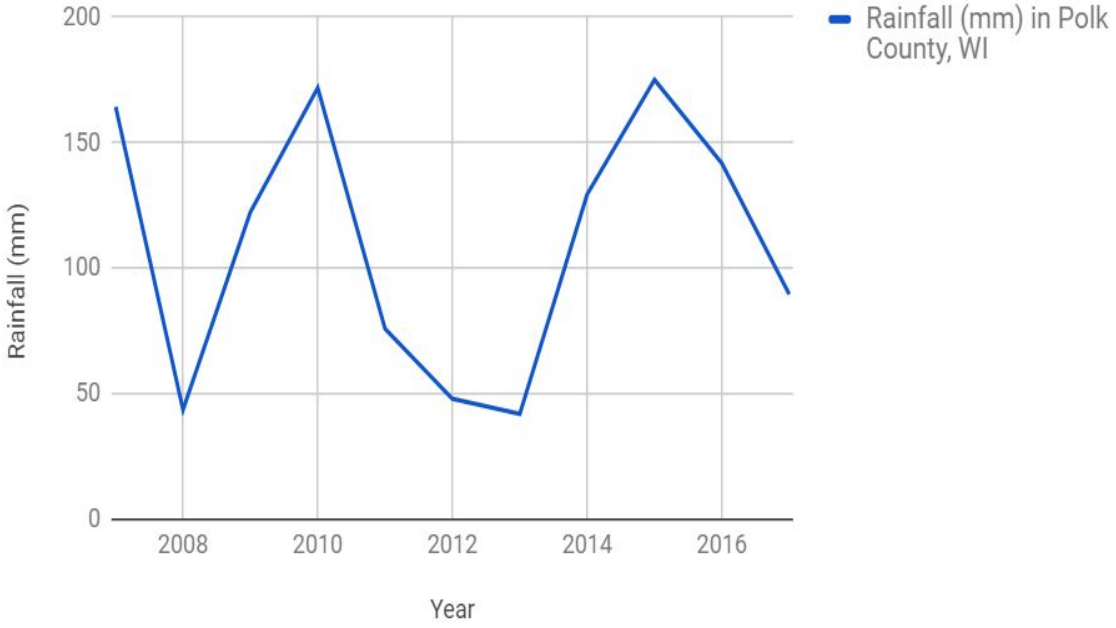
Policy Recommendations

On a larger scale, there has to be a consistent effort to reduce emissions in order to minimize the effects of further climate change in the future. On a smaller scale, there needs to be sufficient infrastructure and proper policy to deal with the problems that are now unavoidable. As discussed previously, convective rainfall has increased, and with it comes the problem of runoff. Runoff often brings chemicals with it and seeps them into lakes, river and groundwater,

thus polluting them. Attention needs to go towards minimizing pollution due to runoff. Since we can't control the rains, we must control what we put into the soil. Broadly speaking, a shift is required in agriculture in general towards using less chemical implements. Instead, farmers should make greater use of crops resistant to disease and pests. Runoff due to excessive rain brings about another challenge for farming: soil erosion. Water washes away the organic content in the soil, thus reducing its fertility. Practices to minimize soil erosion include mixed cropping over monocropping, contour farming in areas with slopes and usage of low-till methods where feasible. If low till methods are used, the soil is not disturbed drastically. Leaving the crop residue on the soil leads to an increase in the soil carbon. The soil thus regains organic matter(Smith et al, 2008). Moreover, intensive tillage accelerates carbon dioxide emissions in the atmosphere(Luo and Zhou, 2006). On the other hand, conservation tillage practices such as low-till or no-till can play an important role in the sequestration of carbon(Utomo, 2014). Hence low-till methods reduce soil erosion and also tackle the root cause of global warming: emissions. Taking appropriate measures in time can also severely reduce the damage sustained by crops due to flooding and drought. A policy framework that encourages the practices mentioned is required.

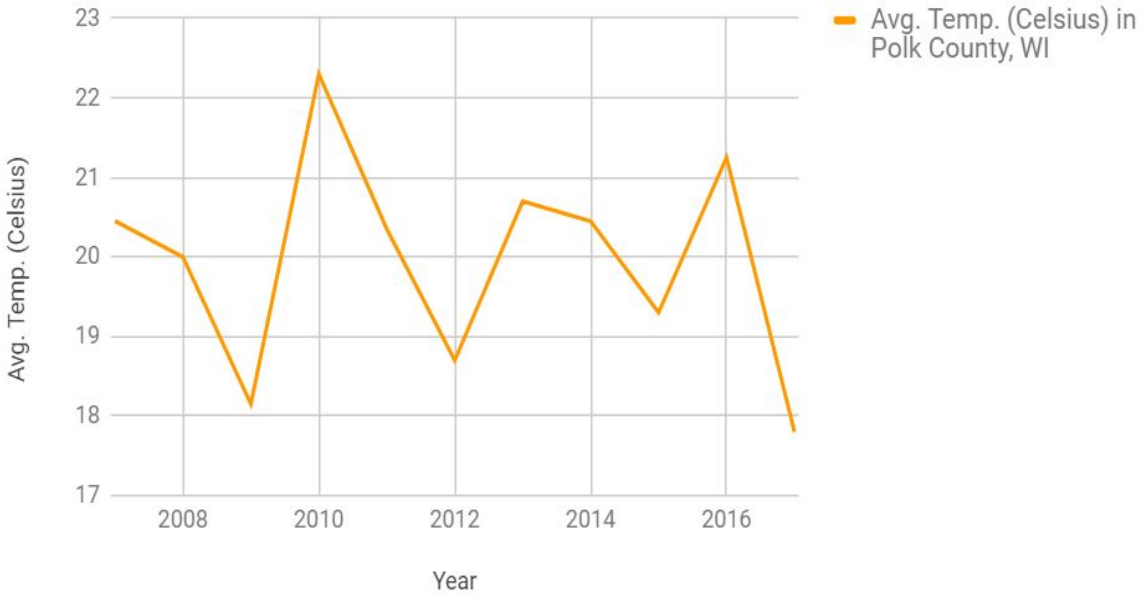
Rainfall (mm) variations in August since 2007 in Polk County, WI

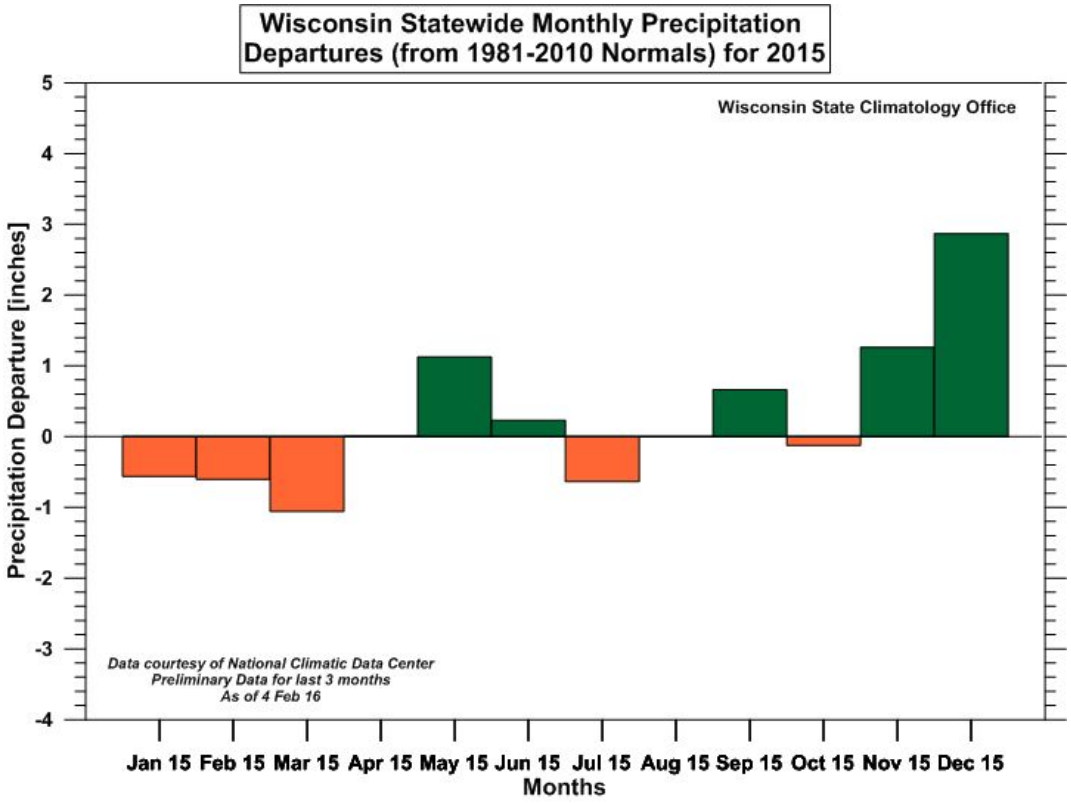
Source: https://www.usclimatedata.com/climate/amery/wisconsin/united-states/uswi0015

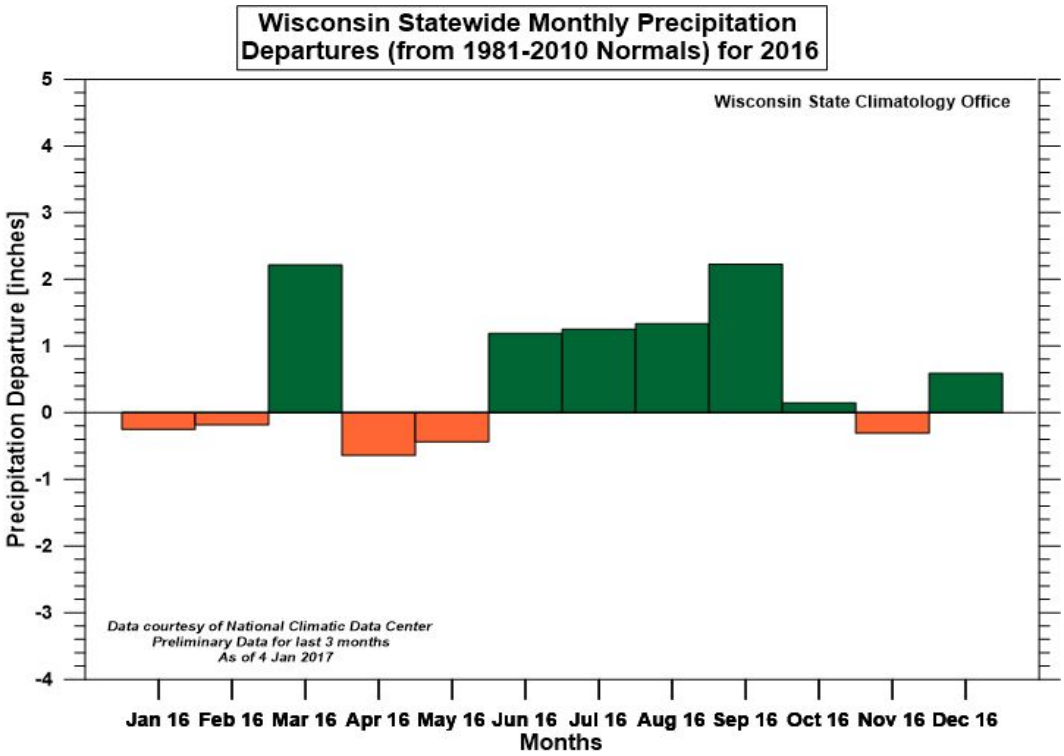


Avg. Temp. (Celsius) in August in Polk County since 2007

Source: https://www.usclimatedata.com/climate/amery/wisconsin/united-states/uswi0015







Source: http://www.aos.wisc.edu/~sco/clim-watch/archives.html#annual

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11 October 2017

The Viability of the Community-Sustained Agriculture (CSA) model: Climate Change as a Compounding Factor

Introduction

As erratic weather patterns continue to increase due to global warming, small farm owners are facing the difficult situation of trying to keep their community-supported agriculture (CSA) members happy while also dealing with compounding factors out of their control. The CSA model was introduced to the United States in the 1980s and in 2015, data collected by the U.S. Department of Agriculture disclosed that there are 7,398 farms operating on a CSA model (Alternative Farming Systems Information Center 2017). There are multiple ways to organize a CSA; however, most operate in a fashion where members pay up front a few hundred dollars for a seasonal variety of vegetables each week for the growing season. Periods of drought followed by heavy rainfall are just two examples of the inconsistent climate farmers are trying to work with in today's increasingly fossil-fueled world. According to a study conducted by the United States Department of Commerce National Oceanic and Atmospheric Administration (NOAA), the warming atmosphere is increasing precipitation rates, and it is predicted that the Northern Hemisphere will experience a 20-30% increase in maximum precipitation by the end of the 21st century (Kunkel et al. 2013). Combined with the fact that many have overtilled, or overworked, their soil for centuries and fractured soil bonds that help disperse water and air throughout the soil, it will be even harder to reverse soil degradation with the unreliable weather patterns (Guenthner 2017).

The overarching question I am addressing is how the CSA model is holding up in the face of weather extremes caused by climate change within the Twin Cities metro area and the

region more broadly. Within this broad question, my sub-question focuses on how farmers and members are handling climate change effects on their program, and if the CSA model will be able to survive with more unpredictable weather patterns. My findings will be useful for farmers looking to start a CSA and trying to be mindful of the benefits and drawbacks of investing in a program, as well as farmer's that have a CSA program and are looking to see how they can improve member retention, all within the backdrop of climate change. This paper seeks to understand how farmers in the Midwestern United States are adjusting to these climatological conditions and if members are adapting to these changes as well, to see if ultimately the CSA model can exist in a future where weather variability is only going to increase.

Research Methods

To understand the scope of the CSA model, a general search for peer-reviewed journal articles was conducted on the positives and negatives of the model, from the perspectives of both the farmer and the member. My classmates and I also took a trip to Common Harvest Farm in Osceola, Wisconsin, where we were able to see a CSA program in action. We also posed questions to farmers Dan Guenthner and Margaret Pennings about their opinions on the CSA model in the progressively unstable climate. Interviews were conducted with two urban CSA farmers in Minneapolis, Minnesota and one rural CSA farmer in Polk County, Wisconsin. A CSA coordinator for an urban CSA farm in Minneapolis was also interviewed. The interviews were based on the following questions:

1. How many acres is your farm?
2. How many members do you have on the average year?
3. Does this number fluctuate?
4. On the average year how many of your members return for the next year?
5. How do you attract potential members?

6. Has this changed over time with experience, farm productivity, or political climate?
7. Do you talk to your members about risk (namely the potential for low crop yields)?
8. If so how? And has this changed over time with experience, farm productivity, or political climate?
9. In your personal experience, have you experienced in the past five to ten years an increase in interest in CSA farms?
10. Have you or your farm been affected by changes in climate or extreme weather events over the past 20 years?
11. What about the CSA farm model appealed to you?

Interviews with four CSA members from the Twin Cities area were also conducted to understand the consumer side of the equation. The interviews were based on the following questions:

1. If not CSA, where do you shop for produce?
2. What made you decide to join a CSA? And how did you hear about this particular CSA?
3. What do you like about your CSA?
4. What would you change about your CSA?
5. Is there a minimum amount of produce that would make you drop your CSA?
6. How does the risk of the CSA model as a consumer impact your choice to continue membership?
7. Do you share your CSA produce?
8. If government subsidies, for example in the form of SNAP benefits, were available for being part of the CSA, would this make it more affordable for you to continue membership?
9. What are some ways you think can persuade other consumers to participate in a CSA? Education? Subsidies? Health reasons?
10. There was a hailstorm earlier this June that delayed deliveries by two weeks, which must have inconvenienced you. What was your reaction to that?

I also had the opportunity in the summer of 2017 to work on an urban CSA farm, Open Farms. It is run by the non-profit organization Open Arms of Minnesota and is located in Minneapolis. I have included information related to my experience and knowledge I gained as a farm intern.

Findings, Analysis and Discussion

Climate change aside, farmers have been making decisions based on a season's varying weather patterns for centuries. Farming is a profession that is controlled by nature, but farmers have created innovative techniques to try and produce healthy plants despite the

variability of the environmental elements. One of the urban farmers interviewed used the example of permaculture as a technique to help address climate change (CSA farmer informant 2). Permaculture refers to agricultural designs that coincide with the natural environment by using indigenous plants. One common design is the permaculture spiral, where herbs are planted at staggering heights within a rock-enclosed spiral of soil that align with the amount of water needed for each plant. For example, heat-loving rosemary is planted at the top of the spiral, so as the water drips down the spiral, rosemary will dry out quicker. Mint, on the other end of the spectrum, thrives in water, so by planting mint at the bottom of the steep spiral, it will receive a pool of water to grow in. Even if there is a season with a less-than-ideal ratio of sun to rain, mint will still be the plant receiving the most rainfall in this design. This is an example of an innovative use of plant biology to address weather variability.

Another technique farmers can use to address changing weather patterns is planting the same species at different intervals, so that they can hopefully get CSA members the vegetable they are looking for, just at a different time than usual. This past June was particularly dry, and so the farm coordinator of Open Arms had us interns wait to plant the mixed greens until there was adequate rainfall. Not only did we not waste seed, but by tracking weather patterns, we determined the best time to plant the crop. In our first few CSA newsletters, we let our members know that lettuce was on the way, and subject to the weather changes. By keeping members informed of the factors affecting their vegetables, they were sympathetic and definitely more understanding than they would have been if they were to receive a light box with no explanation.

In terms of running a successful CSA membership, all the farmers seemed to believe that transparency was the best way to address inconsistent yields. One farmer has members sign a form at the beginning of the season that explains the incongruity that can occur in crop production due to a season's individual weather patterns and that there are no refunds for a season (CSA farmer informant 3). She feels that by being up front about the expectations members should have, she can hopefully avoid member dissatisfaction. In the United States, 27% of CSA farmers rent their land (Schnell 2007) and thus the money collected from the CSA is used for rent, not only for the land, but for greenhouses as well so farmers can get a jump-start on transplants in the winter (CSA farmer informant 2). Therefore, the money collected from the CSA is calculated into the farm's budget, and that is one reason why they cannot refund members. When a CSA is conducted with a member agreement and payment before the growing season even starts, farmers have the financial opportunity to get ahead on the upcoming season, with both economic and emotional support from their members.

Farmers of course still want their members to feel like their money is going to good use, and multiple interviewed farmers explained that they try to make up for one crop's disappointing yield by including more of another one (CSA farmer informants 2 and 3). Farmers also understand that many of their members, especially new members, might not be used to some of the vegetables in their boxes. Thus, two farmers interviewed explained that they always put a newsletter in each box with recipes using that week's vegetables (CSA farmer informants 2 and 3). In one example, a farmer said this past June her carrot plants were very slow to mature due to the lack of rain. To problem solve, she included carrot greens in the boxes along with a recipe for carrot top pesto. Much to her delight, she received multiple emails from members that loved the recipe and enjoyed learning something new (CSA farmer

informant 2). Therefore, communication is one of the main segments of a successful CSA, as members are much more likely to adapt to changes in their boxes if they know how to use the produce and why the changes are occurring. CSA farmers also conduct end-of-season surveys to see what members liked and did not like about the previous season, and if they have any ideas to improve the process (CSA farmer informant 2 and CSA coordinator). Not only do members want to get their money's worth, but many are looking for that connection with local food production, and thus keeping them informed makes them feel more like a part of the process versus just another customer. If they just wanted to buy fresh vegetables, they could go to the local health food store. But by specifically seeking out a CSA membership, a member is clearly looking for a deeper connection to their food, beyond the health benefits, and certainly beyond convenience.

Another factor that plays a role in the flexible nature of the members is their socioeconomic status. There is a specific demographic that is attracted to CSA membership and a study conducted with the From the Ground Up 240-member CSA in Upper Marlboro, Maryland found the population is overwhelmingly white (92.2%), female (83.5%) and college-educated (98.2%) (Lang 2010). 87.2% were also democratic and 53.9% made greater than $75,000 a year (Lang 2010). A study conducted in New York State had a similar outcome, where the average income of a CSA member was 30.7% higher than the New York State average (Brehm and Eisenhauer 2008). Thus, I feel like it can be concluded that those who make the effort to join a CSA tend to be understanding in terms of weather variability and therefore crop variability because they do not have financial constraints that limit their spending on food. Hence, I was not surprised to hear that all of the CSA members I interviewed said a bad vegetable production year would not cause them to cancel their

membership, because beyond wanting to eat fresh vegetables, they are members because they enjoy supporting local farmers (CSA member informant 1-5). A point to be noted is all of the interviewed CSA members revealed that the cost of a CSA membership is not a toll on their finances (CSA member informants 1-5) and thus a bad crop year will not result in their families struggling to eat. Consequently, families with less stable finances would feel differently as the cost and unpredictability of a CSA membership would be too big of a financial risk for them to take. Therefore, it can be stated that most CSA members are of an economic status where irregular vegetable production would not lead to members discontinuing their membership, and thus the CSA model is not at risk for terminating for this reason. Many CSAs are addressing this food access issue by, for example, creating payment plans, which is a wonderful way to get lower-income families involved. However, this development will not be concentrated on in this paper, as this paper is addressing the viability of the CSA model itself, not the socioeconomic demographic it is benefitting.

It must be addressed that the pros and cons of joining a CSA vary based on the interpretation of the member. One member stated that she feels more people would join a CSA if they realized how convenient it is. She pays a flat fee at the beginning of the season, and then each week she is able to pick up vegetables for her family (CSA member informant 1). While this member sees paying once as an efficient use of her time, a member that does not have a consistent income would find paying the full membership up-front impossible. Another CSA has a program where workplaces can have their own vegetable box drop site, and multiple members said it was the convenience of picking the box up after work that drew them into the program (CSA member informants 4 and 5). In a unique CSA set-up, one farmer has a “work-share” program where each of her CSA members volunteer for 4 hours a

week on the farm (on their individual schedules) to help off-set costs of the membership. She said her members love getting outside and seeing how the farm operates, but she agrees this might be a deterrent for some: it is clearly all based on perception (CSA farmer informant 3). In terms of the vegetable boxes themselves, one member said she loves getting previously-unknown vegetables because then she learns something new, while another member said her biggest complaint with her CSA is that she does not always get the vegetables she wants (CSA member informants 1 and 2).

While a farmer is not going to be able to satisfy every member, it is clear that varying preferences between members will cause a season's membership to be viewed as worthwhile or not. One way a farmer has addressed this discrepancy is by including a weekly optional e-mail survey for members to complete that has that week's harvest listed (CSA farmer informant 2). That way, members can choose which vegetables they want, and thus choose to be adventurous by picking the vegetable they have never heard of, or sticking to their favorite basics. In fact, two members admitted they switched from another CSA due to the repetitiveness of vegetables (CSA member informants 3 and 5). Beyond preference, having members complete a survey enables those with health ailments to chose the vegetables that will make them feel their best, as one member noted that her Irritable Bowel Syndrome symptoms cause her to throw out vegetables she would rather the farm kept and distributed to someone who can enjoy them (CSA member informant 5). Flexibility on both the farmer's and the member's part is the only constant across all interviews conducted, as the CSA model is not a perfectly organized system, and the ability for those involved to adapt will increase its viability with the unforeseen future of the climate.

Conclusion

In conclusion, the increasing variability of weather patterns due to climate change is not detrimental to the CSA model due to the innovativeness of farmers and the flexibility of current members. Those that are attracted to CSA membership are aware of the risks, but some farmers are having members sign agreements to ensure that everyone is informed of the inherent liability involved in joining a CSA. Based on studies conducted, it is clear that most members of CSAs are not financially strapped and thus enjoy being a member to support a local farmer, even if the season does not produce a satisfying bounty. However, to increase retention rates, one member had a noteworthy idea: "I believe that just advertising the difference in cost (broken down by what a consumer spends each week/month, etc) between organic produce at your local Whole Foods, Lunds, etc. and a CSA membership would increase CSA participation" (CSA member informant 4). This would be a great way for CSA farmers not only to convince newcomers to get a membership, but help retain members that were unsure of their decision financially to join a CSA. The farmer would have the opportunity to prove the value of a membership. Moreover, multiple CSAs in the Twin Cities have started partnering with businesses as a drop-site for boxes, thus building a CSA into an already existing community of coworkers (CSA member informant 5).

The CSA model is about more than just providing people with fresh vegetables: it is about creating a community passionate about living a healthy lifestyle, out of concern for both lasting human and environmental health. Therefore, it can be concluded that the CSA model is not at risk for crumbling due to erratic weather patterns, but effective communication between farmers and members is essential and must continue so members can be aware of the realities of the CSA program. Multiple CSA farmers mentioned that they conduct an end-of-season survey each year (CSA farmer informants 2 and 3), but I recommend that CSA farmers

begin conducting mid-season surveys as well. That way, they can address concerns early enough in the season to make the change, and thus will hopefully retain members that would have left the following season, as testimonies from members indicate they will leave if they are unhappy with the service (CSA member informants 3 and 5). Creating a collaborative dialogue through recipe newsletters and weather updates between farmers and members will not only result in happier customers, but a healthier atmosphere for all. As a result, farmers can focus all their energy on developing innovative farming techniques, knowing they have a community in full support of their endeavors.

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Interview with farmer informant 2 via email, September 28th, 2017.

Interview with farmer informant 3 via email, September 29th, 2017.

Interview with CSA coordinator for farm via email, October 4th, 2017.

Interview with member informant 1 via phone, September 27th, 2017.

Interview with member informant 2 via phone, September 26th, 2017.

Interview with member informant 3 via email, October 5th , 2017.

Interview with member informant 4 via email, October 5th , 2017.

Interview with member informant 5 via email, October 5th, 2017.

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10 October 2017

Implications of Global Warming on Community Supported Agriculture

Introduction

Over the past three decades Community Supported Agriculture, known as CSA, has become known in the market of alternative agriculture. The rise of the CSA model is associated with people demanding to know more about their food, have sustainable and quality produce, and to support local farmers. The CSA model embodies these ideals by joining community members with local farmers to share the risk of sustainable agriculture. Traditionally, a upfront membership cost is established and every week members receive a box of that week's harvest which varies depending on the farm's success that particular week. This model empowers farmers with smaller plots of land to make sustainable agriculture both feasible. Throughout the years, fluctuating issues such as labor laws and recessions have challenged the CSA model. Today, a challenge the CSA model contends with is the variability of weather patterns in which global warming presents. As the climate begins to warm and adverse effects accumulate, pressure on CSAs grows to provide a constant crop. This paper will address a broad question of "how the CSA model is holding up in the face of weather extremes?" with a focal question of "how global warming is affecting members attitudes and enrollment in CSAs?".

Research Methods

The research in this paper sources a variety of materials ranging from USDA censuses to email interviews. The majority of the research stems from data from one CSA in Polk County,

Wisconsin known as Common Harvest Farm. Dan Guenthner, one of the owners and operators of Common Harvest Farm, provided insight about how his CSA is being affected by global warming. Then, three members of Common Harvest farm responded to these effects and provided general information about their involvement in the CSA in an email interview. Since the depth of the research is limited by small population of the respondents from Common Harvest farm, national data is incorporated to balance speculation with evidence.

Findings, Discussion and Analysis

There are many ways to measure how the CSA model is holding up under the pressures of global warming. While exploring global warming's effects on Common Harvest and its members this paper focusses on anecdotal data and while looking at national trends quantitative data is utilized.

Impact of Global Warming on Common Harvest Farm

Global warming is imposing many problems on CSA farms in the Twin cities, Midwest and across the United States. Common issues include increasing insect pressure, unpredictable seasons and severe weather. One impact global warming has is how weather patterns such as rainfall, droughts, snowfall and seasonal discrepancies affect growing crops. Another impact is how organisms such as insects and molds have been influenced by the changing climate and how that in turn has affected crops. In an email interview with Dan Guenthner he identified the impacts global warming have on his farm.

First, examining the scope of weather patterns, Guenthner communicated that “rain events are more intense. In 1970, 70% of rainfall came in all day showers and 30% in thunderstorms, today that ratio has reversed where now the majority of rain falls at a rate that the

soil has a difficult time absorbing" (Guenthner 2017). Guenthner also remarked "we are receiving less snow in the winter". Snow cover prevents deadly frost from diving deep into the soil and its absence is detrimental to plants. Instead of snow, the farm has been experiencing more rain during the winter season. Guenther wrote the winter rain "is very problematic, especially for garlic which we plant in the fall. Two years ago we lost all of our garlic after a rain event in the winter displaced the air trapped in the mulch to keep the garlic from freezing" (Guenthner 2017).

Yet another physical change of the environment is "cooler springs and warmer falls" (Guenthner 2017). Guenthner reports, "we have had a difficult time seeding fall spinach because it needs a cool soil to germinate. With warmer summer temperature more heat is stored in the soil well into the fall" (Guenthner 2017). The changing climate is creating seasons that challenge the farmers way of planting, especially small CSAs who are being forced to adapt or risk the loss of an entire harvest.

The climate does not only affect how plants grow, but also how other organisms grow. A detrimental effect of global warming is increased populations of insects. Common Harvest Farm has first hand experience with this, Guenthner stated that "life cycles of insects are based upon heat degrees and in many cases it only takes a seemingly insignificant rise in temperatures for a given insect to go through an additional breeding cycle. Given that insect populations grow exponentially even one more life cycle can result in some cases in a tenfold increase in insect pressure" (Guenthner 2017). On a small organic farm like Common Harvest, insects are already hard to control with no pesticides, however, when the amount of insect populations increase ten times the expected number the farm must invest even more time and resources to the problem.

Rising temperatures have also been cited to cause more fungal and air born water molds as the warmer air holds more moisture. Guenthner commented “in the first 24 years farming we had late blight once, now we have had it 3 of the past 4 years. Late blight is the pathogen responsible for the infamous Irish Potato Famine of the mid-1900's” (Guenthner 2017). Insects and freezing soils are decreasing yield by destroying produce while increasing the production price creating more and more pressure on retail price. Since the CSA shares risk with its members this means less produce for a potentially higher cost.

Members Reactions

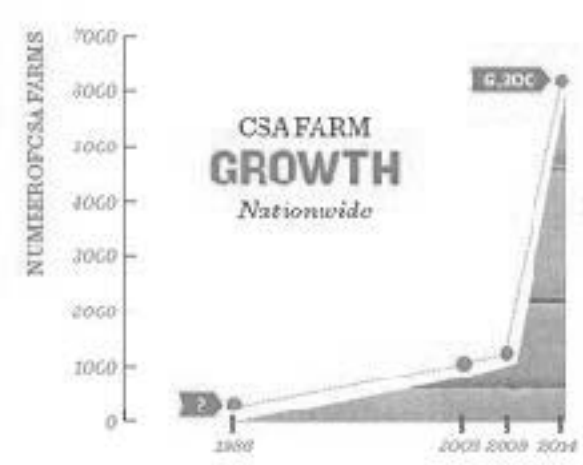
Despite the many challenges CSA farmers must deal with in the rising climate, their members seem to remain unconcerned. In coming years, global warming will determine more and more of what crops members get, the quantity of those crops, and when they receive them. Common Harvest Farm has already experienced this first hand in June of 2017, when a hail storm delayed their box deliveries by two weeks. In an email interview, two members commented on how they were impacted by the hail storm and if it challenged their membership. One member responded “I was disappointed, but I grew up on a farm. I got it. It’s just part of the deal” (Anonymous #1 2017). Another answered “to be honest it wasn’t a big deal. I just kept buying my veggies with my other groceries like I do in the winter. I was sad for them and I was happy when the boxes started, but it didn’t affect my feelings about CSAs at all” (Anonymous #2 2017). Based on these two reactions the consequences of the shared risk did not seem to deteriorate their thoughts on membership. To answer why people became shareholders in CSAs may be part of the reason that CSAs will not see as severe repercussions with global warming.

Shareholders seem to fall in love with the values behind CSA rather than get wrapped into the personal risk and economics of it. When members of Common Harvest Farm were asked their reason behind joining it ranged from forcing them to eat more vegetables to supporting a local business. When asked if there was a minimum amount of produce that would make you drop their CSA membership, one member answered “I’m not motivated by value; I suppose an entire year’s harvest could be destroyed and I expect I’d still be a member”. However did remark that her “husband feels differently – [they] have argued about this” (Anonymous #1 2017). Another member answered “I wouldn’t drop based on a bad crop year. It would be based on a pattern of smaller amounts. Or getting lots of things that we didn’t want” (Anonymous #2 2017). And yet another answered “It really doesn’t impact my decision at all. My budget isn’t that tight. I can see it mattering to some families but I’m willing to take my chances. I know that some years I will get more for my money and some years less. I’m ok with that. I like fresh veggies. I like supporting a local farmer” (Anonymous #3 2017). These three answers give an insight into the minds of a CSA member. Economically able to support and with parallel morals to the CSA model. Thus, the CSA model looks as it will hold up among a certain demographic.

As climate change continues to impact CSA yield, it may become less of an economically sound option, and shareholders who have small budgets may be pushed out as they can find cheaper, organic, and local food at grocery stores. However, those who can afford to support a more forthright form of sustainable agriculture that the CSA embodies, will continue their memberships.

How are CSAs Nationally Holding Up?

Over the past 30 years the number of CSA's across the nation have dramatically increased as well as the average amount of members each CSA has. The graph included shows CSA growth in number of farms over the years, suggesting farmers are not being deterred to start a



CSA by the challenges global warming is presenting. The average number of CSA members between 2007 and 2009 among all farms surveyed grew 50% (Woods). From 2013 to 2014 there was a "77% average growth of CSA memberships" (The 2014 CSA Farming Annual Report). The following years report found a "28% average growth of CSA memberships" although still increasing at a much slower rate. The growth in both the number of farms and members is a good sign that the CSA model is persisting despite the warming climate. However, one concerning statistic for CSAs is retention rate. In 2014 a survey of 248 CSAs found an average retention rate of 45.2% that year (The 2014 CSA Farming Annual Report). Blackbrook farms in Minnesota reported their "retention rate has been between 60-75%" (Blackbrook 2017). Part of this number can be due to switching membership at one CSA to another CSA which does not reflect upon the model itself. A member of Shared Ground recounted their motivation behind joining that CSA stating "I was looking for a new CSA after I was feeling unsatisfied with my old one and googled CSAs in my area. Luckily I found Shared Ground! I love them!" (Anonymous #4 2017). Every CSA has a unique personality, some advertise more variety in produce others have a more convenient pick-up spot and others support racial minorities. It comes down to if the consumer's values and match the farm's values, some

models work best for some people and other models work better for others. Another explanation for the relatively poor retention rate could be due to people experimenting with CSA and realizing they waste too much produce or are not satisfied with the diversity of produce. This may further point to the CSA model working very well for a certain demographic but lacking attraction for others.

Recommendations and Conclusion

Given the national trend of growing CSA membership and people's interest in investing in local organic food, I do not think CSA will have to revolutionize their model. Crops will continue to be damaged and destroyed by weather variability, however, members who view their food as an extension of their morals will uphold CSAs. A fiscal discrepancy may evolve as global warming brings more risk to the model. A hailstorm, a loss of a crop, pest infested produce and delayed deliveries are all parts of an increasing risk that may make CSAs less attractive, especially to economically strained demographics. In the coming years, there will also be much more competition for CSAs with the rise of meal plan services and organic sections in chain grocery stores. Although these are all very different in practice, the market is blurring their differences through greenwashing. Greenwashing can be defined as making a product appear more eco friendly then it is. To protect CSAs from unequal competition, policy change to be targeting greenwashing of products to allow consumers to make honest decisions. Consumers should be able to make informed decisions not letting price be the determining factor in if they join a CSA or not. Other ways to preserve the CSA model in the face of global warming is for CSAs to invest in technologies and practices that do better in a variable climate and to wake up consumers to the advantages of sustainable agriculture. While mentioning the possible reforms

that could be made to aid CSA in global warming, based on the anecdotes and growth trends of CSAs, I believe the CSA model will hold up within a demographic of morally conscious, action based consumers.

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Carter D'Angelo

October 10, 2017

Alternative-Agriculture Paper

On Selling the Chickens Before They Hatch

Introduction:

We live in a country divided. People are living drastically different lives, with different needs and desires, but food is central to everyone. Although the United States is one of the wealthiest countries, access to food and malnutrition are still concerns. The population is still grappling with the question of *how* we will feed the over 300 million people who live in this country. But is important to note that the questions of *where* people buy their food and *why* they purchase *what* they purchase will become increasingly vital if we hope to conserve the environment and resolve issues of structural inequity on a national and global level. Currently, community supported agriculture makes up a very small percentage of food produced and consumed in the U.S., but as an alternative to conventional agriculture it should be explored as a potential answer to some of these questions. Climate change complicates the issue. It means that CSAs have a greater risk of under producing and may become more expensive to maintain. At the same time the rise in concern about the changing climate in popular culture may increase people's desire to invest in intentional and eco-conscious agriculture. The number of CSAs has climbed consistently since their introduction in 1986, and although climate change has a negative impact on the farmers ability to grow consistent produce, it could be responsible for the growth in public interest in CSAs. What exactly draws people to CSAs as members and how do CSA farmers

market themselves to consumers? How might that change with rising temperatures and extreme weather events becoming more common?

Research Methods:

In the past decade in particular, climate change has become highly politicized, but it has also moved closer and closer to the forefront of people's consciousness. A lot of the local food movement has grown out of this concern about the environment and how the food we eat impacts our ecosystems. Although it is hard to tie motivations to actions without a larger set of data. It seems that there is anecdotal evidence that fear about climate change may help increase the number of people interested in participating in CSAs, even if the reality of climate change makes it harder and harder for small scale farmers to produce sufficient yields. For this reason we interviewed several members of Common Harvest Farm, a CSA of about 200 members based in Osceola Wisconsin. These interviews took place over email.

Simply talking to CSA members would not give me a full enough picture of the future of CSAs, and how CSAs are responding to these issues right now. So I reached out of about ten CSAs in the Twin Cities and surrounding counties. I heard back from three and interviewed all of them over email with the same set of a dozen questions focused on climate change, attracting members, and how these two intersect. These CSAs varied in size from 1.6 acres to 140 acres, and in members from 30 to 450. Additionally they differ greatly in cultivation and agricultural philosophy. However, these farmers did display some common and consistent themes. That being said any trends should be considered anecdotal because of the limited pool of data and unsubstantiated nature of the data itself. For example, all three farmers claimed that there year to year retention rate was between 60% and 80%. Data from the Small Farm Member Assemble,

suggests that the average CSA has a retention rate of 46.1%(Member Assembler, 2015). This could suggest that the Twin Cities has an unusually strong and dedicated number of CSA members, or that these three CSAs are well above average, or, perhaps more likely, that without concrete number, most farmers estimate a higher retention rate than they have in reality.

I wanted to see if I could connect some of the trends I have observed in the Twin Cities areas to other areas in the country. My home town in Massachusetts seemed like an obvious choice to conduct some interviews. A, the man whose CSA my family has belonged to for a decade is a good family friend. We used to give him a dozen eggs a week for a reduction in price. Additionally, I thought it would be interesting to look at CSAs that exist in a slightly different climate. Although Tisbury is very close in latitude to Saint Paul, the difference between continental weather patterns and the stabilizing effect of the ocean means that year round temperatures are less variable and warmer overall. It would be reasonable to postulate that CSA farmers and members have experienced fewer direct effects of climate change than those in the Midwest.

The town I grew up in had at least a few CSAs probably each had around a hundred or so shares. In a town of less than 2,000 people this a fairly high percentage of CSAs per capita, although it is fair to assume a lot of those shares belonged to people from more populated towns nearby. Regardless, I was surprised to discover that CSAs are not so common in most parts of the country. After talking to CSA owners and members, it makes sense to me that CSAs would spread slowly. Because they are so community oriented, and most people heard about them through friends or family, and CSA owners reached out for members in similar ways. Additionally, they need a very specific combination of factors. They need to live close enough to a metropolitan center to have a customer base, but also enough space to sustainably grow a variety of vegetables.

They are also more common in liberal areas, and areas where people have expressed higher rates of concern about climate change.

I reached out to A only to find out that just last year he shut down his CSA and sold his land because he was no longer able to support himself. Although in some ways this disqualified him from from answering the same questions I asked other CSA, it also made him an interesting interview candidate. I spoke with him on the phone and he admitted that it was a combination of factors which contributed to his choice to close Whippoorwill Farm. One of these factors was a series of unusually hot, dry summers were rain fell in storms instead of showers. He said the last three years he had produced lower than expected yields. He also said that more people in our town were choosing to buy their local food at farmers markets instead joining a CSA, which protects them from the risks experienced by farms. This lead to A reducing his prices with the hope that it would attract some of the people who typically bought from farmers markets. He admitted that this was successful in slightly increasing membership for a while, but it also resulted in the year ending in a net loss.

I supported the information I got from interviews with scholarly reports and larger scale data gathering. The two main resources I used for this was a survey of 300 CSA farms in 2014 and 2015 done by Small Farm Central, and a one conducted by the University of California Davis od over 1,000 current and former CSA members in California. Both of these studies were limited by a relatively small sample size and did not necessarily represent the geographic and demographic context of the Twin Cities. However, they effectively gave my interviews greater context. I also spent some time on small farmer internet forums and advice websites, with the hope of getting a better grasp on what issues CSAs and other alternative farms are most concerned with right now.

Findings, Analysis, and Discussion:

The effects of climate change on farming in the northern Midwest is an especially interesting case study because of how susceptible this area is to climate change, and because of its historical significance as a center for agricultural production. The upper midwest sits at the convergence of three different biomes and experiences strong seasonal variation in temperatures, and rests above soil that was once incredibly rich in organic matter. The last couple centuries of agriculture has stripped that soil of organics and fractured the soil structure. Additionally climate change has resulted in less consistent seasonal variations: warmer than usual winters, cool summers, the polar vortex. (Kump, Kasting & Crane, 2014)

The internet plays an interesting role in the marketing of CSA farms. I found several online CSA organization groups encouraging the use of online marketing tools to reach out to new customers. However, it appears that many CSA members still join through neighborhood connections and social networks. Margaret at Common Harvest said that much of their member base came through a community organization they were a part of, and one of the two farm members we spoke to found Common Harvest exactly this way(Pennings, September 16, 2017). The other member said she found them through a google search after a friend joined a CSA and she was interested in the concept. (H. September 28, 2017) Although the choice of which CSA to join may be shifting based on online advertising and reviews, the concept behind CSAs still seems to be one that travels through community.

Online databases of CSAs also means that it is easier than ever for a disappointed CSA customer to find a new CSA quickly and easily if they experience a year of lower than expected or

erratic shares. Many small business suffer as a result of the ease and convenience of online price comparing and ordering. I was surprised to hear CSA farmers express fear around Blue Apron and other meal delivery services as a source of competition(Huntly, 2016). These big name competitors are appearing at the same time that the overall number of CSAs are increasing. This gives credibility to the concerns of farmers like A who said, of interest in CSAs in the last decade, "overall more people are probably interested in it, but there are so many more choices than 10 years ago that we are not seeing that increase. And I know most farmers are in the same boat. We talk about it all the time."(A. September 24, 2017)

As more CSAs experience inconsistent and low productivity in the face of climate change will we find more members who are more loyal to the concept of CSAs than to the farms themselves? If so it there could be an decrease in retention rates coupled with a surge in members swapping from one farm to another year after year. There seems to be some substantial evidence to support this possibility. A poll of current and past CSA members in California in 2015 showed that 74% of people who had once belonged to a CSA but no longer did definitively said "Yes" to whether or not they would join a CSA again, 23% were "Unsure" and 3% said "No"(Christensen, Galt, Bradley, Simpson, & Munden-Dixon, 2015). This was the sentiment expressed by B, a Common Harvest farm member, who said that she and her family "left another CSA that we felt didn't give us as much for the money." But this did not result in her giving up on the CSA model as a whole. (B. September 29, 2017)

In the same study the two most important reasons people listed for why they were members of a CSA were "to obtain high quality, fresh food" and "to support alternative/organic agriculture". Although people's top priority is the produce they receive, commitment to the idea of community

supported agriculture is second. The fourth top reason was “for environmental benefits”. Despite the all of which offers the possibility that many of these customers are unlikely to be turned off of alternative agriculture even if extreme weather and climate change negatively impacts yields.

A perfect example of this sentiment can be found in H. When asked how much risk she was willing to incur as a member or a CSA she said “I’m not motivated by value. I suppose an entire year’s harvest could be destroyed and I expect I’d still be a member. I grew up on a farm – I get that you can’t control nature.” However, she went on to admit that her husband didn’t agree and they had fought over the issue. Clearly in this case H’s experience growing up on a farm influenced her perspective on alternative agriculture. She also admitted that if her family income took a serious hit she would most likely consider not longer being a CSA member. This supports the possibility that income rather than cost, is a predictor of sustained membership. (H, email interview, September 25, 2017)

It brings me back to AW. The median family income of Tisbury, MA in 2015 was about $42,000(Rocheleau, 2015) and the California study showed that “58% of member households have incomes over $100,000 and (2) less than 3% of households have incomes under $35,000.”(Christensen, Galt, Bradley, Simpson, & Munden-Dixon, 2015) He said that many of his customers were switching to options like farmers markets of organic produce from conventional grocery stores which exempt them from the risk incurred by farmers. These are people who are passionate about alternative agriculture and interested in eco-conscious consumerism. They simply *aren’t* people who have the kind of income to gamble on how much food they will get in return. This is of course in addition to lump sum payment of the CSA model which is already less realistic for low income individuals.

Emphasizing the risks and costs of climate change can be a dangerous advertising strategy. “The majority (89.5%) of farmers in the Upper Midwest perceived there was too much uncertainty about the impacts of climate to justify changing their agricultural practices and strategies, despite scientific evidence regarding the causes and potential consequences of climate change.”(Morton, Roesch-McNally, & Wilke, 2017) This is a shocking statistic revealing that although global warming could be catalyst of change in agriculture, it could also be a deterrent. However, I think that models like the CSA may be the most effective way to coax farmers away from the conservative farming practices and toward methods that emphasize soil stewardship and organic fertilizers.

Conclusions:

CSA farming addresses many of the ethical and environmental concerns that have arisen around farming and agriculture. Workers rights and climate issues are at the forefront of many liberal and progressive social movements, but they are also issues that will at some point in time affect nearly everybody. There appears to be a strong connection between interest in these broader social and environmental issues and membership in CSAs. They are *not* the only factors. Income and familiarity with the concept are incredibly important to whether or not an individual will consider joining in a CSA(Christensen, Galt, Bradley, Simpson, & Munden-Dixon, 2015). However, I believe that if we can make alternative agriculture more affordable and accessible, then marketing it as a climate and worker friendly consumption choice will ultimately benefit the spread and growth of these kinds of farms.

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Chapter 2:
Given that climate change likely fosters more variable weather patterns, how is the CSA model (which distributes risk to members) holding up in the face of weather extremes in Polk Country, WI, other areas of the Twin Cities metro, and the region more broadly?

The Findings of Research Group 1b (Katherine Podol, Kori Suzuki, Allison Dwinnell, Allegra Berman, Arendje Louter)

Katherine Podoll
10/5/17
People, agriculture, and the environment
Group 1B

Combatting Climate Change and Insect Growth Rates on CSA Farms

Introduction

The issue of food security has become increasingly prevalent in today's world of rapidly growing populations and climate change. Today, the carbon dioxide level in the atmosphere is already ⅓ higher than it had *ever been* before 1950 (NASA, 2017). A three-decade period from 1983-2012 had the highest recorded temperatures in at least the last 1,200 years, if not more (IPCC, 2014). The sea level rose 0.19 meters from 1901 to 2010, higher than the mean rate during the previous two thousand years (IPCC, 2014). As resources and practices are compromised and replaced by ways believed to be better suited for changing conditions such as these, small-scale farms in the Upper Midwest and around the world are being forced to make decisions and problem solve as their livelihoods are threatened from every direction. In particular, farms of the Community Supported Agriculture (CSA) model are faced with unique challenges given their natural methods and close ties to their customers (members), who support them by pre-paying for regular deliveries of produce from the farm.

One of the biggest challenges facing these farms as a result of climate change and shifting temperature and weather patterns is the changing lifecycles of insect pests. These pests may come for prolonged or differing seasons, or may be introduced to new areas where they did not have to be dealt with before (Gunther, 2017). This paper seeks to understand the role of climate change on the lives of these insects, and in turn the role these insects can have in

harming small-scales farms, thus answering the question: Given the effect climate change is having on the number, variety, and impact of insects on farms, how are CSAs in Polk County and surrounding areas addressing this issue and what impact is it having on crops? Reaching beyond the depth of identifying today's biggest issues with small-scale farming, this paper identifies techniques and ways forward for farmers to combat global warming-related pests as the problem intensifies. Ultimately, by understanding the issue at large and identifying the biggest obstacles to overcome, farmers and growers can better understand their land and produce the healthiest, most fruitful crops.

Research Methods

The research methods in this paper involved field work, interviews, and literature review. Research began with a visit to Common Harvest Farm in Osceola, Wisconsin, where we were introduced to small-scale organic agriculture methods, in particular within the Community Supported Agriculture (CSA) model. Farmers Dan Gunther and Margaret Pennings discussed the partnership they share with their members through the CSA model and the expectations these members hold about what they will be receiving in their box each week--and how the abnormally large number of adverse weather, disease, and insect-related disasters this year has affected the yield in these boxes. This field research was followed up with a phone interview with Dan Gunther, in which he expanded on many of the topics he mentioned on his farm and provided insight into the particular insect pests he deals with. Research for the paper was further supported by literary review of articles relating insects and climate change, and the review of governmental websites discussing insects and pests. All sources are synthesized in the findings, analysis, and

discussion of this paper, and contribute to the overall understanding of the paper's core questions regarding climate change, pests, and crops success.

Findings, analysis and discussion

Current events in today's world make obvious the extent, severity, and universality of climate change. For agriculture, this predominantly means uncertainty. As this state of uncommon and unnatural climate patterns progresses, farmers more and more must deal with extreme conditions on both ends of the spectrum (of temperature, precipitation, etc.), and be ready to adapt with each crop in a unique way (some like the cooler temperatures, some like the warmer, some like the longer summer seasons while others need a distinct winter period). Other issues farmers face in effect of climate change includes ozone, constraints on water, decreased soil quality, and decreased nutrition, as well as more extreme weather events and new temperatures patterns. For example, in 2010 and 2012, high nighttime temperatures in Michigan caused $220 million worth of cherries to be lost due to premature budding (EPA, 2016).

For small-scale and natural, organic farmers, these issues are exacerbated further. Natural events such as drought can make soils dry up, and many weeds and fungi thrive under wetter climates, warmer temperatures, and increased CO2 levels (EPA, 2016). Without the tools of chemical fertilizers and pesticides, farmers must struggle to find other ways to combat the issues. However, perhaps the most underappreciated threat to the success of small-scale farmers is the threat coming from insect pests. We now examine this closer.

The first distinction that must be made regarding insects on farms is that between "good" and "bad" insects. Insects play an essential role on organic farms in maintaining the health of the land, and about 95% of all insects are either benign or beneficial, with only 5% acting as

degrading pests, according to farmer Dan Gunther of Common Harvest Farm. He says that on his small 40 acre farm, there are about 300 beetle species alone, and only a select few are the root of all issues. However, those few pests can make a big impact on the crops, thus making an impact on the lives of farmers and us, the consumer. Gunther identifies the Cabbage Looper (Trichoplusia ni), Cabbage maggots (Delia radicum), Colorado Potato Beetle (Leptinotarsa), Striped cucumber beetles (Acalymma vittatum), spotted cucumber beetles (Diabrotica undecimpunctata), and Flea Beetles (Alticini) as the most prominent pests on his farm in Osceola, Wisconsin. Similar insects can be expected to be present on other farms around the Upper Midwest, but Gunther emphasizes that every piece of land is different, and it is one of the roles of the farmer to know what is on his land.

The effect of climate change on insects (particularly pests) will be two-fold: first, it will extend the range of many pest species to encompass new or larger territories; and second, it will introduce invasive species to new areas (Trumble, 2009). For example, the Mountain Pine Beetle, a major pest in the US and Canada, has extended its range northward by nearly 200 miles due to warmer winters (Trumble, 2009). Outbreaks of insect pests such as this can lead to substantial ecosystem-wide changes in carbon and nitrogen cycling, biomass decomposition and energy flow (Trumble, 2009). This in turn leads to less healthy soil, crops, and lower quantity and quality of food sold to consumers. In addition to these indirect harms pests cause to crops and farmers, there are also direct consequences. Pests adversely affect CSA farmer's crops by damaging plants (by creating holes in leaves, etc.) and making them unsellable to the public (Gunther, 2017).

TABLE 2. Examples of how increasing temperatures affect arthropod species and arthropod-related systems

Increasing atmospheric carbon dioxide leads to:	Reference
Increasing . . .	
Northward migration	Parmesan 2006
Migration up elevation gradients	Epstein et al. 1998
Insect developmental rates and oviposition	Regniere 1983
Potential for insect outbreaks	Bale et al. 2002
Invasive species introductions	Dukes and Mooney 1999
Insect extinctions	Thomas et al. 2004
Occurrence of human and animal diseases	Juliano and Lounibos 2005; Patz et al. 2003
Decreasing . . .	
Effectiveness of insect biocontrol by fungi	Stacy and Fellowes 2002
Reliability of economic threshold levels	Predicted in this paper
Insect diversity in ecosystems	Erasmus et al. 2002
Parasitism	Hance et al. 2007; Fleming and Volney 1995

source: UC Davis, 2009

According to Gunther, the lifecycle of insects are based around temperature, and insects are catalogued based on heat degrees. The laying and hatching of insect eggs are contingent on a certain narrow temperature range. Thus, as climate change causes temperatures to increase, heat degrees accelerate and insects emerge earlier in the season (Stange, 2010). Crops on organic farms are then not as developed when insects are born, and have less force to fight them off with. Insects prey upon weak plants, so when they are forced to deal with adverse conditions, such as adapting to new weather and temperature patterns, they are less likely to hold up against other forms of attack, such as pests. In their young state as pests emerge earlier, crops are incredibly susceptible to any form of harm lain on them (Gunther, 2017).

Another worry with the early seasonal beginning of the insect's life is the increased number of lifecycles which the preemptive beginning allows for (Stange, 2010). Insect populations are exponential; with every generation, a single insect can make thousands of offspring, as can those offspring. A single insect's lifespan is less than a season, and as much as three or four generations can live in a single year. As that first generation emerges earlier, it opens up the option of more lifecycles occurring within a single growing season--thus making a huge impact on the number of pests disturbing a farm (Gunther, 2017). This poses a challenging

threat to combat for small-scale organic farmers who are committed to not using synthetic fertilizers or chemicals on their crops. If they can't change the conditions, farmers will have to find new ways to adapt and work around these issues.

Small-scale farms, and in particular CSA farms who are so tightly committed and indebted to their members, must be strategic in forming plans for yielding the same amounts of produce despite environmental barriers. The first step for any farmer, as Gunther points out, is to really know your land and understand the types of insects and pests present, and how that might be changing. The farmer knows what crops will be most adversely affected by certain pests, and can plan accordingly in what crops will have to be limited that season and how to replace them with others which will not. This poses serious issues for CSA farmers, as they make commitments to their members in the beginning of a growing season, and cannot simply fail to produce what they have promised. It sometimes might go to the extreme where in order to discourage certain pests who favor a particular crop, farmers must completely bypass the crop or crop family for an entire year (Gunther, 2017). For example, if the cabbage maggot was posing particular issues, a farmer might be forced to not grow any members of the cabbage family. This can cause economic problems and complicates relationships with members for CSA farms who rely on predictability and having enough produce to put in people's boxes each week.

There are many other natural methods for helping reduce the problem of pests, though none carry guaranteed successes. One is to bring in other insect species known to prey on certain pests, thus lowering the harmful populations (Mahr, 2001). This can be done through importation and the establishment of new natural predators, or conservation of existing natural enemies by focusing effort on maintaining the health of the environments in which they thrive. Another

technique, which may appear simple but is the most fundamental and important pillar of farming, is maintaining soil fertility. According to Gunther, healthy soil breeds healthier plants, which can more easily combat pests and hold up against disease. Farmers on small-scale organic farms must also pay particular care to the varieties of crops being grown; certain varieties are more resistant to pests and can withhold adverse conditions better than others (FAO, 2015). These are the types that must be grown in this unpredictable, changing time.

One method being utilized in some parts of the globe, with particular emphasis in Cuba, uses entomophagous and entomopathogenic organisms as a natural biological control for pests. They take organisms such as the *Trichogramma*, a wasp, and infect their eggs into species of a rice or grain moth. These wasps are then used to kill crop pests such as the cassava hornworm and tobacco budworm (Nicholls, 2002). Worldwide, this technique has been used in over 50 countries and commercially on more than 32 million hectares per year (Smith, 1996). This has proven to be a viable biological control mechanism, and is an example of the type of thinking which must go forward in small-scale agriculture in the United States in order to find new, natural ways to combat the issue of increased pests.

All of the techniques outlined above provide methods for natural control of harmful insect species. These are just some examples of how organic CSA farmers must deal with issues and overcome challenges in unique and difficult ways. This classification of "organic CSA" farming is two-fold: first, it deals with the question of organic versus conventional agriculture, eliminating any aid from synthetic, non-organic methods of pesticide prevention; and second, it incorporates a much larger group of individuals invested in the well-being and success of the farm, adding a layer of responsibility which goes beyond the farmer needing to do well solely for

his own sake. It requires communication, and deliberate planning by the farmer of how much business to discuss with his/her members and how much to keep quiet. Gunther emphasizes the importance of this equilibrium; it is vital to get members to understand *why* they might not be getting, for example, any cabbage the entire year when they might see it in plenty at the grocery store, but there are also certain details which the farmer might choose not to disclose.

Conclusion

Due to increasing global temperature and adverse, unpredictable weather conditions, harmful insects are thriving in greater and greater numbers on farms in the Upper Midwest and around the world. These pests are maturing earlier in the season, thus affecting crops at a less-developed stage and creating more lifecycles possible in a single season, dramatically increasing the shear number of pests present on a given piece of land. CSA farmers must know the species on their farm, and plan ahead in mapping out which crops will not be affected and which will have to be carefully maintained or not grown.

The next steps in this process requires more long-term research and creating new methods for pest eradication. Techniques such as that modeled in Cuba, where wasps or other harmful insects are injected into pest species, are alternative yet proactive practices which have the potential to greatly help farmers maintain the health of their crops. However this process must be a continuing search for innovative ways for combatting the issues at hand. On a macro scale, the biggest task to slow the rate of pest growth is by stopping the increase in global temperatures, which requires the buy-in of all parties to combat climate change. Individuals can do their part by relying less on fossil fuels, turning towards alternative forms of energy, and producing less waste, but we must call on our government to implement preventative policy

changes and set goals to plateau our climate change emissions. Climate change poses a serious threat to the CSA farm model, as members dislike the unpredictability associated with adverse conditions on farms. In the case of small-scale, naturally-inclined farmers, these conditions are of no fault of the farmer, but they must face the ramifications. Consumers and citizens of the world at large must each take their part by supporting farmers and decreasing their carbon footprint to slow climate change. Farmers must continue to search for innovative ways to handle any new issue thrown their way.

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Evolution or Extinction:
The Importance of Member Education in Community Supported Agriculture

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Introduction

The world is changing. Decades of unregulated industrialization have released massive amounts of methane and carbon dioxide into the atmosphere, causing a continual rise in global temperatures. Climate change has the potential to affect the lives of billions of people and industries. In Minnesota, the effects can be seen in increasingly warm winters, hotter summers, and spikes in the frequency of storm warnings (Transition Twin Cities, 2017). Agriculture is one of the industries that is greatest affected by these climatic changes, especially small-scale operations such as community supported agriculture (CSA) farms which will most likely experience the consequences most severely. Community supported agriculture is modeled around the distribution of risk between the growers themselves and community members who support the farm financially, typically through a subscription system. CSA members pay regular subscription fees which fund the agricultural practices of the farm and grant growers some financial security. In return, members receive regular shares of the farm's harvests. In the states of Minnesota and Wisconsin alone, 701 farms operate using the CSA model according to the 2012 Census of Agriculture by the US Department of Agriculture (USDA, 2012). However, increasing risk as a result of climate change could potentially influence how this model functions. Recession of winters has allowed foreign invaders such as bark beetles to spread into uncontaminated regions, compromising local ecosystems and reducing crop yields. Later snows and sudden thaws also have hugely detrimental effects on many crops, as well as the increasing prevalence of flooding and violent storms, both of which can damage crop growth and soil fertility (Transition Twin Cities, 2017).

Critical to predicting how these changes will affect the integrity of the CSA model, however, is understanding how CSA farmers educate their members on the current and projected risks of financially supporting a CSA farm (Kelley 2013). Depending on how growers choose to inform new and current members of the consequences of climate change and how they relate to the CSA model, members may decide that the benefits of CSA subscription outweigh the increased risk, or vice versa. This paper is

designed to examine both how growers decide what information to provide in educating their subscribers, as well as to what extent CSA members internalize that information and use it to make an informed decision relating to CSA subscription. It is therefore important to ask the question: How and to what extent are CSA farmers educating their subscribers on the increasing financial risk associated with climate change, and to what effect?

Methodology

The majority of research for this paper was conducted in the form of interviews with members of Common Harvest Farm, a small community supported agriculture farm located in Osceola, Wisconsin, as well as in the form of a visit to Common Harvest Farm. Supplemental research was conducted online. Common Harvest Farm supplies boxes of fruits and vegetables to over 200 members located across a variety of nearby regions including Polk County, other regions of Wisconsin, and the Twin Cities metropolitan area, consisting of St. Paul and Minneapolis. During the visit to the CSA, qualitative and quantitative forms of data were collected through direct observation of relevant information such as hail damage to crops, as well as through dialogue with Dan Guenther and Margaret Pennings, co-owners of the farm. Additional qualitative data was also collected in the form of a hard copy of the educational brochures distributed to the members of the CSA. Due to logistics constraints, the interviews with current Common Harvest Farm members could not be conducted in person or via video or audio livestream, and were instead conducted over email by sending a series of questions to each interviewer. Four members were interviewed in a collaborate effort by researchers. The goal of this paper is to determine how and to what effect CSA farmers are attempting to educate their members on the increasing risks agriculture bears due to climate change and the CSA model's diffusal of that risk onto CSA members. Questions used in the interviews were therefore designed to examine members' knowledge and understanding of the increasing financial risks associated with remaining a CSA member. They also tested for their feelings

concerning these risks, their past history with CSA farms, and their intentions for the future as this level of risk likely increases. Because this paper focuses on the implications of the relationship between CSA farmers and their members, the majority of this paper is qualitative by nature. Supplemental online research was also conducted to verify qualitative data cited in this paper, and to find quantitative data that supported the conclusions suggested by qualitative observations and reasoning. Online research referenced in this paper includes data from previous agricultural censuses by the National Agriculture Statistics Bureau, papers published in *Proceedings of the National Academy of Sciences of the United States of America*, information on the effects of climate change in the greater Minnesota-Wisconsin area from the activist group Transition the Twin Cities, and explanations of the CSA model from the US Department of Agriculture.

Results

Understanding how CSA farmers are educating their members on the functions of the CSA model and the increasing effects of external factors is critical to answering the question posed in this paper. In the case of Common Harvest CSA farm, the answer is straightforward: the educative materials distributed to its members make the element of increasing risk relatively transparent. The Common Harvest 2017 membership contract clearly stipulates under the heading “Cost of membership” that “by participating in Common Harvest Farm, you agree to willingly share in the risks and uncertainties of supporting a working farm” (Guenther, Pennings, 2017). The growers elaborate on the risks and uncertainties discussed in the contract in additional materials provided to members, stating outright that they “did not meet [their] membership goal for the first time in 27 years” in 2016, and posing critical questions examining the integrity of the CSA system (Guenther, Pennings, 2017). The materials were found to for the most part present an honest perspective on the benefits and risks in subscribing to the Common Harvest Farm CSA. There are some factors which could potentially curb a member’s ability to make an

informed decision based purely on these materials. Although the contract describes "risks and uncertainties" associated with a working farm, there is never a description or example given regarding these potential issues, the inclusion of which could help a possible member make a more informed decision. Climate change, a significant factor especially in the context of this paper, is also never explicitly mentioned. However, based on the information found in the CSA's educational materials, it is reasonable to assume that members would be able to make relatively informed decisions regarding their personal CSA subscription.

Additionally, the CSA model appears to be maintaining functional integrity under current environmental conditions. This assertion is based on information collected from the owners of Common Harvest Farm, as well as through interviews with CSA members. Of the four members interviewed for this paper, none were concerned by the effects they due to risk-associated events such as the hailstorm that damaged many crops and the tomato blight that eliminated an entire crop last year. "I was disappointed, but again, I grew up on a farm. I got it. It's just part of the deal," wrote one member in response to a question specifying the effects of the hailstorm, which delayed shipping of the farm's food shares by two weeks (Interview 2, 2017). Another interviewee described how:

> "To be honest it wasn't a big deal. I just kept buying my veggies with my other groceries like I do in the winter. I was sad for them and I was happy when the boxes started, but it didn't affect my feelings about CSAs at all. These things happen" (Interview 1, 2017).

This lack of concern for the increase in risk is likely due to the fact that the vast majority of Common Harvest Farm's subscribers are middle class families with strong financial security. Although these families may consider CSA produce a key part of their diets, none of them are dependant on a minimum

yield from the deliveries, nor would they be unable to find suitable replacement resources should CSA shares suffer due to environmental complications. An awareness of the importance of this point was expressed in our interviews. When asked to what extent the risk distribution of the CSA model affected their decision to continue their membership, one interviewee replied: “It really doesn’t impact my decision at all. My budget isn’t that tight. I can see it mattering to some families but I’m willing to take my chances. I know that some years I will get more for my money and some years less. I’m ok with that” (Interview 1, 2017). This seems to indicate that customers of the CSA model are more likely to be able to absorb adverse effects generated by the distribution of risk system, which may allow the CSA model to continue to maintain integrity as small CSA farms become increasingly affected by the consequences of climate change. An additional factor which appears to contribute to members preferring to support their CSA is the sense of community and responsibility. Guenther and Pennings, the owners of Common Harvest Farm, had sent out an announcement and apology to their members after a hailstorm damaged some crops, and again when a blight eliminated the tomatoes. The near-universal response they received was of encouragement and reassurance, affirming them that the role of acting as a system of security in the event of complications and assuming some of the financial responsibility “is what [the members] signed up for” (Guenther, Pennings, 2017). This shows that members are willing - and may even enjoy - shouldering a certain amount of financial responsibility to provide aid for the CSA.

However, there remains the potential for changes in how CSA members engage the CSA model. Some members expressed concerns about increasing risk. “I would feel OK with that (and have),” one interviewee answered in response to a question about reduced crop shares due to the hailstorm, “however, if it were to become a regular occurrence, I'm not sure how I would feel. I would certainly want to support the farm, but it might become difficult financially” (Interview 3, 2017). Most interviewers also agreed that there would be a point that they would end their subscriptions if the farm shares became too low relative to the membership fees they were paying. “We left another CSA that we felt didn’t give us as

much for the money," said one interviewee, "we want to feel like we are getting our money's worth" (Interview 1, 2017). There is also a lack of full comprehension of the risks members are undertaking that is demonstrated in the interviews conducted. For example, when asked what they liked about Common Harvest Farm, one member responded that they liked that the farm is organic (INterview 2, 2017). However, the owners of Common Harvest Farm take care to inform their members that the CSA is *not* organic-certified due to technicalities associated with the proximity of pesticide use in neighboring farms (Guenther, Pennings, 2017). When asked how they felt about the risks associated with CSA membership, another interviewee described how "although I'm sure [Guenther and Pennings] indicated risks, I wasn't aware of these until this year (hadn't read the fine print)" (Interview 3, 2017). This data demonstrates a lack of member understanding in relation to the risks of the CSA model, which could affect general attitudes toward the agricultural system as environmental conditions worsen, exacerbating the consequences absorbed by the CSA membership base.

Conclusions

Although the CSA model appears to be stable at the moment, there are significant indications that it may not continue to hold up in the Minnesota-Wisconsin area as increasingly disparate climatic changes continue to affect agriculture in the Midwest. The relatively secure socioeconomic strata generally occupied by CSA members and the sense of community and shared responsibility created between CSA farmers and their membership base, among other factors, effectively insulate CSA farms against anything more than minor changes due to current climate conditions. Looking ahead however, security in terms of membership retention and growth appears to be limited, especially given the possibility that current members do not fully understand the level of risk they are undertaking. This seems to indicate a need for the community supported agriculture model to evolve so as to be able to better deal with the increasing effects of climate change. If CSA farms and farmers do not find ways to adapt to these changes, they may

not last long as it is unclear how long the current CSA model will be sustainable. One potential short-term solution could be to adopt industrial techniques such as usage of pesticides or genetically modified crops to resist climatic changes. The owners of Common Harvest Farm are considering switching their tomato stock to genetically modified plants in order to avoid the tomato blight which has been affecting their farm with increasing frequency due to the warmer weather. However, it is unclear whether members would support these solutions as they tend to diverge from the organic, environmentally-conscious image of the ideal CSA farm. It is also important to note that there is a potential for erroneous conclusions in this paper due to the fact that the vast majority of data utilized was sourced from a single case study, Common Harvest Farm, which should not be treated as representative of all CSA farms. However, the examination of this particular case study seems to indicate it will be necessary for CSA farmers to adapt if they are to survive.

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Demographics of Climate Change and Future Enrollment in CSA

Introduction

Climate change has fostered more variable weather patterns throughout the world, making it increasingly difficult for farmers to provide for their consumers. In particular, climate change has had an increasing effect on the Community Supported Agriculture (CSA) model. The CSA model has become more popular over the years for consumers to purchase locally and seasonally from a farmer (Local Harvest, 2017). The CSA is built on a foundation of trust and understanding between members and their farmers. CSA farmers use varied agricultural techniques in order to provide weekly delivery of food or products for their members who pay for a specific number of shares from their farmer (Local Harvest, 2017). Natural events are affecting the success of farms across the United States, and there is limited research to combat the multiple aspects of the agricultural systems effect on the economy. Locally, CSA farmers are beginning to question how natural events will affect subsequent enrollment in CSA farms. This research is important because it could benefit small-scale farmers. The purpose of this research paper is to, on a large scale, analyze what research has been found and what research is needed in order to address how natural events are affecting the success of farms in the United States. The question this paper seeks to answer is: How will natural events affect subsequent enrollment in CSA farms?

Research Methods

To analyze the effects of natural events on the success of farming nationwide, online sources and academic papers were used specifically pertaining to knowledge of natural events, their effects on crop yield due to climate change, as well as what further research needs to be done in order to fully analyze and provide solutions for climate change's effect on crop yields. In order to analyze how natural events affect future enrollment in CSA programs, Common Harvest Farm was investigated as a case study. Members of the CSA were interviewed in order to gain their understanding and opinions of CSA farms. Through interviews with CSA farmers as well as CSA members, Common Harvest Farm was used in order to apply large-scale research to a small scale, local agricultural system. Interviews revealed local responses to climate change and its perceived effect on food production as well as the influence of demographics and the farmer-member relationship. Information from interviews was then used to hypothesize how natural events may affect future subsequent enrollment in a CSA farm. All members interviewed were contacted and asked questions via email. The questions were as follows:

1. How long have you been a part of Common Harvest Farm? Do you expect to continue your involvement?
2. What made you choose Common Harvest?
3. Where else do you get produce besides from the CSA?
4. Have you noticed a change in seasonal crops and can those be attributed to environmental changes?
5. What do you expect to find in your boxes each week?
6. What are the risks that Dan and Margaret warn you of when you sign up? Is this a big factor in being part of the CSA?
7. To what extent do you think climate change is impacting small farms like Common Harvest Farm?
8. To what extent do you think there is financial risk involved in becoming a Common Harvest member?
9. There was a hailstorm earlier this year in June that delayed deliveries by two weeks, which must have inconvenienced you. What was your reaction to that?

Finding, Analysis, and Discussion

Common Harvest Farm has suffered late blight, a destructive fungus, four times in the past twenty-eight growing season. This pattern of natural events affects CSA members experience with risk and the CSA model of farming. For example if a member joined the CSA for the first twenty eight seasons their experience with the risk of natural events would be much different than someone who joined five years ago. Increasing temperatures, floods, and droughts are all possible side effects of climate change. With increased temperature, yields will decline (EPA, 2017). For example in one study, there was a 17% decrease in both corn and soybean production for every degree increase in the temperature during the growing seasons (Lobell, 2003). In addition, if sufficient water and nutrients are not available crop yields may also decrease dramatically (EPA, 2017). With the decrease in crop yields as a result of climate change, this also fosters financial losses for farmers. In Michigan, "in 2010 and 2012, high nighttime temperatures affected corn yields across the U.S. Corn Belt, and premature budding due to a warm winter caused $220 million in losses of Michigan cherries in 2012 (EPA, 2017)." As temperatures increase the frequency of pests, weeds, and fungi will increase as well. "Many weeds, pests, and fungi thrive under warmer temperatures, wetter climates, and increased CO2 levels (EPA, 2017)." There are multiple different aspects of food systems that will be affected by climate change, making it more difficult to pinpoint one solution for a variety of problems. Research needs to be done on how to reduce the vulnerability of food agricultural systems and increase food security. Famine and natural hazards are historical roots that exposed the vulnerability of food systems but such knowledge has not yet been incorporated into climate change research (Lobell, 2003). There is a

necessity to develop an infrastructure of research that considers economic, social, and political constraints that introduce additional external stressors when climate change increases the frequency and magnitude of natural events (Lobell, 2003). In addition to constraints natural events play on agricultural systems, society's ability to cope and recover from environmental stress plays a key role in the stability of food systems. There must be a push in research to evaluate possible adaptation technology and structures in order to strengthen societal understanding and farming methods in coping with environmental stress (Gregory, 2005). Such environmental risks may "require more community solutions of which the CSA model may be a good example (Dan, 2017)."

Common Harvest farm in Polk County, Wisconsin is facilitated by Dan Guenthner and Margaret Pennings, who are dedicated to the CSA model and have a sincere, knowledgeable, and understanding relationships with their members. Dan Guenthner, owner of Common Harvest Farm preaches "farming for good reason," by acknowledging all aspects of farming when it comes to responding to natural events (Dan, 2017). For example a farm with poor irrigation would not be farming for good reason if they were to blame crop failure on drought alone. CSA farmers, like Dan, who invest in building a sense of community among their members "often find that following a natural event their members are very supportive (Dan, 2017)." Each party involved in CSA farming does their part in sustaining a healthy consumer-producer relationship. The CSA farm is responsible for aspects such as refrigeration, irrigation, transpiration, labor, and environmentally sustainable growing practices. Members offer support for their farmers and receive direct insight into how their food is being produced. "Active participation also allows for new knowledge gain and a chance to participate in the joys

of growing food (Brain, 2017).” Natural events such as flooding, late blight, tornadoes, drought, etc. are “well beyond a farmer’s ability to ameliorate (Dan, 2017).” One CSA member whose identity is protected stated, “I know that some years I will get more for my money and some years less. I’m ok with that. I like fresh veggies. I like supporting a local farmer (Interview 2, 2017).” In addition, many CSA members enjoy participating as well as eating healthier and greater varieties of food. “CSA shareholders in Minnesota and Wisconsin said their CSA participation led to eating more, fresher, and greater variety of vegetables, shopping less, and changing to healthier eating habits (Ostrom 2017).” Many CSA members enjoy the benefits of joining CSA farms including fresh produce and eliminating the time it takes to travel to a local market. The responses of CSA members who are loyal to their CSA farmer often offer support despite circumstances that may affect their produce. On June 11, 2017, Common Harvest Farm was damaged by a hailstorm, but instead of hostility from members they received cards with words of support and encouragement. A CSA member whose identity is protected stated, “I was sad for them and I was happy when the boxes started, but it didn’t affect my feelings about CSAs at all (Interview 2, 2017).”

CSA farms may be affected based on what regions or specific sub regions they are located in across the United States. Many natural events have been targeting specific sub-regions of the upper Midwest. There was significant flooding in 2007 and 2008 that were some of the first major natural events to impact a large number of CSA farms, particularly those in Southeastern Minnesota and Southwestern Wisconsin (Dan, 2017). Such risks pose a threat to the use of the CSA model because region-wide events such as extended drought or heat impact multiple farms and in turn affect multiple CSA

members. Patterns of natural events and failure of the CSA model deters future investment in CSA farms because the risk is much higher than the reward. Although CSA models are built on a foundation of trust, that trust must be gained first before CSA farmers may cultivate a deeper relationship with their members. While Dan stated how Common Harvest Farm grows "forty different crops and nearly every year a few of them will not do well, yet overall there is still enough food to deliver to our members," the variation in produce may prove a risk for how food is used or wasted by members (Dan, 2017). If a member does not see consistency in produce they can and know how to use, the risk of food waste will outweigh their desire to join a CSA farm. "Surveys indicate that members do not appreciate being overwhelmed by produce (UW-Madison Center for Integrated Agricultural Systems, 1999)." On the other hand, larger, corporate farms that rely on monoculture are more at risk financially because if there is a natural event, for example late blight, a farm that harvest only tomatoes or potatoes could be completely destroyed, eliminating the possibility of profit in that growing season. "A more diverse cropping landscape would mean viable farms, healthier diets and a steadier food system (Moseley, 2017)." In contrast, some members do not see the financial risk emerging quite yet. "I do not think that there is a financial risk, and yet minimal at this point in time, since crops could be damaged, although not all are affected (Interview 1, 2017)." Dan spoke about the possibility of raising share prices even though members may be receiving less for their membership than in previous years. This course of action may deter future members from enrolling in a CSA farm, introducing economic stresses on the system for people who may not be able to afford eating local food from their CSA farm. A survey conducted by UW Madison found that "most members want to have a sense that they are

receiving a fair amount of food for the price of their membership, averaging over $400 (UW-Madison Center for Integrated Agricultural Systems, 1999).” Many wealthy, middle and upper class CSA members can handle the financial costs of a CSA share, but the CSA model does not provide equal access to local food for the poorest of the poor. A member, whose identity is protected, stated that, “I would certainly want to support the farm, but it might become difficult financially (Interview 1, 2017).” On the other hand a current CSA member whose identity is protected stated, “I’m not motivated by value. I suppose an entire year’s harvest could be destroyed and I expect I’d still be a member (Interview 2, 2017).” The demographics of the CSA model are finite but not elastic, making it difficult for society to adjust and cope with climate change’s effect on agriculture. This limits who is able to take advantage of the CSA model and have access to local produce.

Conclusion

Although current members of CSA farms revealed their loyalty and support of Common Harvest farm, future natural events still pose a threat to subsequent enrollment in CSA farms. People looking at CSA membership will be deterred by variation in produce or lack thereof, increased costs, as well as possible lack of produce for more expensive shares. On the other hand the unique and profound relationship CSA farmers develop with their members may be just what people need to see when looking at future enrollment in a CSA. Agriculture is more than just about providing enough food for the population, it is a about society’s ability to cope with natural events and how they affect production and the economy. With climate change fostering more variable natural events, future enrollment in the CSA programs could be of less desire due to the increasing risks.

A possible solution that can be implemented on CSA farms to combat climate change's effect on agricultural production is to start broadening what produce is found on the farm. CSA farms could start raising chickens or other livestock so if a natural event were to hit and damage a large majority of their crops, the farm would still be able to make a profit in a different way. Another alternative could also be to establish an insurance policy protecting CSA farms. There are insurance policies that can be purchased to protect unavoidable damage to crops due to natural events, as well as protection from "market price volatility" and coverage of "specific crops with a crop insurance policy (Trusted Choice, 2017)." It is important for CSAs to recognize the changes ahead and act accordingly as well as proactively to combat the effects of natural events on agriculture.

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Insects, Pests, and the Survival of the CSA Farm Model

Introduction

CSA farms have a slew of challenges and problems that they have to deal with each year. Especially for small farms, there are many limits that could put them out of business. Increasingly variable weather patterns have made it more difficult for farmers to continue providing their members with consistent quantities of produce. Along with environmental variables, CSAs such as Common Harvest Farm in Polk County, Wisconsin, also have to deal with growing insect and pest populations that are destroying significant parts of their crops.

This past year tomato and potato crops across the U.S. were struck by late blight (Vegetable Crop Update No. 24, 2017). To prevent the spread of the late blight, the affected crops need to be destroyed. To large-scale farms, this would not necessarily prove a significant problem. The same cannot be said for small-scale farms.

As CSA farms rely on their members for existence, they have to take steps to ensure that they can produce what the members are expecting. Thus I decided to

explore the question: given that insect and pest populations have been on the rise, how are CSA farms dealing with crop size inconsistencies to maintain their members?

Research Methods

A variety of sources were used to help answer this question. I visited Dan Guenthner and Margaret Pennings' CSA Common Harvest Farm in Osceola, Wisconsin with Bill Moseley's *People, Agriculture and the Environment* class. Dan and Margaret were then both interviewed. The visit and the interviews helped establish a base understanding for how organic CSA farms function and what problems they have been facing in recent years. They also provided insight into the kind of farming that is done around the Twin Cities and in Polk County, Wisconsin.

Three members of the CSA Common Harvest Farm were interviewed as well (for future reference, they will be mentioned as interviewee one, interviewee two, and interviewee three). The interviews were useful in that they helped us understand the consumer end of the spectrum.

Finally, newsletters, updates, and scientific journals that Dan and Margaret use, along with other scientific journals were used to further understand the current situation that farmers and consumers are dealing with.

Findings, Analysis and Discussion

In 2017, at least 16 states, including Wisconsin, were hit by late blight (Vegetable Crop Update No. 24, 2017). Late blight is a disease that affects tomatoes and potatoes (image 1) and is usually destructive. To eliminate it and ensure that it does not spread, the crops need to be destroyed. On non-organic crops in Wisconsin in 2017, 67 different fungicides were used to combat this blight (Potato Late Blight Fungicide registry, 2017).

The Common Harvest farm was hit by the late blight this past summer. Dan and Margaret lost one variety of tomatoes and all their potatoes.

Furthermore, they were also hit by a hailstorm last June. One method used for eliminating blight-infested plants is to cut them at the base of their stalk and then leave them in the field to die. Dan and Margaret used this method (image 2). The hailstorm resulted in a two-week delay in delivery of produce (Dan Guenthner, 2017). This would not be problematic on a hobby farm, but at a CSA, the members are paying for weekly shares or every other week. This means that the farms need to find a solution for their inability to produce weekly boxes full of fresh food.

For Dan and Margaret the solution was a combination of things. “An important part of CSA is honest communication with members. When we were hit by hail, we immediately sent a letter to our members explaining what had happened… The CSA model is built upon mutual trust and shared risk,” (Dan Guenthner, 2017). When people first become members of the CSA Common Harvest Farm, they are informed of the risks of membership. These risks include natural disasters and all sorts of unpredictable weather patters.

Maybe due to a mixture of the honesty with which Dan and Margaret approach these situations, and the mentality of members, so far, the challenges that they have faced have not been too harmful to the overall existence of their farm. In fact, members have been empathetic. For example, in response to the delay of delivery caused by the hailstorm, Interviewee two said, “I was sad for them and I was happy when the boxes started, but it didn’t affect my feelings about CSAs at all. These things happen. We had hail damage at our house too.”

For the potatoes, they had to make a more difficult decision. According to Dan, the Rhizoctonia pathogen that caused the potato failure was predictable due to the nature of its presence in wet and cool conditions, conditions that were present that season. Because of their sense of responsibility, Dan and Margaret decided to buy potatoes from a close by farm at a cost to their bottom line. Although this was not an ideal option for them, it helped reinforce the relationship that they have with their members. If anything, Interviewee 3 felt bad for the farmers: "I was sad for them and I was happy when the boxes started, but it didn't affect my feelings about CSAs at all. These things happen. We had hail damage at our house too."

The practice of buying vegetables or other produce from fellow farmers is not entirely uncommon. There are numerous CSA farmers' guilds and associations nationwide, many of which are in Wisconsin. Farmers can barter for whatever crops they are in need of (CSA Guild, 2017). For example, the recent hailstorm destroyed a farmer's onions and he bartered with another farm to replace them. This system helps create support between farms when necessary.

Conclusion

Thus, it can be concluded that although CSA farming is extremely difficult, if farmers use a variety of strategies to stay afloat, they can survive. In dealing with failed crops and environmental inconsistencies, for CSAs honesty and openness

between farmer and member is critical. When farmers are upfront from the beginning with the risks that come along with that type of farming, members will be less likely to terminate their input in the CSAs.

Another resource for CSA farmers is CSA farm guilds and associations. These guilds and associations are great sources of information for farmers and also provide a support system. If crops are lost, farmers can trade within guilds to help replace what was destroyed. The resources provided are extremely useful.

A method that Dan and Margaret discussed but I would further emphasize the importance of, is diversity in crops. Maintaining a diversity of crops is essential because it helps ensure that if one crop fails, there will be other vegetables to distribute. Due to the variety of crops that Dan and Margaret are growing, they were able to continue sending boxes to their members throughout the season. If they had only grown tomatoes and potatoes, they would have been dry. Thus along with a variety of crops, they have to be crops that aren't all impacted by the same pests or diseases. If they were then growing a variety would be pointless.

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Climate Change and the Risk of Food Insecurity

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October 2017

Introduction:

Climate change is an overwhelming topic, one of the most significant global issues of our time. The visible effects of climate change, such as glaciers shrinking, rising sea levels, and extreme weather patterns, seem like a far-off phenomenon for those who don't experience these effects directly. Most people living in the Midwest don't come in contact with these effects in their everyday lives. On the other hand, farmers, who live on and make their living from the land, are at the front line of climate change impacts. Agriculture dominates Midwest land use, with more than two-thirds of land designated as farmland (National Climate Assessment, 2014). With this fact, the agricultural industry is very important to the Midwest, thus making climate change one of its greatest threats. Climate change and the effect of climate change on crop production are having a significant influence not only on agricultural as an industry or way of life, but also on food security around the world. With around 815 million people food insecure around the world, climate change places them at greatest risk, with the potential to affect and make worse existing problems with food availability, food access, food utilization, and food stability. Climate change is affecting agriculture and the next step is to think about how both the agricultural industry and climate change are impacting food security, not just about how the agricultural industry will survive. I will examine the current research available on climate change and use this information to focus on how these changes are impacting agriculture. Furthermore, I will discuss how the implications of climate change and its effects on agriculture are causing an increase in food insecurity around the world.

Research Methods:

In order to learn how climate change would affect the Midwest, as my geographical area

of study, I employed federal sources and agencies for climate change, such as the National Climate Assessment and the United States Environmental Protection Agency. These sources gave me an overall understanding of not only the current impact climate change is having on our environment, but also the state the future environment will be in due to climate change. Furthermore, I consulted scholarly sources that focused on the impacts of these changes to the area of the Midwest and how it would affect its agriculture. Moreover, I referred to sources that drew some general conclusions about the vulnerability of agriculture as a direct impact from climate change, such as food production and yields. Finally, in order to understand the threats of food security in relation to the connection of agriculture and climate change, I examined organizations, including Food and Agriculture Organization of the United States that specifically focus on these issues.

Temperature:

With the average global temperature on Earth increasing 1.4 degrees Fahrenheit since 1880 and two-thirds of that warming occurring since 1975, we are already living in a different climate (NASA, 2017). One degree of warming doesn't seem like a big impact, so why should we care? The global temperature mainly depends on the amount of energy the planet receives from the sun and then how much it radiates back into space. Therefore, a one-degree global change is significant because it takes a vast amount of heat to warm all the oceans, land, and atmosphere by that much (NASA, 2017). To put 1.4 degrees Fahrenheit in perspective, a one to two degree drop in the past was all it took for Earth to plummet into a little ice age. Climate scientists have decided that once we hit a global temperature increase of two degrees Celsius,

there is no turning back from the damage we have inflicted on our planet. There will be no way to avoid disastrous consequences.

The Midwest has been experiencing rises in temperature over the past one hundred years, and a crisis it seems is coming. Between 1900 and 2010, the average Midwest air temperature has increased by 1.5 degrees Fahrenheit with the rate of warming increasing twice as quickly between 1950 and 2010 and three times as quickly between 1980 and 2010 (National Climate Assessment, 2014). [See Figure 1] This trend is expected to continue if nothing is done to stop it with changes in temperature increasing between 2.4 and 2.8 degrees Fahrenheit over the next few decades (Hayhoe. K., 2004). In addition, the amount of hottest days, days over 95 degrees, and the length of frost-free seasons are also predicted to rise. Agriculture is also contributing to a significant share of greenhouse gases emissions that are adversely causing climate change.

Changes in temperature are going to affect agriculture in the Midwest in positive and negative ways. The increase in temperature will cause the growing season for crops to be extended. This can be seen as a positive outcome because due to the increased levels of carbon dioxide in our atmosphere, farmers can increase their crop yield. Even though this is seen as a current positive aspect of climate change, in the next few decades the longer growing season and the increase of carbon dioxide levels will be offset by extreme weather events (National Climate Assessment, 2014). These combined stresses linked with climate change are expected to decrease agricultural productivity.

In general, the increase in temperature will affect plants on a crop-to-crop basis. Each of the crops grown in the Midwest has a specific temperature range with a lower and upper limit in order to maximize the growth of the plant. With corn and soybeans being the most common crops grown in the Midwest (65 percent of U.S. corn and soybean production), this increase will

have detrimental impacts on the region's food staples (Hatfield, J., 2012). [See Figure 2] Even though soybeans may increase in yield early in the century because of the elevated levels of carbon dioxide, the added stress from the increased temperature is expected to offset this benefit down the road. Corn yields decline as temperatures warm because of a shortening of reproductive development period (U.S. Environmental Protection Agency, 2016). With the Midwest growing season lengthened by almost two weeks since 1950, small long-term average temperature increases will shorten the duration of reproductive development, leading to yield declines for corn, even when offset by carbon dioxide stimulation (Hatfield, J., 2012). Heat waves also affect crops, such as corn and soybeans, as crop yields will decrease during pollination (Hatfield, J., 2012).

One study conducted by Lobell et al. (2011) observed that previous temperature changes from 1980 to 2008 have reduced crop productivity in corn and wheat by 3.8 percent and 5.5 percent respectively (Hatfield, J., 2012). Additionally, Kucharik and Serbin (2008) found in their study that rising temperature has and would continue to significantly have a negative impact on crop yields in Wisconsin, specifically (Hatfield, J., 2012). Furthermore, an essential note about the impact of climate change is the impact of nighttime temperatures. Nighttime temperatures have been increasing more rapidly than daytime temperatures and this will impact plant growth and yield even more significantly (Hladik, J., 2012). When nighttime temperatures remain high, the plant respires at a much faster rate than if the temperature was cool, meaning that the plants are doing unneeded respiration (Hladik, J.,2012). This can ultimately lead to crops that cannot be harvested. Although there are some perceived short term benefits, climate change is overall negatively affecting crop production. The continued rise in temperature is causing nonlinear

effects on crop yields and is having a large impact on productivity because plants are being exposed to conditions that are outside the thermal boundaries for their optimal growth.

Precipitation:

Climate change is predicted to increase average precipitation and influence precipitation patterns. Average annual precipitation has increased during the last century and it is projected to continue to increase, with a majority of the increase being from more frequent intense rain occurrences (National Climate Assessment, 2014). However, the change in the amount of precipitation won't be as severe as the change in precipitation patterns and seasonal distributions. Heavy downpours are already common, but climate change is expected to intensify storms and lead to greater precipitation across the entire region during this century (U.S. Environmental Protection Agency, 2016). Intense rains are expected to continue to rise, especially in large seasonal shifts and in continued emissions increases. [See Figure 3] Even though model projections for precipitation changes are less certain than those of temperature, the shifts in precipitation will increase during the spring season the most. Compared to the decrease of summer precipitation in the Midwest of an average of about 8 percent in 2041-2062, during the spring season the precipitation is projected to increase by 9 percent in 2041-2062 (National Climate Assessment, 2014). In addition, precipitation cycle patterns over the Midwest are expected to change. While average annual precipitation in the Midwest over the last half century increased by 5 to 10 percent, rainfall during the four wettest days of the year has increased by 35 percent (U.S. Environmental Protection Agency, 2016). The intensity of storm events is increasing and this is causing an increase in the frequency of floods in the Midwest.

Extreme rainfall events and flooding have increased during the last century, and these trends are expected to continue, causing erosion, declining water quality, and negative impacts on transportation, agriculture, human health, and infrastructure (National Climate Assessment, 2014). Even though precipitation is more difficult to predict, the increase of precipitation intensity and more frequent flooding indicates more crop damage and soil erosion. The shift in precipitation patterns towards more spring precipitation will also have negative impacts on labor practices. These shifts in precipitation will affect field preparation time in the spring. An analysis of workable days for April through mid-May in Iowa shows a decrease from 22.65 days (1976-1994) to 19.12 days (1995-2010) (Hatfield, J., 2012). This inquiry means that there is a significant change in the number of available days farmers can work during the spring. The decrease in the number of workdays affects farmers' ability to enhance crop production because the growing season is shortened. Changes in the seasonal timing of precipitation will be more evident in the success of agriculture than changes in precipitation totals.

Food Security:

Climate change affects all dimensions of food security and nutrition. It will reduce food production and increase the vulnerability of food production in the future. Although food security has a lot of different working definitions, the Food and Agriculture Organization of the United Nations uses the following description: "food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food which meets their dietary needs and food preferences for an active and healthy life" (Food and Agriculture Organization, 2017). This is not the case right now. Many people are currently food insecure. The Food and Agriculture Organization estimated about 815 million people were chronically

food insecure in the world in 2016 (Food and Agriculture Organization, 2017). [See Figure 4] Poverty is the driving factor of the lack of resources to purchase or otherwise obtain food. Climate change, growing use of food crops as a source of fuel, such as biofuels, soaring food prices, and inefficient food safety systems are also factors of food insecurity.

Problems with food insecurity and malnutrition tend to be amplified where natural hazards, such as floods and droughts lead to the consequence of conflicts. The coexistence of conflict and climate-related natural disasters is likely to escalate with climate change, as climate change not only impacts malnutrition and food insecurity, but also can "contribute to further downward deterioration into conflict, protracted crisis, and continued fragility" (Food and Agriculture Organization, 2017). In some cases, the main cause of the conflict is the competition over natural resources, because an estimated 40 percent of civil wars have been associated with natural resources over the past 60 years. Almost half of these conflicts (48 percent) have taken place in Africa since 2000 because in Africa residents depend access to rural land for their livelihoods (Food and Agriculture Organization, 2017). Competition over natural resources, such as productive land, and water is a potential trigger for conflict, as this environmental degradation can threaten households and community livelihoods if people lose their land and resources, or their labor conditions worsen (Food and Agriculture Organization, 2017). Therefore, when conflict and climate change are compounded together, this is a key factor when trying to explain the long-term increasing trend in global hunger and this is posing a major challenge in ending world hunger and malnutrition.

The reasons for food insecurity can be broken down into four different sections: food availability, food access, food utilization, food stability. Food availability is affected by changes in climatic conditions, specifically with the production of stable crops, and higher temperatures

will have an impact on yields while changes in precipitation will impact crop quality and quantity (World Food Programme, 2017). As previously stated, people with lower incomes have to sacrifice more of their already limited income to meet their nutritional requirements. Food access is becoming more difficult, especially with the poorest people, as prices of major crops are increasing due to climate change (World Food Programme, 2017). Nutrition is also something people who are food insecure struggle with. As climate change affects calorie intake, particularity in areas where chronic food insecurity is already a significant problem, changing climatic conditions could also create a vicious cycle of disease and hunger (World Food Programme, 2017). Finally, food stability can dismantle the stability of individuals' and government food security strategies as the climatic variability is caused by more frequent and intense weather patterns. These patterns then create fluctuations in food availability, access, and utilization (World Food Programme, 2017). Climate affects human behavior, and so in an altered climate, individuals may choose to consume different foods. This practice could have important consequences for nutrition and food safety.

Conclusions:

Climate change is well documented and far reaching. Even though the impacts of climate change in the Midwest are more indirect than other parts of the world, they are still worthwhile to take notice of. With the rise of temperatures and the changes in precipitation patterns affecting the agricultural industry, such as crop production and soil degradation, climate change is making its impacts in the Midwest. For agriculture, it has serious implications not only to an industry that occupies a large amount of land for a single use—which has its own history of ecological consequences, such as the dust bowl, but also due in large part to transforming natural

landscapes for a single use. With an industry seemingly on the edge of collapse, and with it a way of life like farming, that might disappear, it's safe to say that food production and yield will be affected. With climate change as pressing as an issue as it is, there needs to be more awareness and research of its effects. Specifically, with helping issues relating to the agricultural industry policymakers can take many actions at all different levels. At the national level, social, economic, and environmental policies should support the objectives of a sustainable, climate friendly, resistant and effective agriculture sector. At the sector level, governments should strengthen their consistency with their environmental policies and have incentives that correspond with agricultural policies that remove polices that generate unsustainable production systems, such as the overuse of natural resources, and intensify climate change. At the farmer level, there should be an emphasis on incentives that enhance farmer capability to adopt practices that contribute to sustainable productivity growth while also responding to climate change. Overall, there should be further investment in research concerning sustainable productivity and ways to face the impacts of climate change within the agricultural industry.

With the impacts of climate change, the future of the agricultural industry is being tested and people's access to food is being threatened. When viewed from the perspective of food security, this change has serious and immediate implications. All of this change leads to decisions that can be made about the direction of the agricultural industry that should be taken in the future. A number of actions can be taken to help combat food insecurity, including developing agricultural markets and expanding trade so farmers can sell what they grow for profit; helping farmers access capital allowing them the ability to expand their farms and buy equipment; expanding sustainable agriculture strategies which permits countries the capability to feed their populations without depleting their natural resources. These are just a few

improvements that can be done to help strengthen global food security, but with climate change, these actions need to happen sooner than later as countries, especially in the global South as these countries are feeling its effects at a larger scale. Furthermore, there needs to be an investment in agricultural research to not only have ways to face the effects of climate change on crop production, but also be able to develop ways where farmers can grow more in an approach to strengthen global food security. Is it more important to focus on using local agriculture and adapting to a changing climate with less reliance on the larger, commercialized agricultural industry in order to build up food security or food stability?

Appendix

Figure 1

Source: http://nca2014.globalchange.gov/report/regions/midwest

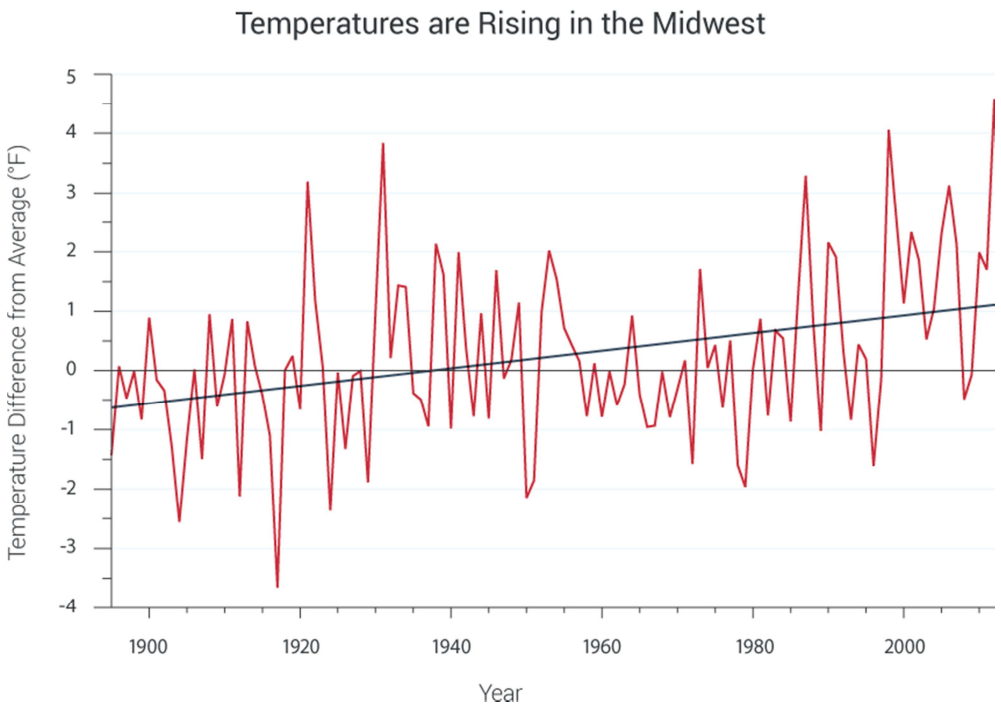


Figure 2

Source: http://nca2014.globalchange.gov/report/regions/midwest#graphic-17080

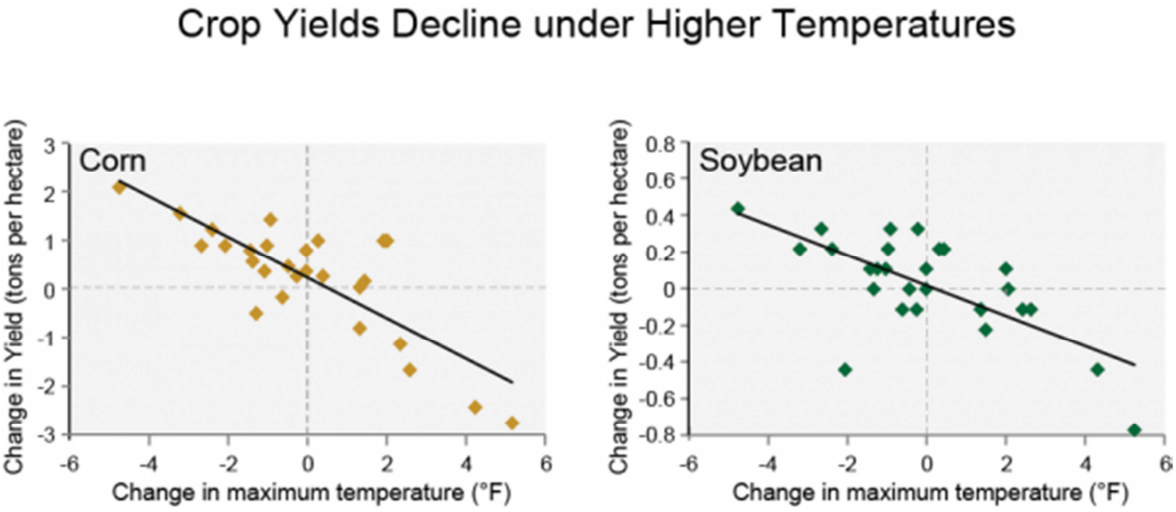


Figure 3

Source: https://ncics.org/report-landing-page/nca3-data/

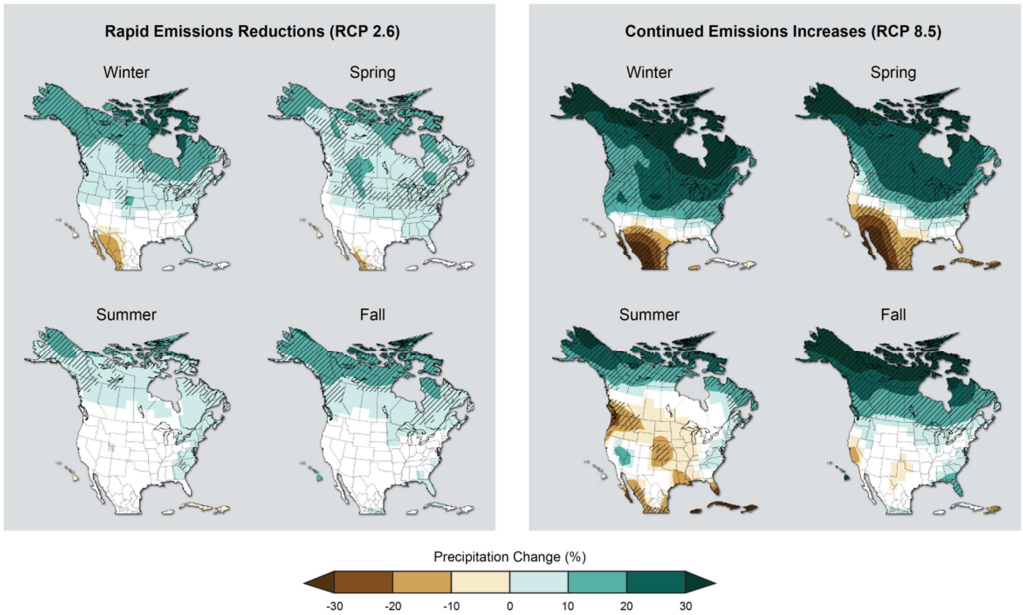
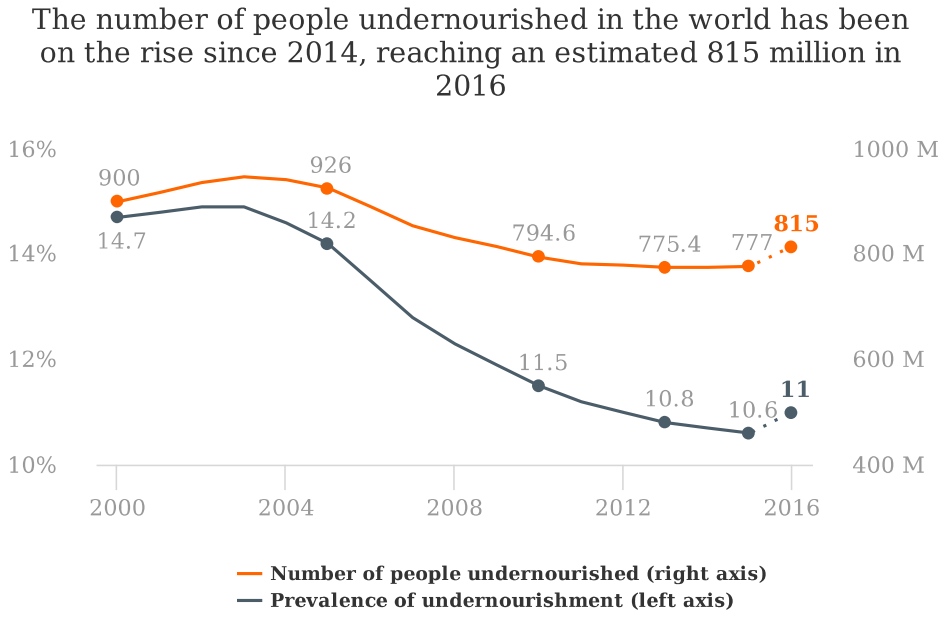


Figure 4

Source: http://www.fao.org/state-of-food-security-nutrition/en/



NOTE: Prevalence and number of undernourished people in the world, 2000–2016. Figures for 2016 are projected estimates. SOURCE: FAO.

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Chapter 3:
What are the pros and cons for farms in Polk County, WI of being located relatively close to the Twin Cities Metro Area? How does the mix of pros and cons shift depending on the type of farm in question? What happens when the Metro area essentially gets 'closer' following the construction of the Stillwater bridge?

The Findings of Research Group 2 (Lauren Weber, Sabri Fair, Anonymous)

Lauren Weber
People, Agriculture and the Environment
10 October 2017
Group 2

Can We Use the O-Word?
A Case Study of CSAs and Organic Certification in Minnesota and Wisconsin

Introduction

Called "the decade's biggest culinary buzzword" by the Smithsonian.com, the term "organic" took off in 2002, when the USDA released national organic standards (Callard, 2009). Although it may now be associated the modern icons of Whole Foods, locavores, and farmers markets, the idea of organic farming is an antiquated one. If we go back prior to 1940 – pre-pesticides, herbicides, antibiotics, and Haber-Bosch process – everyone was an organic farmer. But now, when our food travels more miles than we do and is sprayed by substances we cannot pronounce, the idea of greater transparency in food production is an appealing one.

But who do we count on to tell us where our food comes from? The USDA complicated the food production debate when they released a report in September of 2017 admitting that the verification process of organics is "not transparent" and has "inadequate controls" over ensuring that imported food has been produced according to organic standards, which can make it all the more confusing for the consumer in the supermarket who shops the shelves by that little green label (USDA-NOP, 2017).

The other, more involved way of knowing where your food comes from is by *knowing* where your food comes from. That's the idea behind CSAs, or Community Supported Agriculture. By selling and transporting direct to the consumer, CSA farms allow consumers to know where, how, and by whom their food was produced.

So why would a CSA, which prioritizes the safe and sustainable production of food, not be certified organic? I talked to Dan Guenthner of Common Harvest Farm, a CSA in Osceola,

Wisconsin, and he explained why his farm – while practicing organic farming – is not certified organic. His reasoning centered around two things: first, the certification process and cost; and second, the lack of necessity for the certification.

So, if organic certification isn't important to a relatively small CSA, close to the Twin Cities Metro Area, what reasons do CSAs have for being certified organic in Wisconsin and Minnesota? Is organic certification economically or socially significant on the scale of a CSA?

Methods

One important aspect of this project was retaining the perspective of a consumer – the person who would be searching out these CSAs and trying to understand what organic certification means. And this means qualitative data was a large part of my research; although I had inquiries about the spatial significance of organic certification, I found it more useful to document how each CSA describes itself, its mission, and its farming practices.

I started by researching the process and cost of organic certification, as well as the current state of organic agriculture in the Midwest, using Minnesota and Wisconsin Departments of Agriculture reports, scholarly articles and news articles.

To find CSAs in Minnesota, I used the Minnesota Grown Directory, which has mapped out all the CSAs in the state, and labeled whether or not they are certified organic. It was more difficult in Wisconsin – I found all of the certified organic CSAs on the Fairshare CSA Coalition, and then non-certified CSAs on the Land Stewardship Project's database. All of these databases require membership by the CSAs in some form, whether that be an application, a fee, or both.

I looked at the CSA's distance from the Twin Cities to find whether location had any correlation to certification, as a study focusing on organic farming in general found that

"distance to markets was found to be positively associated with the decision to certify" (Torres, et al., 2013). After finding the least conclusive data possible, I returned to my list of CSAs and randomly selected ten certified and noncertified CSAs from each state, in order to look at the type of the CSA more closely. What do they produce? What are their distribution networks? What is the size of the farm, and how long has it been established?

I also reached out to these selected farms by email, asking their thoughts on organic certification, and whether they find it relevant in the CSA context. However, I only had one response from Norm Gross (also known as Norm the Farmer) of Earth Dance Farm.

From these qualities, I drew conclusions about what kinds of CSAs tend to pursue organic certification in Minnesota and Wisconsin, and what this means about the significance of certification. I also read through the research done on organic farming and CSAs in the Midwest, in order to reinforce these conclusions.

Discussion: Organic Certification and CSAs

The organic certification process takes an average of 12 weeks, but it begins long before the application – 36 months is the transition period for farmers, when they have to begin using organic practices. The application requires a third-party agency, like MOSA (Minnesota Organic Services Association), to conduct a farm inspection, along with a paper application, and a fee of $1,100 for first time applicants. The time and cost are not always realistic for CSA farms, especially when there is only an average of a 9% price increase on certified organic CSA products – which can also be thought of as only an extra $48 per summer season share (Connolly & Kleiber, 2014). In short, third party verification is time consuming, expensive in terms of the yearly fee, and leads to marginal profit on the scale of the CSA model.

Another critique of organic certification is the confusion around what it really conveys to the consumer. “Certified organic” is not synonymous with “free of chemicals,” as many believe. If inputs, like fertilizers, livestock feed ingredients, or a processing aid, are approved by the Organic Materials Review Institute (OMRI) or on the USDA’s National List, which is the official run-down of what can and can’t be used in organic farming, a farmer is free to use it and still market their products as organic (USDA-AMS, 2017). Although, the product may have been sprayed by pesticides similar to those used in conventional farming or contain “potent natural extracts” considered “slightly toxic” by the EPA, substances which the OMRI or the National List have permitted (Langlois, M., 2011).

As organic food has morphed into a “wildly lucrative business for Big Food,” additional resistance has come from non-profit groups, such as the Cornucopia Institute. Large companies like General Mills, Kraft and Cargill have all tapped into the “premium-price-means-premium-profit” potential of organics and their employees have landed spots on the National Organic Standards Board, which is responsible for voting on what can and cannot be done under organic certification (Strom, S., 2012).

In the CSA model, members are part of a community, which means they have more access to the farmer producing their food than the average supermarket consumer. A conversation at the weekly drop site with the farmer or a fellow CSA member can be more informative than the little green label, more accessible than the USDA’s dense National List, and less prone to conflicts of interest than a board of corporate employees promoting whatever standards allow the most profit.

Discussion: CSAs in Minnesota

In Minnesota, using the Minnesota Grown Directory, I found 76 total CSAs, and of those, 20 are USDA certified organic. In looking at the certified organic CSAs, there was plenty of variation. They range from 2.8 to 222 miles away from the Twin Cities and have distribution channels that include restaurants, farmers markets, and wholesale. In terms of distribution, Norm Gross of Earth Dance Farm explained that certification "can definitely open up markets, like selling to chefs or stores" (Interview, 2017).

But there were trends distinguishing the certified CSAs from the non-certified. For example, I found four certified organic CSAs run by nonprofits or other groups, and only one non-certified run by a nonprofit. One of the organic CSAs, WEI Amador Hill Farm & Orchard, is run by the Women's Environmental Initiative – which owns many other gardens in the state and relies on volunteers for much of their work. Another, Wozupi Tribal Gardens, is owned by the Shakopee Mdewakanton Sioux Community, and includes multiple gardens and livestock operations. Therefore, organic certification is useful when there are more than just the land-owning farmers involved in the CSA. If there is a larger organization overseeing the operation, organic certification is the mode of communication ensuring farming practices to CSA members across multiple locations.

On the other hand, some CSAs did not pursue organic certification likely because the "one-size-fits-all characterization of the value of organic may not be appropriate in the local foods market" (Connolly & Kleiber, 2014). Ter-Lee Gardens, located in Bagley, MN, elaborated on their reasons for not being certified: "We have chosen not to be certified organic, with the major reasons being the cost of certification by agencies, paperwork and time, in addition to our firm belief that using biologically sustainable production is better for the environment than just being certified organic" (Nennich, 2013).

Another non-certified farm, My Minnesota Farmer, said, “We feel we do not need a government ‘organic’ label to tell our customers that our meat and produce is naturally grown. Our openness is our labeling. In addition, our children pick and eat the produce right in the garden, they play in the dirt between the rows; and it simply is not worth risking the health of our children for the perceived benefits of chemically grown food” (My Minnesota Farmer, 2017). A unique aspect of the CSA model is its ability to evoke trust through its direct communication. A larger farm owned by a corporation could never claim that their children play in the farm – but for a CSA, evoking these images pulls at a consumer’s sense of ethos and allows a farmer’s credibility to be established, without any third-party verification.

Discussion: CSAs in Wisconsin

With the Fairshare CSA Coalition and Land Stewardship Project databases, I found 52 total CSAs in Wisconsin, with 44 of those certified organic – which means Wisconsin has at least double the certified organic CSAs of Minnesota. The CSAs in Wisconsin ranged from 44 to 334 miles away from the Twin Cities, but again I did not find a relationship between distance from the Twin Cities, Madison, or Milwaukee, and the tendency of the CSA to be certified organic or not.

Certified organic CSAs n Wisconsin differed from those in Minnesota – namely, in the production of livestock. Four out of the ten certified organic farms produced poultry, beef, or dairy products, while also managing a CSA program. This can be attributed to the “niche market” that has grown out of Wisconsin organic dairy; the premium price of organic livestock and dairy products allow small farmers to stay afloat as prices for conventional productions depress (Sato, et al., 2005). In addition, the USDA approved the Organic Trade Association

(OTA) to grant a new organic certification to farms in transition, with the goal of increasing the availability of organic feed for chickens and cows, as lately "it's been hard to satisfy consumers' hunger for organic meat, milk, and eggs" (Charles, D., 2017). Having multiple aspects of production increases the need for organic certification, even on farms with a CSA, because of the economic advantage it allows in more conventional markets.

But seven of the ten non-certified farms advertised their CSA as the farm's mainstay – and their passion for sustainable agriculture extended past the CSA. Foxtail Farms has an "internship incubator program" where students can come learn about sustainable farming practices. And others, like Threshing Table, Steady Hand Farm, and Common Harvest Farm, host events, share recipes with CSA members, and send out newsletters. For those farms focused on the CSA specifically, member involvement and communication is a priority – which means organic certification is not as important, because CSA members "are more concerned about the getting connected to the farm, knowing food growers and supporting them" (Gumirakiza & Hopper, 2016).

Conclusion

Examining CSAs' tendencies to avoid or choose certification is significant for farmers to better understand the market, but also for consumers to recognize what organic certification is actually conveying about food production. And in nearly every case of the CSAs that I looked at, sustainable farming and the avoidance of chemicals were prioritized, certified organic or not. Because the cost and lengthy process create barriers to organic certification, consumers cannot treat the certification as the best way of knowing how their food was produced. The issue of

gaining greater transparency in food production encompasses the smaller, but still notable issue of requiring transparency in the organic certification and verification process.

Minnesota has a wide variety of CSAs – including CSAs run by nonprofits or larger groups, which require organic certification to ensure the standardization of farming. But the non-certified farms were often proud for their reasons in not being certified – raising the point that the farmer can say just as much, if not more, than organic certification. Wisconsin, as the state with the second highest number of organic farms, highlighted the importance of being certified organic in terms of dairy and livestock production, but undercut organic certification's importance when the farm's main focus is the CSA (Bauer, L., et al, 2017).

In both Wisconsin and Minnesota, organic certification is a marketing tool – which explains why it falls under the jurisdiction of USDA's Agricultural Marketing Services. Because all of these CSAs farmed very similarly – avoiding as many chemicals as necessary, practicing soil stewardship, and taking pride in caring for the land – the little green certified organic badge is less about achieving transparency in food production, and more about making products available, and appealing, to the growing market of consumers who prioritize buying by the little green badge. Although organic certification allows for greater access in the traditional market, the CSA model is not where "The O-Word" holds the most economic or social sway.

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10-10-17

Geography 232(Environmental Studies 232)

Group 2

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A Tale of Two Cities:

Why Emerging Market Farmers are thriving in the Twin Cities Metro Area

Introduction:

The population of the state of Minnesota is 5.52 million people and the Twin Cities Metro area has a population of approximately 3.5 million (Press P. 2016). With nearly 63 percent of the state's population living in the Twin Cities Metro area the farming and food culture of the entire state is greatly affected by the way people live and eat in this area. To answer my question of why small farmers are doing so well near the Twin Cities area I will be addressing what the pros and cons are for emerging market farmers in Polk County Wisconsin and for farmers in the surrounding Twin Cities Metro area. Farming so close to this area has many benefits like access to business growing tools, accessible market places and a community that values their products. It also has its draw backs such as lots of competition and competition with certified organic food from big farms this makes small scale farming difficult in Minnesota and in surrounding states like Wisconsin. I will also address how certain issues vary between different types of emerging market famers in the area because of the products they sell or the size of their operation.

Before I step into what I found it is first important to discuss what an emerging market is in economic terms. An emerging market is a small scale market with low to middle per capita income. Other characteristics of emerging markets are that they have high transparency in the market place, high volatility, rapid growth and higher than average return. They tend to be built upon trust in the market because they operate on a small scale with a close connection to consumers. It is important to study this type of agriculture because although they are small individually, together they play a large part in the food market of the Twin Cities. Small farms fit into all of the categories that define an emerging market. Some examples of emerging market producers in the Twin Cities area are; CSA's, Beekeepers, Fruit Orchards, Vegetable Farmers and Bakers. These producers are able to make high profits because their production costs are low, they are high quality goods and consumers really value the connection they can create with small scale producers. All of this leads to high return on their investments. Downsides these emerging market producers face is they are highly susceptible to economic problems and environmental issues such as drought, frost and flooding.

Investigation:

To investigate the pros and cons of being an emerging market farmer near the Twin Cities Metro area I visited a local farmers market with farmers that came from around the city and a few farmers that traveled from Wisconsin to sell their products to the Macalester-Groveland community. At this farmers market I talked to a Farmer from Clear Lake, Wisconsin about her ability to access this market and what her thoughts were on the installation of the new Stillwater Bridge that connects Wisconsin to Minnesota and cuts about 30 minutes off of commute time to the metro area for people living in Polk Country. While at the St. Thomas More farmers market I also talked to a bee keeper about the farming community and how the

farmers worked together or didn't to learn more about the emerging market culture. He also helped me understand that the struggles of becoming certified organic vary greatly from product to product. Another place that I gathered information from was the internet, from websites and news articles about things happening in the Twin Cities area that affected. I found lots of information there about how many markets there are in the Twin Cities and what types of resources are available to help farmers reach new consumers. The last tool I used to gather information was a visit to a local grocery store that prides themselves on their commitment to local food. I contacted the marketing director of that establishment in hopes that she could tell me about their connection to Wisconsin farmers and their guidelines for considering food local. I was able to find information on other websites of local co-ops about their guidelines.

Analysis:

Being in the Twin Cities Metro Area gives farmers access to many valuable tools like websites that seek to connect the people of the Metro Area to fresh food. One example of this is twincitiesfarmersmarkets.com that has information on when and where farmers markets are as well as recipes for obscure vegetables, local events and help for connecting farmers to farmers markets. Access to customers through the internet is very important for modern farmers and being so close to so much ingenuity is an amazing asset. Not only does the website provide information about where markets are it also provides local reporting on various famers each week so buyers can learn about new products and sellers and so farmers can meet with new clients. This sort of networking is very important in a big city because the competition for clients is very fierce especially with so many farmers markets and sellers. This support also makes local food more lucrative and accessible for people who may not know where to begin

looking for local food and other products. I used twincitiesfarmersmarkets.com to find a farmers market where I could talk to local farmers.

Being situated near The Twin Cites Metro Area gives great access to a market place for emerging market producers. Having access to buyers is critical for small businesses because transportation costs can be very difficult to cover when your product needs to be competitive in the modern market place. For small emerging market farmers transporting their produce across the country isn't an option because they don't produce enough volume for this method of business to be cost effective. This is where living close to the metro area is very helpful. For farmers in Polk County being only an hour's drive from more than 70 farmers markets alone is a valuable asset. This asset allows farmers to sell their produce quickly and to not have to worry about long term storage or preservation as is the case for larger farms that ship across the country. For farms in Polk County such as the Gilbertson Farm in Clear Lake Wisconsin the Twin Cities have been where they sold their produce for nearly 26 years (Gilbertson Farm, personal communication, Sep 29, 2017). The owner that I talked to only commented that the bridge had made getting to the market quicker. Because the Twin Cities have always been the closest market she has not noticed or heard of any increase in competition from Wisconsin moving to the market. She looked at me like I was crazy when I asked if there were any other places that were closer that they had tried to sell their produce. So now that the food is here who buys it?

The market for niche products and local food is booming in the Twin Cities area and that means that to be competitive the products you offer must be the best possible and they have to be

profitable. Having such an educated community and great access to higher education gives the local economy tools to create its own emerging markets and products that have never been seen before. With so much access to higher education farmers in Polk County have access to many innovative products that are being made in and around the Twin Cities. One example of this is the Winfield United Innovation incubator that has opened up specifically to help agriculture innovation in River Falls. The new facility aims to help local and international farmers grow food more sustainably and productively (New Incubator 2017). Furthermore not only do educated people create new goods, they also tend to live healthier lifestyles. The Twin Cities Metro area is a liberal area that places high value on fresh food and a healthy lifestyle. For farmers an area like the Twin Cities is a gold mine of consumers that crave their products. In the Macalester – Groveland neighborhood the median income was $73,462and according to U.S. census data 49% of the population makes more than $75,000(Neighborhood data, n.d). This means that consumers in this area have disposable income that they can spend on local, organic food that some urban consumers cannot afford.

One downside of being in a market with so much competition is that as a small farm getting certified organic can actually make business harder. Aside from the price which occurs annually and is a payment to a third party accredited agent that gets to decide if you are organic or not(Organic 101, n.d.). Another issue for small farmers is if you are organic and have an infestation you can't use any products to salvage your crops and that would leave the farmers with no income for the year and that is not an option (Gilbertson Farm, personal communication, Sep 29, 2017). If you do use spray you have to wait three years before you can apply for recertification (Coleman 2012). As a small farmer you have no protection from the government or your insurance company that would allow you to stay in business and survive until the next

season. A beekeeper that I spoke to who was from Cambridge Minnesota said that if you are keeping a small amount of bees you can manage it organically but once you get to too many hives chemicals are quite necessary(North Country Farm, personal communication, Sep 29, 2017). Another difficulty for becoming organically certified as a small beekeeper is that your hives need to be in the middle of 16 square miles of organic plants (USDA 2017) which is nearly impossible in the farming landscape surrounding the Twin Cities. This leaves consumers with a tough choice between buying big organic or from small local food that has only the assurance of the farmer. Luckily many local consumers are comfortable with the latter because of the strong connection between buyers and sellers in this community.

Now once a farmer has decided how they are going to grow their crops near the Twin Cities they have a couple of options for selling their products. Luckily for them there are local stores that are committed to selling local products. One of these stores is called Kowalski's. Kowalski's is located Grand Avenue which is a major thorough fare for St. Paul. Kowalski's prides themselves on having local, organic, sustainable and natural food. Local food is very important to the company and all the food in the store that comes from Minnesota is aptly marked as such so customers know where it came from. Having stores like this with a commitment to local food is a major plus for farmers that want to operate on a larger scale and don't have time to spend at farmers markets. These stores also increase the size of the market and make these local items available every day for consumers in one place so they wouldn't have to scour through all the farmers markets in the Twin Cities to get what they want.

For farmers in Polk County the way that Kowalski's identifies and markets local food hurts them greatly. When you walk into Kowalski's and you can find Apples that are from 1 hour and 20 minutes away in Minnesota that are marked as local but nowhere in the store will you

find food from Wisconsin that is aggressively marked as local. From my visit to Kowalski's it appeared to me that only food from Minnesota was considered local and that Minnesota Grown food was a big piece of their marketing of produce. When someone from Kowalski's got back to me about their guidelines they said they considered food grown within a 250 mile radius to be local (Kowalski's , personal communication, Oct 5, 2017). This prompted me to go back to Kowalski's and see for myself and double check what I thought I had noticed the first time. When I went back I still saw no produce from Wisconsin that was marked as local so I am not quite sure what to believe. They did have pumpkins from Wisconsin but they did not aggressively market it as local as it was apparent they did for Minnesota produce. The strict division that is set up by some stores in their consideration of what is local vs what is not can be very tough on farmers from Polk County. This effects them greatly because the Twin Cities is their closest major market. One major part of being able to be competitive in a market is how you can get away with labeling the product so it seems as lucrative as possible to consumers. Local food is very important to the Twin Cities Metro area but stigma around food from Wisconsin is an obstacle for those farmers. One aspect of the debate whether food can be considered local or not is how local food is defined (PDF). Some people define food as local if the benefits go back to the community it was bought in. So under this definition food from Wisconsin couldn't be considered local when sold in the Twin Cities. If local institutions use a definition of local that is based on mileage this could benefit farmers in Polk County. The Mississippi Market which is a local food co-op based in The Twin Cities defines local food as having come from the five state region of Minnesota, Wisconsin, Iowa and North and South Dakota(Mississippi). Being able to label food as local is very important for the marketability of food because rarely do consumers look too past the words on the cover. Having a market that

defines local in such a manner is a major plus for farmers in Polk County because it assures them a place in the local food market without the need to bring the produce themselves. Other grocers are not quite so lenient.

Conclusions:

From my research I can conclude that the Twin Cities Metro area is a great place for emerging market producers from Polk County and the surrounding area in general to market their products. I believe this because of how involved these farmers already are in the market in the middle of the Twin Cities. Coupled with the fact that as an emerging market producer they have higher than average return rates, high growth rates and transparency in the market place. From the farmers I spoke to they made it clear that local consumers respected their transparency and had no trouble believing in the quality of the products offered. This market is also good for emerging market farmers because they have a large amount of consumers that are willing to pay for their products. The city is also host to lots of innovation that can hopefully make farmers jobs easier. Some policy recommendations that would help local farmers would be providing government subsidies and protections to small farmers because they still do provide a sizeable amount of the food consumed in certain parts of our country and they provide healthy options to our society. Large GMO corn and soy are not the only crops that should receive help from the government. Another thing to take into consideration for the benefit of small farmers would be making organic certification less of a hassle and working change the American public's idea that if it isn't certified it isn't good because certification really only helps large corporations control the market. Emerging market farmers are thriving because the Twin Cities community wants products that are created in their community and that have the community's interests in mind.

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Anonymous
Alternative Agriculture in Context
Question 2
Final Draft

Environmental Impacts of the Stillwater Bridge

What are the pros and cons for farms in Polk County, WI being located relatively close to the Twin Cities Metro area? What happens when the Metro area essentially gets "closer" following the construction of the Stillwater bridge? These are the relevant broad questions that connect to the sub-question: what are the environmental impacts of the bridge on the St. Croix river and the surrounding area? What can we learn about from the history of this area? This question is pertinent because now more than ever is a time when environmental consciousness should be at the forefront of everyone's minds. Even more so it is important for individual states to take full responsibility for and seek to actively improve the environment. A bridge might not seem relevant or impactful in the face of multiple hurricanes and other large-scale natural disasters but infrastructure like this matters to the future. The bridge that this will be functionally replacing, the Lift Bridge, was constructed in 1931, so this bridge will have a lasting impact on the river and surrounding area for a long time to come.

It is difficult to investigate the long-term environmental impacts of a bridge that has only constructed in recent years and open to the public for two months. However, it is possible to research the environmental history of the St. Croix river valley. In doing so it can be determined how human use has shaped the land in the past and what the trajectory might be moving forward. It can also draw a larger picture of the relationship between the Metro area and the more rural

counties of the river valley. What has the historical relationship to the environment been in both communities? How are they connected? How did agriculture impact this relationship to the land and each other? It will also be important to discover how environmental consciousness affected the construction of the Stillwater bridge.

Before the introduction of European settlers to the St. Croix river valley, human impact on the environment with the land was minimal, at the very least in scale to modern usage. In the last one hundred and fifty years, there has been incredibly rapid change in the environment of the river valley. It has been converted to farmland and urbanized with “remnant patches of prairie, oak savanna and mixed coniferous-deciduous forest” (Andersen, 1996), when those small preserved areas used to be the diverse rule of the land. Originally, before the European settlers, the St. Croix river valley was home to shifting populations of both the Sioux and Ojibwa peoples with a small traveling population of French fur traders down the river. This era saw very little environmental impact influenced by the people living there until the European settlers. In fact, the most relevant impact the people of this time period had was a sort of inaction: fires used to be a much more common occurrence in this environment of prairie and the like. Before the land was converted to farmland and heavily privatized which resulted in the containment of fires this allowed the land to cleanse.

Before the conversion of prairie to farmland and urbanization, the first major stress on the land that European settlers created was the logging industry. Logging in the St. Croix valley began in the 1820s and increased rapidly throughout the remainder of the 1800s. Logging was an influential industry throughout the St. Croix river valley counties. It depleted certain types of

trees that were especially sought after for their wood. There was also very little replanting during this period, in part likely due to the spirit of Western expansion in the United States and the sense of entitlement and endless bounty. In 1872, railroad lines were constructed from St. Paul to

Stillwater which was because of and beneficial to the logging industry, which was connected to a metropolitan area for the first time, and had a means of efficient exportation. The population of the St. Croix river valley had a boom and more than doubled from 1860 to 1870 after the Civil War. Even with an increased population, the logging industry was very dominant and produced few farmers. The only focus on agriculture was subsistence farming for the population of loggers and their families. European settlers came to the area by way of Steamboats in the 1840s which have a negative impact as they produce many pollutants. In the 1850s land travel became more widespread and accessible because of the creation of roads from trails and paths (Andersen, 1996). Although the counties do not have the exact borders that they do today, they are still the most clear ancestor to the modern county. Although the logging industry changed and generally slowed through the twentieth century, Polk County was still outpacing other counties in the area by millions of board feet of wood (nearly five million, well above the average of just under a million) in 1973, 1988, and 1990 (Andersen 1996). The original industry of logging began in the area as the very first impactful environmental stressor. Even though it began in the 1820s it is still relevant to today's environmental landscape in the area.

From the trend shown in the 1850s in the region, the construction of roads became prevalent and led to settlements formed by European-Americans. Roads created a beneficial

environment because they created not just an easier way into the river valley but a clear way out for exports, not just logging but time sensitive products like perishable food, which promotes farming. The amount of farms and farmlands rose sharply from 1850 to 1860 when the St. Croix river valley counties were mostly transitioning from subsistence agriculture to support logging to a market agriculture to support itself. During this time agriculture and logging supported each

other as cohesive industries in the area. There was a lot of environmental damage to the region as a whole for the benefit of agricultural progress. Wetlands were drained while being converted to farm use. In 1850 this was encouraged and thought to be making an improvement to the land by making it better suited for the needs of the human population. The "hydrologic processes are also altered with forest clearance" (Andersen 1996), by clearing forest land and leaving stumps, never taking the time to replant or burn, these agricultural practices reduced infiltration and decreased water storage in the subsoil for a lot of these lands. Significant alterations in the quality of water can also be directly tied to agricultural expansion in a given area. The water is affected by "non-point pollution that originates in large part from agricultural lands" (Andersen 1996). Agriculture, particularly bad or commercially-oriented farming practices can harm the land for years to come. Although the Stillwater bridge doesn't have an agricultural impact on the land, this is the history of the land and the water that it it occupying.

In 1859 there was a particularly good harvest that allowed farmers to begin to export crops from the St. Croix river valley. In particular: "wheat, oats and potatoes were shipped from Stillwater," (Andersen 1996) and they were able to reach the Metro area. Railroads in the 1870s became integral to the transportation system of the area. Polk County's population tripled from

3,422 to 12,968 people in 1890, but it was not actually until 1900 that more than fifty percent of Polk County was farmland. In the late 1800s while the St. Croix river valley was developing as an agricultural area, Minneapolis and St. Paul were growing as well and began to impact the river valley. “It was roads, not the rivers, that eventually linked the rural area with the city. Roads made the landscape accessible by facilitating more rapid and more regular exchanges between city and country. Roads were avenues of commerce, and city and country developed

together” (Andersen 1996, 259). Logging and farming remained particularly important economic activities in the rural area because of their demand and easy exportation relationship to the Metro area.

At the turn of the twentieth century, people began moving into the cities for job opportunities outside of the rural counties. This was the beginning of urbanization in the rural St. Croix river valley. This fact was particularly relevant to the application of history to the modern climate. Dan Guenther, a local farmer, provided a list of pros and cons to being a small farm close to a large urban area. He listed the ease of exportation to the cities and therefore a larger client market as a benefit while losing workers to better paying and a wider range of jobs in the Metro area was a struggle. These patterns that farmers were observing over a century ago still have their relevance to the problems of a farmer in the present day. And, of course, with the Stillwater bridge these areas only become more easily connected and the duality of the good and bad become exacerbated. After World War II there was a boom in population in the St. Croix river valley, and it was said that “urbanization changes the flows of energy, water and materials on the landscape” (Andersen 1996). Still, by 1940 the number of farms, and the total acres being

occupied and used as farmland were decreasing in the valley. This trend in agricultural land use continues in the present. Dan Guenther also said that people from the cities move out to the more rural areas and then demand city amenities. Though this is more of a social issue, these changes in the type of land owners and the energy they can consume could pose a problem. Even by the 1880s recreational tourism was increasing steadily in the rural counties. There were thirteen trains that ran daily between St. Paul and Stillwater, so there has been a long connection between these areas not just for practicality but also for the interest of people seeing the area and enjoying spending time there, which might sometimes seem like a new novelty. And beyond tourism, by the early 1900s, there was a substantial portion of people who lived in the St. Croix river valley who commuted between the lower St. Croix area and the Twin Cities. There was a streetcar line that traveled between Stillwater and St. Paul every thirty minutes for commuters like this. Throughout all of this time, seemingly very distant from modern day, there is a trend of connection between these two areas. Moving from roads to trains to more frequent trains and then a routinely scheduled streetcar shows a clear trajectory towards quick, efficient, and commonplace ways to travel and connect the Twin Cities and the St. Croix river valley. Major highways being built also contributed to this connection and ease for those who wished to live in the rural areas while being able to benefit from the work opportunities available in the Metro area. The St. Croix river valley has technically been in the commuter ring for the Twin Cities since 1940, showing their long-term connection and the increasing accessibility between them throughout time.

The last bridge connecting these two areas was constructed in 1931 and it was almost dangerously outdated. Why, for two areas that have such a closely tied history, was there such a

long time spent better connecting them? The Stillwater Bridge had perhaps more than its fair share of delays and concerns raised. In 2010 a U.S. district judge, Chief Judge Michael Davis, blocked plans for a St. Croix river bridge for the second time during its development. Davis had ruled in the favor of the local chapter of the Sierra Club whose lawsuit was trying to prevent construction of the bridge. Davis found fault with the National Parks Service's approval without commentary when they had been strongly against a new structure in 1996. The St. Croix is federally protected under the Wild and Scenic Rivers Act which can make attempting projects revolving around it very difficult to complete. This is frustrating, from the perspective of people who fought for the bridge for twenty years, eventually having to lobby for congressional exemption in 2012 before being able to begin this project (Kremer, 2017).

The Parks Service defended its change of opinion because the original 1995 proposal was very different from the one in 2010. Which is perhaps why there are so many precautions that the Minnesota Department of Transportation has carefully outlined. They report that environmental compatibility and protect was intrinsic to the process of all people working on the project. Bridge developers tried to integrate the bridge into existing ravines so as not to have to disrupt the natural bluffs. There is a drainage system which St. Croix crossing project coordinator Charles Clarkowski claims: "the water coming out of the new bridge's holding ponds will be cleaner than the water currently running off the lift bridge into the St. Croix river". There are several endangered species who inhabit this area. The Department of Transportation details that the Higgins eye pearly mussels were relocated and the U.S. Fish and Wildlife Service was compensated to raise new mussels, and that the native mussels will be reintroduced. They also say that the seeds of an endangered Dotted Blazing Star flower were gathered and stored for

future planning. They reported that they kept a strict perimeter around a bald eagle nest as well. The crew reportedly used less disruptive methods like digging by hand or using smaller machines near the bluffs in Wisconsin. Time will tell if these measures are enough, and how they eventually impact the river and the region as a whole. It is probable that this measure is far more environmentally conscious than a measure that was not contested so strongly for so long. But it does seem that environmental impact was carefully measured and an integral part of the thought process. Perhaps if an earlier iteration of the bridge had been approved, there likely would have been more environmental concerns that would have merited policy change. However, a couple months past the bridge opening and everything seems to be fine environmentally. The dedication of people to protect the river played a large role in this apparent improvement.

The Metro area of the Twin Cities and the rural counties of the St. Croix river valley are now more easily connected than they ever have been before, which is a clear trajectory that they have been leading towards for a long time. Throughout their history their industry and its impact on the environment have been intertwined. This latest connection, in the form of the Stillwater bridge, seems to be the most environmentally conscious option there has ever been. Time will tell any long-lasting effects of the bridge and the new “proximity”. But for now it seems like a natural connection in the best way people have created, with many people watching and trying to make the best possible decisions for the planet.

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Chapter 4:

The US has a history of transferring its model of agriculture to other countries. What can the reverse teach us? To be more specific, what farm challenges do you observe in Polk County, WI and what lessons could we take from elsewhere to try to address them?

Findings of Research Group 3a (Elo Wittig, Sowinta Kay, Anya Ptacek, Anonymous*, Emma Pickett)

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GEOG 232
10/3/2017
Group 3a

Intercropping and Monoculture
What Polk County Can Learn from Cuba

Introduction

Farmers at every scale in Polk County, whether on the 40 acres of the CSA farm, the 400 acres of the particular family farm (briefly discussed in this paper), or the 4,000 acres of the largest farmers, have to do something to maintain their soils. The CSA and the family farm rotate and plant cover crops while the biggest farmers spray synthetic fertilizers. In the hopes of improving soil maintenance in order to maintain healthy diets, this paper looks abroad for solutions that might make one of the biggest tradeoffs in farming, balancing books this year vs. long-term sustainable soil stewardship, less of a contradiction and more part and parcel to one another. Specifically, African and Latin American intercropping carries the promise of sustainable production of various market crops arranged in the same field so as to take advantage of each crop's contribution to soil ecology. Traditionally, intercropping and monoculture are considered two ends of a spectrum. At the intercropping extreme, farming is labor intensive and one farmer cannot farm as much land. The monoculture extreme is characterized by high mechanization, large farms, and high input requirements including synthetic fertilizer, pesticides, herbicides, and hybrid seeds. In turn this paper asks: does intercropping, particularly that seen in Cuban farming after 1989, have possible applications for maintaining healthy soil ecology at any scale in Polk County? If so, what recommendations can the CSA farm and farm bill policy makers learn from the findings?

Research Methods

To answer the research question I will use my field notes from the CSA fieldtrip and some communication with Dan Guenther since then to ground analysis of the intercropping-monoculture spectrum in the CSA and other farms in Polk County. As I learned on the trip, there is certainly crop rotation, produce variety, and even instances of intercropping taking place in Polk County. I then relate the field notes to literature sources on the subsidy structure in the American farm bill and American research on intercropping. Finally, I give a brief background of intercropping in Africa and Latin America before delving into the research and success of full-fledged intercropping of market crops seen in Cuba.

Findings, Analysis, and Discussion

Looking out the window on a bus-ride through Polk County, Wisconsin on our way to the CSA farm gives even the most untrained eye the sense that corn is king. “All of this corn will be chopped for silage,” said our teacher and guide, local farmer Dan Guenthner. He described the struggling dairy operations using the corn to feed their cows, a process that in sum costs more per gallon of milk than we pay at the grocery store. A large fraction of American corn is chopped used for animal feed and high fructose corn syrup while another 40% of the American corn crop is devoted to ethanol production. The subsidies involved are enormous, according to Dan, including one program that pays corn farmers in years of below average yield enough money to have average revenues and a separate program that pays 60% of a corn farm’s insurance. The subsidy structure creates such an incentive for mono-culture that little differentiation is considered across the enormous fields. Dan’s portrayal is far from anecdotal. More farmers of the big three commodity grains (corn, wheat, and rice) receive agricultural

subsidies than any other group of farmers, and the size of subsidy received is directly related to a farm's acreage of those commodities (Blank 2008). Passing a hill, Dan laments the planting of corn on inclines as steep as 10-15%. He wouldn't consider planting corn even on 4-6% inclines due to resulting soil erosion. (Guenthner 9/16/17)

Then we went by a particular family farm operated by friends of Dan's, a 400 acre farm with the tallest corn seen on the entire trip. Dan described some of their farming techniques that differ from those on the farms surrounding them. For one, they use a corn-picker to harvest their corn rather than a combine. Their cows graze on the grass in fields that are not being planted with corn that year. They grow oats, an annual small grain with extensive roots that improve soil capillarity and organic matter when they die. The result is that this farm has soils with 14-16% organic matter (as opposed to less than 8% on industrial farms) and corn roughly 15 feet high. The farm of Dan's friends represents a place on the monoculture-intercropping continuum. While the farm primarily grows corn, it does so without the most aggressive mechanization and with crop rotation that maintains prime soil ecology. (Guenthner, 9/16/17)

Finally while at the CSA farm, Dan described his farmerly love for order in his field. The CSA is not a monoculture to be clear, but its market crops are grown in rows isolated from adjacent market crops, meaning it is not intercropping either. Nonetheless, the CSA does exercise intercropping with it's cover crop mix. When land is set aside for soil maintenance, it is covered with a mix of three types of seeds, oats, field peas, and radish. There are other cover crop mixes, but that mix is fairly cheap for the CSA farm which gets the oat seed from a nearby farmer. Each crop in the intercropping mix has its ecological function. The oats grow an extensive root system and scavenge leachable

nutrients like volatile nitrogen not available to other crops (2017 Cover Crop and Winter Grains; Guenthner 9/22/2017).The field peas are nitrogen fixers that perform the same function as the synthetic fertilizers used on industrial farms. Radish grows a deep root system that pulls nutrients from deep below the soil up to the surface where it can be used by market crops. Along with the oats, the root systems of these annual plants decay, leaving soil structure conducive to organic matter with good capillarity that increases water retention and reduces erosion. (Guenthner, 9/16/17)

Intercropping is an African innovation that should be considered an achievement of indigenous technology. It is possible that African intercropping spread to the Americas as part of the cultural cultural exchange of the Atlantic world (whether it did or not is not within the scope of this study). For a sense of the scale of intercropping operations in Africa and Latin America, it is estimated that over half of the African yucca crop is grown in intercropped agricultural systems, and that in Latin America where we are about to focus, that intercropping accounts for 40% of Cassava production, 60% of corn, and as much as 80% of beans (Leihner 1983).

At the intersection of the Atlantic World lies Cuba, where intercropping has been practiced continuously on various scales since Columbian times when it functioned as a means of feeding plantation laborers (Casanova et al. 2002). Fast forwarding to the early 1960s, Communist Cuba had become heavily geared toward export-oriented, sugar monoculture. The U.S.S.R provided generous terms of trade that involved paying world market price for sugar, with a fifth of the price paid in U.S. dollars while the rest was paid via Cuba's purchases from Russia. A bonus of $100 million dollars was intended for the purchase of mechanized farming equipment, inputs, and expertise from the U.S.S.R

(Walters 1966). In many ways the Soviet trade deal mirrored the contemporary scenario in Polk County where farmers are subsidized to produce commodity crops for export, creating incentive for highly mechanized, input intensive monocultures.

Then the Soviet Union collapsed in 1989 and Cuba no longer had a secure market for its sugar in Eastern Europe. American policies cut it off from most foreign trade, making sugar impossible to export and fertilizer inputs impossible to import at the former scales (Moseley, 2017). Recognizing that the sudden inability to import petrochemicals, food, and spare parts represented a potential humanitarian crisis, in the late 1980s the Cuban government rapidly set about addressing the problem with a policy called the "Rectification of Errors and Negative Tendencies" (Nieto and Delgado, 2002). Most significantly the new policies diminished the central state apparatus and through land reform centered Cuban agriculture on the campesinos, thereby increasing the prevalence of cooperatives, collectives, and private farming (Nieto and Delgado 2002).

Without petrochemical inputs to artificially restore vital nitrogen and phosphorus to the soil, intercropping based on the knowledge base of traditional Cuban farmers became the most prevalent method for maintaining proper soil ecology (Casanova et al. 2002). The Cuban experiment, born out of crisis, has allowed opportunities to study particular crops that when grown in side-by side in intercropped plots produce higher yields than each crop would in isolation. By calculating the Land Equivalent Ratio[1] (LER) for several combinations of market crops, researchers have found that all studied combinations have LERs of 1.1 (sweet potatoes and squash) or greater, with some combinations as high as 1.9 including the cucumber-radish combination and the cassava-

[1] LER x = yield of crop x when intercropped/yield of crop x in monoculture.

tomato-maize cluster (Casanova et al. 2002). Protein per hectare and food energy per hectare have also increased due to intercropping (Casanova et al. 2002).

Conclusions and Policy Recommendations

Unlike most of Polk County and other places in United States where commodity-oriented monoculture still rains supreme, Cuba has successfully transitioned away from such the capital-intensive inputs and mechanization of monoculture to the benefit of soil ecology. They have seen intercropping take over as the dominant method of soil stewardship, to the benefit of soil ecology as shown by considerable yield increases.

Before I began extensive research into Cuban intercropping, I asked Dan what he thought about the idea of intercropping in his fields, just in case I was completely barking up the wrong tree. "Rather than inter-cropping two market crops in the same field, it would make more sense to try to grow more cover crops simultaneously with market crops," he responded. He described the success that the CSA had when planting clover among their broccoli, which did not affect that year's yield but had some valuable effects on the soil. What the Cuban experiment shows is that there is potential for market crops grown in and amongst one another to increase the yield of each crop in the mix. In turn, with regards for the CSA farm, there might be opportunities for research to see which if any of their crops have been found to increase LER, protein per hectare, or energy per hectare when grown in intercropping schemes rather than in isolation. (Guenthner, September 22, 2017)

The Cuban economic crisis and subsequent agricultural revolution shows that subsidized commodity-oriented farming was not necessary in Cuba. With the loss of external subsidies, and with the motivation of an imminent food crisis, Cuban farming

showed the potential to transition away from mechanized and input intensive agriculture to sustainable farming based on agro-ecology's core principles. The same could be true in Wisconsin, but it might be prudent not to wait for imminent collapse of the entire system as occurred in Cuba. American agricultural subsidies merit a revisit when they incentivize bad farming practices like planting steep slopes with corn. Reducing the subsidy for commodity grains could incentivize more soil differentiation in fields currently devoted to industrial monoculture. Furthermore, if the reasoning behind the agricultural subsidies is to feed the world, why not subsidize other types of farmers? In a number of ways, vegetable farmers do more to feed the world per acre than industrial farms. For one, 40% of their crop does not go to ethanol production. Secondly, chopping grain for silage adds a trophic level before human consumption which is not only inefficient but incentivizes eating less healthy foods like meat and dairy as opposed to fruits and vegetables.

Finally, what Cuba's story shows is that it is not entirely inconceivable that the vast industrial farms of Polk County could be converted to intercropping farms with the right motivations. It is possible to grow plants in association so that soils absorb more rain, thus requiring less water. It is possible to grow plants in combinations that keep sufficient nitrogen in the soil so that fossil fuels are not necessary to do so artificially. Without petro-chemical inputs financed by subsidies, corn production is impossible in Polk County. With adjustments in policy, there is reason to expect that farmers will buy and sell land so that farm plots return to ideal sizes for economically and environmentally sustainable farming.

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GEOG 232: People, Agriculture and Environment (Fall 2017)

Professor William G. Moseley

Alternative Agriculture in context

Sowinta Kay

Group 3a

Question: The US has a history of transferring its model of agriculture to other countries. What can the reverse teach us? To be more specific, what farm challenges do you observe in Polk County, WI and what lessons could we take from elsewhere to try to address them?

Sub-question: How can farmers in Polk County learn from other countries to manage their manure more efficiently?

"Manure is not a waste; not properly using manure is a waste."

(Livestock Research report).

Introduction

With the aid of a great tour and discussion from Dan Guenthner and Margaret Pennings (CSA farmers at Common Harvest Farm in Osceola, WI), the topic of manure management caught my attention, in terms of farming strategy, that farmers in Polk County have difficulties with initially. Manure management seems to be improving now, because of the knowledge-sharing from neighboring farmers. In fact, there are success stories from other countries like Cuba, the Philippines and India regarding how they use their manure in the most productive way for better crops. However, as Dan mentioned, there is still a lot to learn from each other and internationally on how to make their farming production to be as efficient and sustainable as possible in Polk County. Manure management is an important topic to discuss because, as one of the strategies to improve farm's productivity, farmers could still stay on their land, and not having to sell off their farms, for instance. It has become more costly to farm because of the rise in oil price, and crop prices are getting lowered. These two main factors forced farmers to quit farming, or rent out their land in order to be doing some other work that could allow them to earn more money to sustain their living, despite the fact that they love farming and producing agricultural products.

My research question for this paper is to explore ways in which Polk County farmers could reduce their cost and become more sustainable through managing their manure better to enrich their farm's nutrients by looking at other countries' success stories.

Research Methods

For answering this question, I will be using (not in specific order): notes from the trip with Dan and Margaret to expand what I know about Polk County's farming strategy, FAO website on the topic of vermicomposting, articles on vermicomposting from Journal of Waste Management, a report on sustainability from Livestock Research, a paper published by Soil Science Society of America, two papers published by Canadian Journal of Soil Science, and a blog written a physician on composting and vermicomposting.

This paper will first summarize the main points regarding successful manure management practices in the Philippines, Cuba and India from the sources mentioned above and will end with policy recommendations for Polk County farmers based on these success stories.

Findings, Analysis and Discussion

Manure management is a problem for farmers in Polk County, because the processing needs intensive labor capital and labor cost is expensive. Manure naturally produces both nitrous oxide and methane, and if not managed properly, could impact negatively to greenhouse gases emission. Dan mentioned that surrounding farmers reuse solid waste that cows produce by pumping it into liquid form. The manure also does not stay well on the farm, because it get dried quickly, and release more greenhouse gases into the atmosphere. Dan's family use organic fertilizer instead by spreading the manure across his fields as an attempt to reduce the amount of methane produced. However, he also stated that farmers, including himself, occasionally do not have enough manure to be reused, because the price of milk is getting lower, and therefore, owning a cow does not help them financially as much anymore. This incentivizes farmers to not own cows, which leaves farmers with converting their way of farming to be more mechanical,

because this method is cheaper relatively, and requires less labor. Manure management can also be very labor intensive, which is a challenge for small farmers because they could be using the time to do some other activities that could bring them more income, instead of trying to reuse their manure which gives them less profit and slower result anyway.

Polk County's farmers are not and will not be the only one who would adopt a heavier manure use, and they should, because there have been many success stories from other countries around the world. In the Philippines, for example, farmers use worms to eat the bedding material of the soil, as a way to break the structure of manure and compost the worms to transform organic wastes into vermicompost. This can easily be done in small farms especially. The way the Filipino farmers have been doing for vermicomposting is as followed: they would set up a worm bin filled with their preferred bedding and composted soil while keeping it moist. The moisture would then allow the microbes to colonize, creating a more structured kind of soil, which is easier and better to farm on. (Urban Vermicomposting Philippines)

Similarly in Cuba, the farmers there also adapt worm propagation and vermicomposting by seeding worms with the cow manure as a way to practice sustainability into their agricultural sector. Moreover, the article on Journal of Waste Management also mentioned that it takes only 30 days to operate, and it could help farmers a lot both financially and in terms of production with a healthier soil. Misra and Roy explained in detail on how Cuban farmers usually compost: "Cuban farmers usually perform this composting on cement troughs to create worm compost. First, farmers placed three to four inches of manure in the empty trough, then worms are added. As the worms consume the manure, more manure is layered on top until the worm compost reaches a couple inches of the top of the trough, about two months. Then the worms are separated from the compost and transferred to another trough." This seems to be adaptable for

Polk County's farmers because it does not involve too much machinery capital. However, this is time-consuming and it needs to be taken great care, which involves human capital and time.

Indian farmers also successfully becoming more sustainable and profitable by breeding worms on a wooden bed and organic waste as a way to recycle their manure. They vermicompost by "applying worms for every part of waste", and mixing other substances like "sawdust, paper, and straw" into the pile of waste to make it "rich in major and micronutrients." This is another example to show that vermicompost is a great way to get started with composting manure waste that farmers at Polk County can adapt.

One natural factor that makes vermicomposting not as effective for Polk County's farmers as the farmers at places mentioned above is the weather. India, Cuba and the Philippines locate closer to the equator compared to Polk County. Therefore, the strategy that farmers in these countries use in composting successfully might not necessarily be as successful for farmers here in Polk County. Despite, there are ways to be flexible and still adopt this strategy by, for example, performing this seasonally, or indoor. As Teenstra et al. (2014) mentioned, manure is poorly stored and handled are often discharged into the environment. Yes, this is not a "one-size-fits-all" approach for managing their manure for all the farmers, given that the soil and environmental structure could be vastly different. However, by being educated on how to manage manure better could help the farmers on a big scale for both cutting their production cost and encourage them to keep helping to feed the world.

In Sui et al. (2011) paper, they tried two treatments of fertilizing, fertilizer alone and fertilizer + manure, in Northeast China to see which treatment is better at decreasing soil erosion. They also found that manure is very beneficial in "reducing the harmful effects of soil erosion processes". One strategy that we can take from this study is that instead of letting the manure dry

outside, farmers can use it to mix with their usual chemical fertilizer and improve the quality of fertilizer, which could help their farms to be more productive.

Agreeing that manure application increased the soil productivity, Aoyama et al. (1999) stated that with their experiment on manure usage in Canada, they showed that "long-term manure application increased the concentration of both particulate and mineral-associated organic matter in aggregate fractions." As shown in this study, there are many ways that manure can benefit the soil, if used accordingly depending on the type of soil and weather, in addition to water resources. The fact that farmers will need to learn about how their soil would react if there is manure application, or how much manure should they use to make it at its best productivity level should also be studied, because again, this is not a one-size-fits-all solution, but it is a trial-and-error method instead.

One way that the report from Livestock Research mentioned regarding making good use of their manure is that farmers can also sell their manure to their neighboring farmers if they have a surplus because it is relatively cheaper than other kinds of intervention for healthier crops. Farmers could save a lot from spending on fuel because they do not need to irrigate the soil or farms as much if they have included great manure use into their production process. Being able to manage their manure better could also save farmers some time to do other income generating activities because manures can save on time spent on biomass collection. This research included a great section on barriers for farmers to correctly use their manure, such as lack of knowledge, in addition to having limited access to credit for some smaller farmers, illiteracy, lack of labor, and the inability to handle liquid manures in a non-mechanised environment.

Yes, manure management seems to be greatly beneficial as mentioned so far. However, is it only the manure that is important in this process? Is it for sure that if we have great manure

management, then our soil is going to be sustainable and productive? Mikha and Rice (2004) seem to raise this question, and this should be given attention too. "[..] it is unknown if the effects of reduced tillage and manure addition on the distribution of Carbon and Nitrogen among aggregates are additive.[...]" Their study found that manure significantly increased the proportion of aggregates. As a result, to be able to use manure correctly by applying it to the current farm's soil could help improve the quality of soil, which, therefore, could then lead to an increase in farming production for farmers.

Conclusion and recommendation

As Dan and Margaret mentioned, composting is important for sustaining their farm. Manure management can be one way of composting that is effective for both cost saving, and eco-friendly if practiced correctly. Farmers in Polk County could adapt some of the strategies that farmers in other countries have done, such as vermicomposting in India, Cuba, and the Philippines. Vermicomposting seems to be practiced not only in these three countries, but also in many other places, mainly because it is not too costly to operate, and it does not involve too many technical strategies to practice.

An ideal practice to manage the manure in Polk County would be the combination of vermicomposting, consistent application of manure, in addition to using the mix of chemical fertilizer and manure that farmers can get from their livestocks, and a limited tillage approach. However, there are constraints and consequences that farmers need to be aware of. One of them would be the fact that most farmers prefer using liquid manure by pumping the manure because it is faster to be digested into the soil structure. This process would release so much methane and other greenhouse gases that are harmful to the environment. This is a long-term harm, and

because farmers also need to make a living, they might not give it too much weight when it comes to deciding what they should do to have agricultural products to sell. As a result, this can also be a shared responsibility of the Ministry of Agriculture or other Education institutions to come help farmers to feed the world. This can be performed through having educational programs by coming on-site, or some kind of informal meetings at a farm and make pizza together, for instance. It would not be as productive if all these great results of what can be done to make great use of manure are only published in papers and not practiced in the field.

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Anya Ptacek
Alternative Agriculture Paper
Group 3A
October 3rd, 2017

Global Irrigation Techniques and their Implications on Farming Practices in the United States

Introduction

Water access is increasingly one of the most extreme issues of our modern world. Nowhere is the issue of water access and conservation more heavily felt than agriculture, both locally and commercially. In comparison to other major countries in the world, the United States is one of the most wasteful countries in terms of water usage at 216 trillion gallons per year. Brazil, which falls right behind the United States, wastes around 95 trillion gallons per year (UNESCO-IHE, 2016). It is crucial that we begin to look at what other countries are doing to conserve water in their agricultural practices if we want to continue being leaders in the global produce market. What are the most successful irrigation practices across the globe and how can we implement these techniques in the United States? This paper will analyze this question by using Common Harvest Farm of Polk County Wisconsin as an example of how a small CSA (community share agriculture) farm can implement more conservatory irrigation methods. Although this paper focuses on a small scale farm in a small county, it has implications for farming practices across the United States.

When researching sustainable irrigation practices, it became evident that water transportation was not the only important factor. Soil organic matter (SOM) plays a crucial role in the retention of water at the root zone of a plant. There are multiple ways that farmers can increase SOM around their plants, including no-tillage and maintaining fallow vegetation cover on top of the soil. Assessing SOM can be extremely telling in what type of irrigation systems should be implemented on a farm. Success in conserving water through SOM has been seen

across southern Brazil, Nicaragua, Honduras, and Guatemala. In conjunction with research on SOM and water retention, this paper analyzes the success of Israel's drip irrigation methods. Drip irrigation technology has been widely adopted across the globe and has proved to reduce water usage while increasing crop yield. This paper discusses the importance of using both drip irrigation technologies and increasing SOM around plant root zones. Lastly, this paper makes suggestions as to how policies in the United States can change to aid farmers in conserving water while increasing yields.

Methods

The research for this paper was done through multiple stages. Farmer Dan visited our classroom to give us a lecture on soil ecology and the issues that farms across the globe are facing due to a massive decrease in SOM. At this point, I was aware that I would not be able to attend the fieldtrip that the class took to personally visit Common Harvest Farms. However, I was able to ask Farmer Dan Guenthner questions about the specific challenges that Common Harvest Farms faces in terms of water conservation and irrigation. Subsequently, I was able to get in contact with Dan via email and interview him about further specifics. Farmers Dan and Margaret Guenthner outlined some of their primary concerns in transporting water to their crops which became the basis for how this paper was researched and formatted. Their insight led me to finding and analyzing relevant literature such as studies done by Netafim, the first Israeli irrigation company. The purpose of this research was to compare the success of a few international case studies with Dan's previously outlined issues in Polk County. Additionally, I looked at water reports from the U.S. Geological Survey to determine the issues that are felt on a larger scale in the United States. I used this literature to make suggestions as to how Common Harvest Farms may be able to conserve water in the future, and how farmers across the United

States can implement more sustainable practices. I used literature directly from Netafim's website (the Israeli drip irrigation company) to gather the most accurate data.

Findings, Analysis, Discussion

Across the globe, water scarcity can be pinpointed as one of the most crucial issues of our time. In researching the most problematic consumptive uses of water, it is evident that poor agricultural practices can have a major effect on the amount of water that is wasted per year, both locally and globally. Two primary issues can be identified when analyzing the main uses of water for agricultural purposes: inefficient use of rainfall and poor irrigation practices. Inefficient use of rainfall can be ascribed to a decrease in soil organic matter (SOM) that is occurring globally and can lead to serious impacts on crop yields due to multiple factors. Poor irrigation practices similarly can harm crops by leaching nutrients from the soil and draining aquifers and other future sources of water. As populations expand and the development of economies continues at an exponential rate, the necessity for clean water is more crucial than ever. At the same rate, groundwater is being polluted, aquifers exploited, salinization is occurring, and wildlife habitats are being destroyed (FAO, 2017). In Polk County Wisconsin, Common Harvest Farm is working to avoid many of these issues and deter water waste as much as possible.

After interviewing Common Harvest Farmers Dan and Margaret, it is evident that their primary issue concerning water waste is due to the difficulty of maintaining nutrients in the root zone of a plant. They suspect that this is because the sub-soil on their farm is very coarse and gravel-like, which means that it is also very porous. Water moves very quickly through this material and beyond the root zone of their crops. Dan wrote in an email, "The challenge for us is to hold onto the water we receive in order for plants to take full advantage of the available rain water or irrigation" (2017). Dan has found that he needs more organic mulches to cover his soil

in order to retain more moisture, keeping the soil cooler for longer and breaking the pathway to evaporation (IBID, 2017). This is a technique that corporate farms in the United States tend not to use, and simply pump more water from aquifers instead. The method that Dan has found useful on his farm is actually widely practiced across South America and is effective because it utilizes ecologically sound farming practices to build up SOM and subsequently conserve water.

SOM affects the health as well as chemical and physical properties of soil. It simultaneously influences soil structure, moisture, holding capacity, and nutrient availability. SOM can also impact the way that soil is effected by synthetic fertilizers, pesticides, and herbicides (Derpsch, 1993). Due to these factors, a one percent increase in SOM allows soil to hold up to 20,000 gallons more water per acre. Different methods to increase SOM include reduced tillage, keeping plants in the soil year round, and integrating livestock into crop rotations (Bryant, 2015). In drier areas, up to 40% of rainfall is lost as runoff. Although this is a natural occurrence, runoff from rainfall is exacerbated by common agricultural practices such as burning crop residues and over-tillage. In Southern Brazil, farmers undertook a no-tillage method to combat water waste and were able to increase filtration from 22 millimeters per hour to 45 millimeters per hour. Similar practices were observed in Guatemala, Honduras, and Nicaragua, in which methods of conservation agriculture such as keeping fallow vegetation as soil cover resulted in a 3-15% increase of retained water. Figure 1 demonstrates the percentage of water

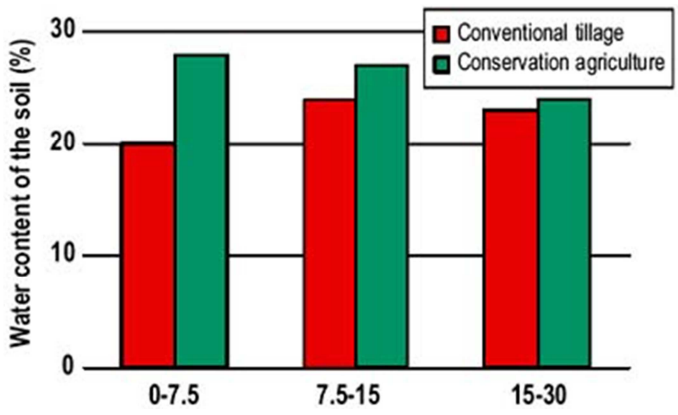

Figure 1 Water Saved through Conservation Agriculture
Source 1: Gassen and Gassen, 1996.

that can be saved when implementing conservation agriculture as shown by case studies in Southern Brazil, Guatemala, Honduras, and Nicaragua (Derpsch, 1993).

Although conservation agriculture is an excellent method to reduce water wastage and increase crop yield, it should not be the only measure taken to do so. Consequently, Farmers Dan and Margaret should also look towards more ecological irrigation methods. Currently, Dan and Margaret use drip irrigation in their high tunnels which is extremely efficient, but use a two-inch pipe with sprinklers in their crop fields. Due to their size, they are not able to obtain an adequate water supply to deliver the recommended one inch of water per week per crop (Guenthner, 2017). Irrigation techniques developed in Israel may serve to help Dan and Margaret expand their current irrigation practices and help them to conserve water while increasing crop yield.

Netafim, the namesake of modern drip irrigation practices, was founded in 1965 as a way to face the challenge of farming in the water-scarce and arid region in Negev. Their products have since been exported all over the world to help grapes grow in California, sugarcane in Brazil, and Bananas in Colombia. Drip or low-flow irrigation is used by only 5% of farmers worldwide, while 79% of farmers continue to use the flood irrigation methods. Researchers from Kansas State University write about drip irrigation, "The inherent ability to apply small irrigation amounts can allow better water-efficient decisions about irrigation events near the end of the cropping season (Lamm, 2002). Drip irrigation technology uses flow regulation, automations, control valves, filters, and emission filters to ensure that the roots of the plants get the optimal amount of water as seen in Figure 2. Farmers using this technology have reported that they save 25%-75% of water compared to more demanding

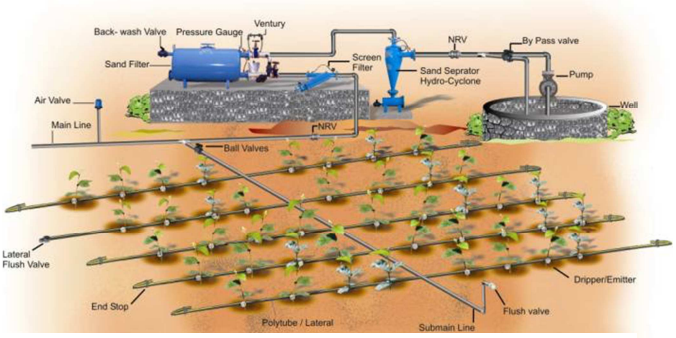

Figure 2 Drip Irrigation System
Source 2: SFAC Kerala, 2017

irrigation methods. Farmers also have to use less pesticides and because of this, aquifers remain less contaminated (Netafim, 2017). Most notably, while Israel's climate has gotten drier every year, their population has expanded by 10-fold and their economy has grown 70-fold since 1948 with a 9% annual increase in gross national product per year (Schuster, 2017; JTA, 1973). Israel's agricultural economy plays a large role in this, jumping from $20 million in agricultural exports in 1948 to over $140 million in 1967 (Kurtzig, 1969).

Despite its success in Israel, drip irrigation does have some disadvantages that are important to address. For instance, Netafim has only reported the success of their technology in horticultural rather than polyculture farming practices. While they boast the success that drip irrigation has had across both subsistence and commercial farming, they don't have case studies that show how farmers can use the technology to accommodate many different plants on the same plot of land. Additionally, some researchers are concerned that while drip irrigation allows water and fertilizers to be more accurately delivered to the root zone of crops, it may actually increase water consumption in some situations. Professor Frank Ward who teaches at New Mexico State University writes that because crop yield is higher and plants are healthier, water consumption may actually be increasing with drip irrigation. There have been few studies that look at rates of water retention in drip versus flood irrigation, and it is very likely that there are more faults with drip irrigation than we originally perceived (Schuster, 2017).

Overall, if monitored and implemented correctly, the potential benefits of drip irrigation far outweigh the potential disadvantages. Netafim writes, "The argument that drip's efficiency increases water usage and yields, thereby leading to greater aquifer depletion, does not point to the drawback of drip, but rather a failure in water resource management" (2017). Indeed, one of the reasons that Israel has experienced such great success with water conservation is that they

have one central water authority that mandates and regulates water usage. In contrast to this, the United States has hundreds of different water authorities. With so many varying authorities, it has been nearly impossible for states to be coherent with any of their water policies in the U.S. The success with drip irrigation in Israel demonstrates a potential and very promising path that American farmers can take to reduce their water usage and increase their crop yield. However, if American farmers are to implement this method they must also be cautious of the percentage of SOM in their soils and push for more coherent water conservation policies throughout the states.

Conclusion

Even a simple internet search for international agricultural success stories demonstrates a wide range of practices and technologies that the United States has not yet implemented. Conservation agriculture is becoming more population in the U.S., but tends to be more broadly used by smaller farms. On the other end of the spectrum, drip irrigation is quite common in the U.S., but is primarily used by commercial farmers who are only growing one or two varieties of crops. If both methods were implemented and regulated appropriately, it is possible that maximum water conservation could be achieved. This would allow farmers to retain the greatest amount of water for the longest amount of time while maintaining a high crop yield. The literature above shows how crucial it is for American farmers to follow in the footsteps of places such as Israel and southern Brazil, where farmers have already discovered the long-term benefits of water conservation.

Dan and Margaret mentioned that they although they use drip irrigation technologies in their high tunnels, they have not been able to transport the recommended one inch of water per week per crop to their plants. They also talked about the soil quality in Polk County as extremely course and gravel-like. For Polk County to conserve as much water as possible, it is necessary to

use a mixture of both drip irrigation and increase SOM in their soil by tilling as little as possible. Although conservation agricultural methods such as no-till require more manpower, if used in conjunction with drip irrigation, it will increase the water retention in their soils so that they will be able to use less water overall and obtain a higher crop yield. Dan and Margaret have the potential to become role models for both local and commercial farms across Polk County, and across Wisconsin as well. Lastly, it is crucial for water authorities across the U.S. to adopt coherent policies that promote water conserving irrigation practices to aid farmers such as Dan and Margaret. Policies should incentivize good water practices by allowing farmers who use said practices to put a "water used responsibly" label on their produce much like an "organic" or "pesticide free" label. This would aid farmers as well as allow consumers to have a choice in the matter. Feeding our growing population relies heavily on the conservation of water, and it is crucial that we switch to more sustainable practices before it is too late.

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Creating a Sustainable Nutrient Management System from an International Lens

Introduction:

Soil nutrient supply plays a vital role in soil fertility and food production, however increased oversupply of soil nutrients, most particularly nitrogen, has resulted in issues of leaching, and soil imbalance. The inefficient use and excess application of nitrogen has impacted soil, water and air quality, biodiversity and human health (Goulding et al., 2007).

Improved pasture management systems are a pathway to increasing food production whilst minimizing waste, maintaining economic profitability and reducing environmental impacts. In addition, the integration of livestock and crops can create efficient nutrient recycling systems. Here, animals use crop residues as feed and the manure produced can be directly used as a fertilizer. Manure is beneficial in that it maintains soil structure, water retention and drainage (Rotz, 2005, p. 2140). Livestock are also beneficial in controlling weeds and this has shown to save up to 40% of costs of weed control (Goulding et al., 2007)).

In a natural ecosystem nutrients are recycled however with increased harvesting of crops, nutrients are being taken away from the soil. This is enhanced with water-borne sewage systems that interrupt the nutrient cycle and introduce a linear cycle moving nutrients away from soil and into nearby water sources (“Nutrient Cycle,” 2012). How can farms create sustainable nutrient cycles whereby most of the nutrients are being recycled back into the agricultural system. Another important aspect is ensuring that these systems can improve air quality, nutrient use efficiency and farm economics (Rotz, 2005, p. 2139). A prominent issue for the Community Supported Agriculture (CSA) farm we visited in Polk County is creating a sustainable nutrient system, whereby nutrient losses and inputs of inorganic fertilizers are reduced. Given that Polk County farms are challenged with linear nutrient systems that do not allow the recycling of

nutrients back into their agricultural systems, what sustainable nutrient management systems in the world, in regard to food production and livestock, can Polk County farms adopt? I give examples of nutrient cycles developed in the Netherlands on an experimental farm De Marke, as well as regulatory policies such as Mineral Accounting System (MINAS) to control nutrient levels. In addition, I examine the concept of Integrated Soil Fertility Management implemented in Zimbabwe.

The objective of this paper is to develop ways in which, internationally, farms can broaden their knowledge on soil stewardship. It takes into account that farms exist in different biomes that experience different climatic conditions which in turn affects the way soil is treated. However, understanding how these knowledge systems exist is beneficial in examining farmers' knowledge system in Polk County.

Research Methods

My research includes speaking extensively with farmer Dan Guenther to understand the main challenges the farm faces. He also provided background knowledge on their soil management system, the type of soil they have and the type of fertilizer they use. I used a number of online resources including articles from academic journals. Main source of information came from essays and articles from Agricultural departments at different universities and large world organizations such as the Food and Agriculture Organizations of the United Nations.

Findings, Analysis, and Discussion

Human alterations to agriculture have led to excess amounts of nutrients in aquatic systems and lack of nutrients in agriculture ("Nutrient Cycle," 2012), this has led to application of artificial fertilizers especially macronutrients nitrogen, phosphorus, and potassium whilst

having a lack of micronutrients (“Nutrient Cycle,” 2012). Proper recycling of manure nutrients for crop production can provide balanced amounts of nitrogen and other nutrients thus tackling issues of decreasing soil organic matter content and deficiencies of micronutrients (IAEA, 2008, p. 91). In my findings I look for strategies that encourage balanced nutrient application. Thereby looking at methods that carefully control the implementation of nutrients in order to decrease excess nutrients that are then carried on to water bodies. In addition, these methods encourage practices that reduce the flow of nutrients into water bodies, such as encouraging intercropping as opposed to tilling, and controlled manure application as opposed to increased synthetic fertilizers.

De Marke Experimental Farm

Due to Dutch government policies in 1985 to restrict the use of nutrients in dairy farming, De Marke Experimental farm was created to minimize external inputs of fertilizer in order to increase the use of manure and homegrown feeds (Rotz et al., 2005, 2146). Main concept includes shortening grazing periods through the implementation of rotational grazing and reduce synthetic fertilization by using manure. Due to risks of nitrogen leaching under pastures of sandy soil, De marke implemented a grazing strategy of rotational livestock. This reduced frequency of urine and dung patches. In addition, to reduce external fertilizer, manure nutrients were collected in barns and used later on crops (Rotz et al., 2005, p. 2147). Rotation was beneficial in reducing organic matter build up whilst improving maize growth. Eleven hectares of permanent grassland and four hectares of rotated grass and maize. Part of the maize was harvested as ear silage. This showed to be suitable for cows and older heifers as energy, protein and potassium concentrates of the maize were low and the fiber concentration was high (Rotz et al., 2005, 2147).

Results showed the De Marke system to be beneficial as nitrogen fertilization (from slurry, clover and residue of grass sod) levels at De Marke were 40% lower than on commercial farms. Important components in De Marke are “enclosed manure storage, manure application by injection and 175 kg N ha -1 of mineral fertilizer applied to grassland” (Rotz et al., 2005, 2154). In result this reduced volatile nitrogen levels and reduced leaching and denitrification losses by 50% (Rotz et al., 2005, p. 2154).

Farms in the United States can follow this model by paying particular attention to nutrient levels, soil nutrient needs and nutrient application. It is important to note that over application of manure also possess issues of nutrient imbalance. Therefore, soil testing, before the application of manure, is essential to assess current nutrient levels. Farms must apply manure at a rate that does not exceed nutrient requirement to limit NH3 losses (IAEA, 2008 p. 97). In addition, the farm should assess the requirements and costs of manure storage, manure application equipment and manure processing. The CSA farm we visited uses some cow manure as fertilizer however because these cows are often borrowed it reduces the stability of this source of nutrients. Here the Integrated Soil Fertility Management System can be beneficial to small farms to ensure crop productivity throughout the year.

Integrated Soil Fertility Management

Developed in the late 1990’s and early 2000’s by the Tropical Institute in Nairobi, Integrated Soil Fertility Management was created to improve soil fertility whilst integrating concepts of local sustainability, economic profitability and improving land management practices (Sommer et al. 43). ISFM works on the main concept of combining the application of inorganic fertilizers and organic residues to increase resource use efficiency (increase in crop

yield per unit applied nutrients) (Sommer et al. 45). Therefore, its main aim is to increase returns per unit input and not per unit area.

The soil fertility management practice is centered around integrating local knowledge systems, using fertilizer and organic inputs in combination with improved germplasm (Sommer et al. 44). The figure below shows the relationship between how with each addition of these components (local adaption, Germplasm and fertilizer and organic resource management) resource use efficiency increases (Sommer et al. 44). Another advantage of ISFM is that it allows for more flexibility. Farmers are not restricted to a set order of implementation, instead the order of adopting components is decided by the farmer (Sommer et al. 44). This creates greater accessibility to the concept as farmers can start with what they have or what they can access first and then proceed how to implement other components in accordance to when they can access them.

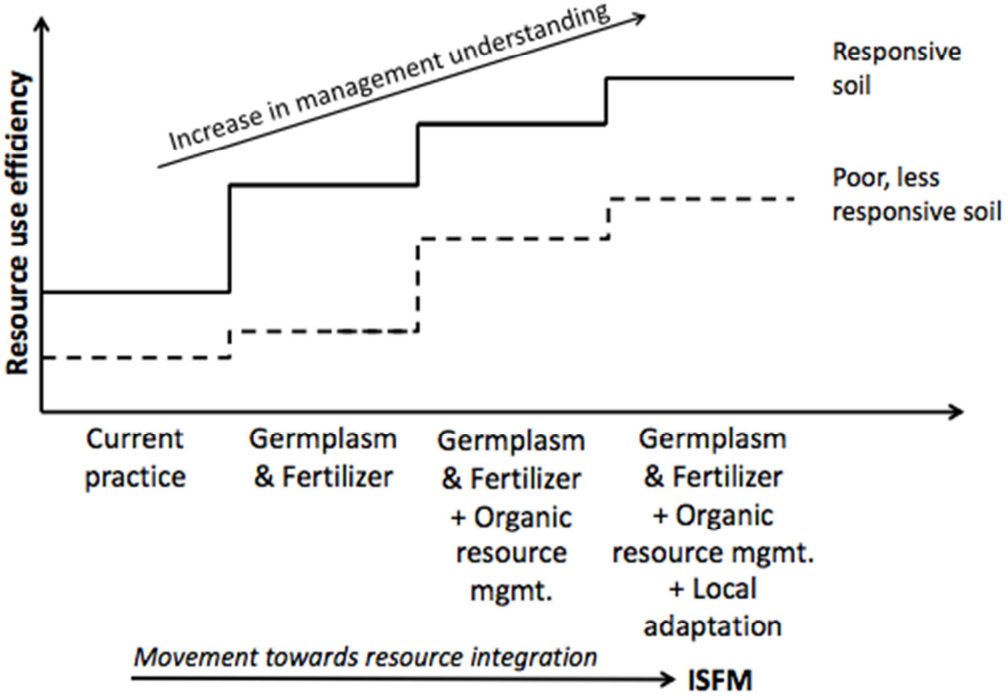

Figure 1: ISFM in Zimbabwe

An example of ISFM implementation is in Murehwa, Zimbabwe. The aim is to restore the soil fertility of degraded fields by using a combination of mineral fertilizers and manure. In the results it was found that fertility was determined by the proximity to homesteads (Sommer et al. 49). Due to smaller responses on fields further away this demonstrated that other factors may have been limiting yield (Sommer et al. 50).

Farms in the United States most specifically the CSA farm we visited can implement this integration of manure and mineral fertilizers. Because the CSA farm we visited has relatively sandy soils solely relying on manure may not be highly beneficial and therefore integrating controlled amounts of mineral fertilizer can ensure crop productivity. CSA is not a dairy farm and only borrows 4-5 cows from neighboring farms therefore it has limited access to animal manure. The integration of cow manure and mineral fertilizers helps counter issue to reduce reliance on manure. When cows are borrowed the farm can collect manure to let it age. Whilst it is aging farms can inject mineral fertilizers into the soil. This improves soil quality as there is not an excess amount of mineral fertilizers. Furthermore, ISFM encourages intercropping, use of germplasm thus discouraging processes such as over tilling that expose soils and causes nutrients to drain away with runoff.

As a whole the ISFM model does hold a few constraints. Implementation of ISFM requires high labor, skilled management and limited profitability in the short term (Sommer et al. 49). Ensuring a sustainable amount of organic matter is difficult especially on farms operating at low production. In addition, the scarce amount of organic matter is often used in producing animal feed, fuel and as a fiber (Sommer et al. 48). Though this can be beneficial as acting as a major source of fuel for example. Another challenge to consider is that nutrients content and

quality of organic matter may be low (Sommer et al. 48). In addition, unpredicted time release of nutrients requires more inputs of labor by farmers. Using organic matter produced on farms improves on- farm nutrient recycling and efficiency by reducing loses, however, these constraints should be taken into consideration when implementing ISFM.

Conclusion:

Due to increased use of fertilizers, the use of organic manures is suppressed as a strategic form of sustainable nutrient recycling. De Marke farm and ISFM demonstrate the current re-evaluation of the importance of managing all nutrients in the soil, not just nitrogen, to enhance efficiency. Though there are a number of issues that arise when solely relying on organic matter as demonstrated in De marke, ISFM shows a potential pathway of using both organic and inorganic fertilizers to ensure soil stewardship whilst still ensuring reliable food production. The use of animal manures has the potential to provide adequate nutrient supply however it is still important to recognize some of the constraints with livestock and its impact on land, climate change, water and biodiversity.

Nutrient management is vital in maintaining food security and effects on the environment. Policies that restrict excess application of non-organic fertilizers can help in securing long term quality soil and reduce possibility of leaching. This is similar to policy set in the Netherlands, the Mineral Accounting System (MINAS). Here farmers that exceeded the amount of nutrients farmers were allowed to put into soil were taxed (Ondersteijn, 2002). This created new innovations such as De Marke experimental farm. A policy to control livestock can include limiting or setting guidelines on the amount of manure a farm can use.

Because federal programs are based on yield, farms with higher yields have access to more federal funding and therefore have the economic means to purchase land with the most

favorable type of soil. On the other hand, upcoming organic farms such as the CSA are largely composed of (sandy) soils this means that they drain water very quickly however dry out quickly and are low in plant nutrients. This often leads to increased practices of over tilling. This shows that policies that are going to be placed need to be inclusive and require participation of all farms organic and non-organic to enhance possibility of being effective. Here the US government should incentivize farmers to follow these practices by expanding federal programs to farms that demonstrate good stewardship and healthy crop productivity.

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9 October 2017

Energy in Agriculture: Sustainable Practices from Around the World

Introduction

Agriculture around the world has become increasingly energy intensive. Now, global food production systems consume thirty percent of all of the world's available energy supply (FAO, 2012). In agriculture, energy is used not only to irrigate crops, power tractors, and process foods, but many synthetic fertilizers require fossil fuels (primarily natural gas) in order to be manufactured. Even more, the U.S., in recent years, has increased investment in its ethanol production. Today 30 – 40% of the U.S. maize crop is reserved for corn-based ethanol (Runge, 2016). With the addition of land devoted to growing crops for ethanol, new carbon stocks from previously untilled soils are being released into the environment and more fertilizers are being applied (Wright et al., 2017).

In addition to high energy consumption, agriculture also generates high energy waste. Around forty percent of energy consumed in global food production is lost due to food that is simply thrown away or wasted. In fact, the world discards one-third, or 1.3 billion tons, of all the food produced each year. Yet, three billion people throughout the world lack access to reliable and modern energy supplies for heating and cooking, and 1.4 billion people have little to no electricity access. For these people with limited access to electricity and sustainable energy sources, chances of obtaining food security prove unlikely (FAO, 2012). In order to meet global food demands, increase food accessibility, and minimize impacts on climate change, the United States needs to improve energy efficiency in its agricultural production. In other words, it must reduce its reliance on fossil fuels, which are limited in supply and contribute significantly to

greenhouse gas emissions, and, rather, seek out renewable energies and adopt less energy intensive methods in food production.

Many countries around the world have implemented sustainable farming and energy conservation techniques. In this essay, I ask and provide several solutions to the question, "What are the challenges faced by farmers in Polk County, WI, my study area, and what lessons may be applied from other countries to address their issues?" With biomass management and intensive irrigation being two major energy consumers in farming, I identify sustainable agriculture developments from Cuba, Israel, and India, from which Polk County, WI farmers and the larger United States agri-food industry may learn valuable lessons and adopt into their practices.

Methodology

To gather information for this paper, I visited Common Harvest Farm in Osceola, WI and researched popular news articles, academic literature, and intergovernmental agencies' reports pertaining to energy efficiency in international farming techniques. The hands-on experience garnered from the visit to Common Harvest, in addition to the discussions in-class and at the farm, provided key insights on typical challenges faced by farms in Polk County, WI and alternative agricultural techniques that could address these problems. To learn of more recent innovations and successes in sustainable agriculture methods, I surveyed popular news articles seeing as some of these agricultural approaches are rather new and have not been researched formally. I also consulted academic literature and intergovernmental agencies' reports such as those of the Food and Agriculture Organization of the United Nations to gain more specific data on farming techniques, their implementation, and suitability for addressing the agricultural issues faced by farms in Polk County and the larger U.S.

Findings, Analysis, Discussion

Cuba - Renewable Energy

According to a 2014 report by the Finland Futures Research Centre at the University of Turku in Finland, Cuba has shifted its focus in energy development in recent years from subsidized oil imports to renewable energies, particularly energy sourced from biomass (Käkönen et al., 2014). By 2030, the country aims to produce 24% of its electricity from renewables. This push for renewables stems, not from concerns about climate change, but from Cuba's economic crisis and the growing importance of its service sector (Fieser and Dezem, 2016).

While Cuba is shifting toward renewable energies, it still relies heavily on fossil energy in its electricity production today (see Fig. 1). It generates around half domestically, primarily through oil-powered thermoelectric plants, and half imported from Venezuela as part of a trade deal made with President Hugo Chavez. The country receives nearly 90,000 barrels of oil a day from Venezuela, paid for in loans, grants, and the barter of 20,000 Cuban medical professionals who now work in Venezuela (Fieser and Dezem, 2016). Such dependence puts the country in a vulnerable position, subjecting it to shifts in the international political landscape. In fact, Cuba's current and former economic crises are a result of this dependence. In a July 2016 address to the country's Communist party, Raul Castro mentioned "a contraction in fuel shipments" from Venezuela, and a February report from Bank of America Merrill Lynch, disclosed that Cuba had accrued $15 million in debt by the end of 2015 (Fieser and Dezem, 2016). To avoid the mistakes of its past, Cuba is expanding its local energy and food production, especially in renewable energies.

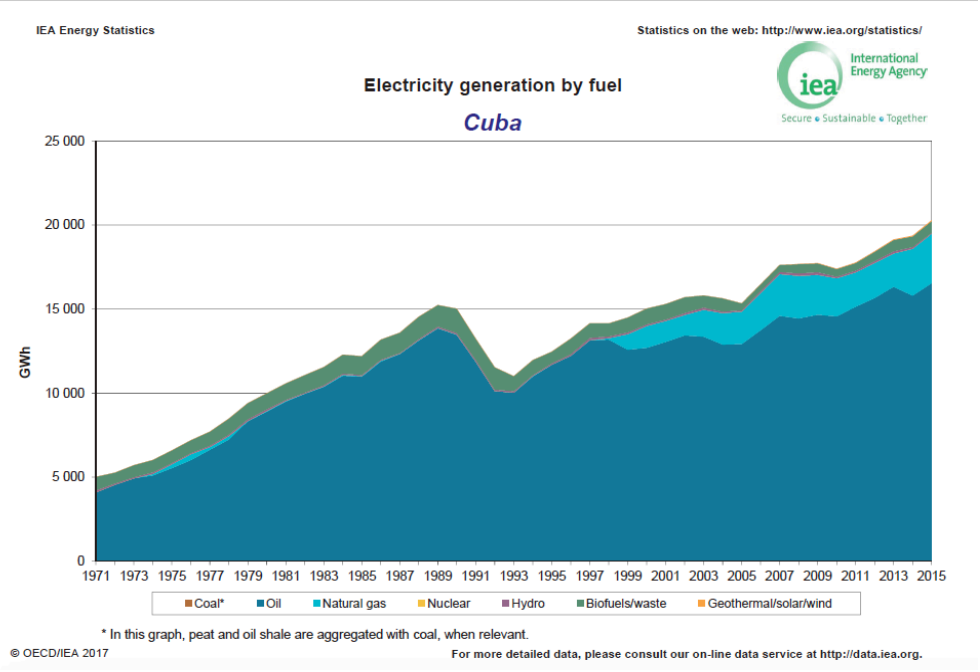

Figure 1. Cuba's electricity generation by energy source, 1971 – 2015.
Source: International Energy Agency, 2017.

According to researchers, Cuba contains high potential for renewable energy production, especially from bagasse, the fibre leftover after sugarcane is crushed (see Fig. 2). Of all of Cuba's renewable energy sources, bagasse is the most widely used. In 2009, it comprised 16 – 20% of the primary energy production, 3% of the total energy in electricity production, and around 80% of the renewable energy in electricity production. Bagasse, which is mainly used to generate the energy necessary for manufacturing sugar and ethanol, has a greater capacity to produce energy for electricity than these figures indicate. Currently, much of the available sugarcane residues are burned to facilitate the manual harvest of sugarcane stalks rather than to generate energy (Käkönen et al., 2014). In 2012, Havana Energy, a UK-based start-up chaired by the former Labour MP Brian Wilson, signed a joint venture agreement with Zerus, a subsidiary of Cuba's state-owned sugar monopoly, to form Biopower. According to the agreement, Biopower will produce renewable energy with sugar cane bagasse and marabú, a hardwood brush that has come to overrun much of Cuba's arable farmland. Although the company planned

to pilot the first 30 MW power plant attached to the Ciro Redondo Sugar Mill in late 2016, Biopower just started building the pilot plant in early 2017 due to issues with financing. Later, the company intends to phase in four more plants at different sugar mills around the country (BBC, 2011; Marsh, 2017). Nelson Labrada, the Cuban Vice Minister of Sugar, says "This strategy of using sugarcane bagasse for power generation avoids one of the primary problems with other biomass sources, which is supply…. In Cuba it is possible via the sugar mills and bagasse-based power plants to generate up to 40 percent of the energy needs of the country today" (BBC, 2011).

Figure 2. At the Ciro Redondo sugar mill, a tractor hauls sugarcane bagasse. Source: Reuters, Ciro Redondo, Cuba, February, 9 2017.

In addition to bagasse, Cuba contains another promising biomass material for energy production called marabú (see Fig. 3). Marabú is an exotic and hearty invasive species that has taken over much of the idle farmland in Cuba. While the origins of marabú's introduction into Cuba are unknown, it is estimated that around 2 million hectares, or about eighteen percent, of the country's land is covered by the woody shrub (Käkönen et al., 2014; The Economist, 2017).

Cuba ships around 40,000 – 80,000 tons per year of "artisanal charcoal" derived from marabú to countries in Europe, the Middle East, and, as of January 2017, the U.S, where it likely will contend with mesquite as fuel for barbecues. (Käkönen et al., 2014; The Economist, 2017). Despite its "artisanal charcoal" exports, most of Cuba's marabú supply is not in productive use. According to Cubaenergía, one of Cuba's leading renewable energy research organizations, around 900,000 to one million tons of the menace crop could be harvested each year for energy production (Käkönen et al., 2014). Marabú possesses long-burning properties. Three tons of the weed yield the same amount of electricity as one ton of fuel oil (Käkönen et al., 2014). Even more, marabú may be heated and transformed into activated carbon (used in water filters and decaffeinated coffee). Priced at up to $2,400 per ton, marabú as activated carbon is five times more expensive than the rate it fetches as barbeque charcoal (The Economist, 2017).

Figure 3. Marabú shrubs lining the road in Ciro Redondo, Cuba. Source: Reuters, Ciro Redondo, Cuba, February 9, 2017.

Although still in their early stages and facing concerns with financing, Cuba's bioenergy production technologies show great potential for reducing the country's reliance on oil-burning power plants. The United States could employ similar practices, turning its agricultural waste

into power. Rather than grow corn for starch-based ethanol production, the U.S. may use its corn crops to feed people and animals, reserving the cellulosic stover, or stalks and leaves of corn plants, to produce ethanol.

This line of thinking may also be applied to livestock manure management. Traditionally, North American farms were dominated by integrated mixed crop and livestock farming, wherein small-scale farmers had a variety of crops and animals all in one location. Today, however, animal husbandry has become highly industrialized and consists largely of concentrated animal feeding operations (CAFOs). CAFOs are responsible, in part, for the massive amounts of animal waste concentrated on single farms. Livestock animals in the U.S. produce over one billion tons of manure annually. Such large concentrations pose serious waste management problems and environmental risks (Cuéllar and Webber, 2008). The waste from these facilities exceeds local demand, is too expensive to ship across the country to large farms, and emits significant amounts of greenhouse gases.

To address these problems, farmers may convert manure into biogas through microturbines and anaerobic digestion, a biological process in which bacteria break down biodegradable material without oxygen (EPA, n.d.). The combustion of biogas then generates energy for electricity. To increase access and encourage farmers to use sustainable technologies such as anaerobic digesters and microturbines, policy makers may offer incentives such as property-tax breaks for the equipment and net-metering, a system where farmers receive lowered utility bills for the electricity they generate on their farms. Informational workshops and training sessions, enabling farmers to learn how to use the equipment, may also raise the adoption of such low-carbon practices (Webber, 2012).

Israel and India - Water Conservation Practices

Crop irrigation in industrial agriculture is water intensive and one of the sector's primary sources of energy consumption. However, drip irrigation methods, developed in Israel in the 1960s, have shown improvements in water-use efficiency in agriculture systems around the world, especially in arid; semi-arid; and dry, sub-humid zones where water is scarce. Despite drip irrigation's capacity for increasing efficiency, the agricultural approach to irrigation has not been widely adopted in the United States. Rather, many farms in the U.S. employ sprinkler irrigation such as the center pivot sprinkler system. In center pivot sprinklers, a rotating sprinkler pipe sprays water into the air at a uniform rate to provide moisture to the plants (Madel, 2016). Because water is sprayed into the air, a considerable amount of it (up to 35%) is lost due to evaporation and wind exposure (USGS, 2016). On the other hand, drip irrigation applies water at very low rates (2-20 litres/hour) directly to plants' roots through applicators that operate on or below the surface of the ground. Unlike in sprinkler irrigation systems, which wet the whole soil profile, drip irrigation wets only the area near the plant's root zone (Brouwer, 1985).

Drip irrigation is not without its problems, however. Regular cleaning of the drippers and pipes is required to ensure that they do not get clogged by algae growth or mineral buildup. While drip irrigation, in many cases, tends to be more efficient due to its precise delivery of water to the plant's roots, this does not hold true for all farms (Madel, 2016). One must consider the trade-offs for one irrigation system over the other when choosing the best practices for sustainable water-use on a particular farm.

Drip irrigation has expanded from Israel to countries all around the world looking to better manage water resources. Netafilm, an Israeli company and the global market leader in drip irrigation manufacturing, has expanded its drip systems in Australia, Egypt, Israel, and the United States, among other countries, for use in cotton production (Postel, 2012). Farmers in

India, in particular, have touted considerable improvements in energy efficiency due to the adoption of drip irrigation (Bajaj, 2011). One study conducted in the Coimbatore district of Tamil Nadu state in southern India found drip irrigation to have a significant impact on resource saving, increased crop production yields, farm profitability, and the lowering of farm operating costs in the study area (Kumar and Palanisami, 2010).

In 2015, India unrolled a plan to replace 26 million fossil-fuel-powered groundwater pumps with solar-powered ones over the next five years (Obiko Pearson and Nagarajan, 2014). The hope is to reduce reliance on monsoons for irrigation and relieve farmers of the high costs of diesel fuel for groundwater pumps. India consumes more than four billion liters of diesel and around 85 million tons of coal per year in water pump support for crop irrigation. If half of the diesel pumps in India were replaced with solar photovoltaic (PV) pumps, the country would cut its diesel usage down by 225 million liters per year, or 7.5% of the country's overall diesel consumption.

One of the issues that has been raised regarding the solar PV pumps is the cost. Despite reductions in the cost of solar module prices from $3/watt in 2009 to $1/watt in 2015, the up-front cost of a solar PV pump is around ten times more expensive than a conventional pump, or $5,000 rather than $500 (Jain, 2015). Banks in India have not approved solar PV pumps as "bankable technology" yet, so many poor and marginalized farmers may not have access to the necessary capital or loans to purchase the solar PV pumps. When examining the cost over the long term, however, solar pumps prove highly economical – able to run for at least twenty-five years with little overhead or management costs (Jain, 2015). Once banks in India enable lending to install them, the solar PV pumps will likely be a much more efficient and viable option compared to traditional diesel-powered pumps.

It should be noted that one of the risks that comes along with the switch to solar PV pumps is increased use of water. To combat this issue, farmers who accept subsidies for the solar PV pumps must use drip irrigation (Obiko Pearson and Nagarajan, 2014). In some states the government has established a net-metering system. In Karnataka, for example, for every unit of solar power sent to the electric grid, customers receive the equivalent of roughly eighteen U.S. cents in return. Already, three hundred farmers have joined a pilot program supporting this approach and voluntarily swapped their diesel-powered pumps for solar ones (Jain, 2015).

Implementing more efficient and sustainable water practices such as drip irrigation and solar PV pumps could help increase water-use efficiency in the U.S. and, in turn, save energy. A study conducted by Iowa State University researchers "estimate that corn farmers in that state would use 40 percent less water and lower their energy bills by 15 percent with drip irrigation" (Webber, 2012). While it is often implied that more efficient water-use systems increase water conservation on farms, this is not always the case. Studies have shown that increased irrigation efficiency can lead to greater intensification of profitable, water-intensive crops. U.S. policy should factor such consequences in when developing incentives for adopting these irrigation technologies and penalties for water waste.

Conclusion

Polk County, Wisconsin farmers, like many other large industrial farmers in the United States, face challenges in energy usage and cost reduction. While this essay only surveys a few techniques from other countries, they are techniques that address some of the most pressing causes of the agri-food industry's high energy consumption, including biomass and manure management and water-intensive irrigation. While such technologies and practices aid addressing issues of energy efficiency in agriculture, they alone are not the solution.

Technologies coupled with changes in consumer behaviors and government policies will help American farmers reduce energy waste in food production.

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Chapter 5:

The US has a history of transferring its model of agriculture to other countries. What can the reverse teach us? To be more specific, what farm challenges do you observe in Polk County, WI and what lessons could we take from elsewhere to try to address them?

Findings of Research Group 3b (Ana Gvozdic, Avik Herur-Raman, Miriam Eide, Ariel Hasak-Lowy)

Hügelkultur: a permaculture practice improving soil quality

Introduction

The United States has a history of implementing its agricultural practices in different parts of the world through international institutions, as in the case of the Green Revolutions. A reversed process, such as the implementation of a practice from elsewhere, could be proven useful for the United States. This paper focuses on the mid-Western region of the United States, as a region of critical importance for not just the economy of the United States, but for the meat and grain exports worldwide (Hathfield, 2012, p.3). The landscape of the region has been changing significantly since the 1820s through lumbering, agriculture and urbanization, resulting in the loss of savannas, prairies, wetland systems, permanently flowing streams, and habitats, as well as water pollution (Andersen, 1996, p.263). On a more local level of the Common Harvest Farm in Wisconsin, the farmers are struggling with ensuring soil quality, mainly in terms of preserving the organic matter in the soil. Drawing on a German permaculture practice called "hügelkultur", this paper will answer the following question: "Would the hügelkultur practice be suitable for the Common Harvest Farm and address their issues related to soil quality?". In order to answer this question, this paper will present the basics of hügelkultur, explain how it can be build, and assess its suitability and efficacy, primarily focusing on its implementation at the Common Harvest Farm.

Research

The research for this paper started with a lecture presented by Dan Guenthner from the Common Harvest Farm, which contextualized their farm into the wider mid-Western context, informed the audience about the community supported agriculture (CSA) model and shared some of the challenges that their farm is facing. The lecture was supplemented by a visit to the farm on September 16th, which helped us visualize the space we are dealing with, get

first-hand experience of the agricultural practices and soil quality, as well as ask additional questions. The process of finding a practice from elsewhere, which would be useful for the Common Harvest Farm or any other farm facing similar challenges, started long before this paper through my encounters with those involved in permaculture. Having sparked an interest in me, I did some basic internet research in order to identify a practice that could be proven useful for the particular context I was dealing with. However, considering that the field of permaculture is not very well explored scientifically, it was almost impossible to find peer reviewed scholarly articles on the topic, which poses a great limitation to my paper. Nevertheless, I recognized value in exploring various books and websites written about hügelkultur, considering that these platforms are used by people to share their real-life experiences in practicing permaculture.

Analysis

What is hügelkultur and how do you make it?

Hügelkultur, translated from German to “mound culture”, is a gardening and farming technique that uses woody debris (Miles, 2010) to create no-dig raised beds. These beds are created by piling up logs, branches, leaves, grass clippings, straw, manure, compost and topping it all with soil (Inspiration Green and Permaculture Magazine, 2017). These materials are organized starting with the largest of the biomass debris, the logs, as the first layer, followed by branches, sticks and twigs to a height of about 3 feet. The formed structure resembles the shape of a pyramid, with the sides of the two slopes between 65 and 80 degrees. (Holzer, 2012, p.131-134,139). The smaller material is then used to fill in the spaces between logs, twigs and branches. Over the final layer of soil, one may also add mulch (Miles 2010).

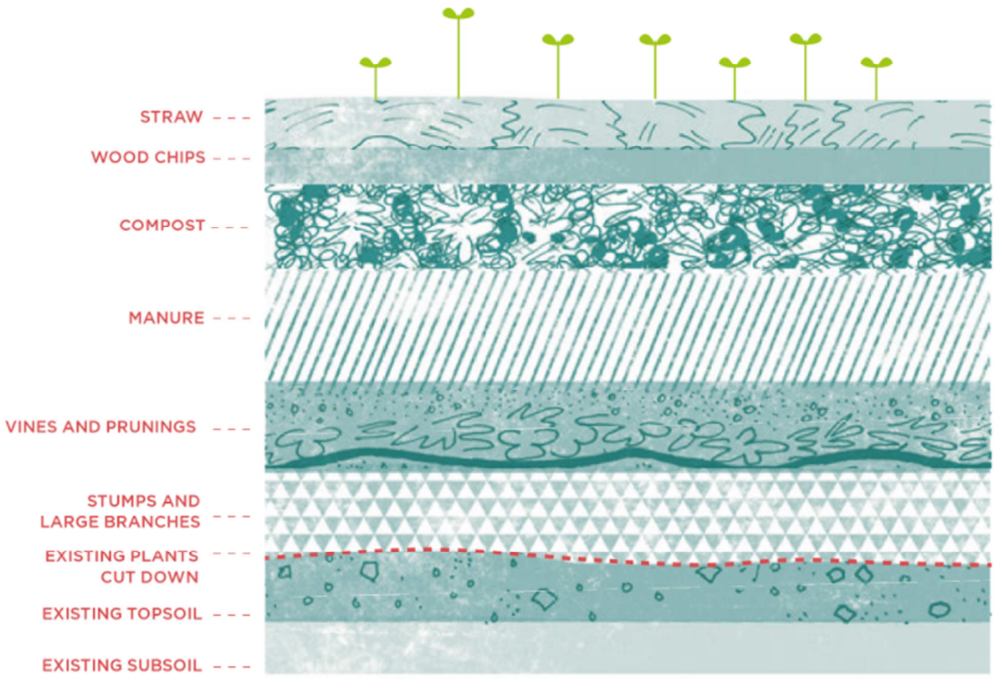

Figure 1: The layers of a hügelkultur bed (Schein, 2013, p.28)

What are the benefits and the drawbacks of using hügelkultur beds?

Hügelkultur provides various benefits by mimicking the natural process of nutrient decomposition that occurs in woodlands (Miles, 2010). This gradual decay of wood is a consistent source of long-term nutrients for the plants (Inspiration Green and Permaculture Magazine, 2017), meaning that the use of fertilizers is not needed (Hemenway, 2009, p.84). However, breaking down of carbon from the wood requires a lot of nitrogen, which is why the hügelkultur mounds are supplemented by manure and compost. Because hügelkultur is made out of woody materials, it retains a lot of moisture (Schein, 2013, p.28), acting like a sponge, hence requiring little, to no watering and irrigation (Inspiration Green and Permaculture Magazine, 2017). The hügelkultur can even release some of the rainfall into the

surrounding soil, making moisture available to nearby plants (Miles, 2010). The decomposing organic matter in hügelkultur raises the temperature, warming up the soil, and thereby prolonging the period during which the soil can be used (Hemenway, 2009, p.84). Additionally, the hügelkultur is supposed to increase the soil aeration as the material is being broken down, meaning that the soil would not require any tillage (Inspiration Green and Permaculture Magazine, 2017).

However, there are many counter-arguments for the use of hügelkultur, especially due to the fact that there are no peer-reviewed, scientific studies to back up the efficacy of hügelkultur. Some promote hügelkultur as a practice based on biological principles, but further explanation for that claim cannot be found. Actually, Professor Chalker-Scott claims that hügelkultur is at odds with the ecological principles behind soil building through litterfall (2017, p.3). Furthermore, the aforementioned need for a large use of compost and manure to compensate for the loss of nitrogen, can actually lead to releasing excessive organic nutrients, which could in turn contaminate the soil and water habitats (Chalker-Scott, 2017, p.3).

Another concern regarding hügelkultur deals with its efficacy – the amount of food that can actually be produced on it. While those in favour of hügelkultur claim that it can produce more than traditional flatland planting, speculating that 100-200 square meters would be enough to sustain a single family, professor Chalker-Scott disagrees with this idea, pointing out that single-family needs about a million calories per year, which typically requires more than 10 times the size of the proposed hügelkultur use (2017, p.4). On the other hand, Dan Guenthner provides an example of a practice similar to hügelkultur, involving organic raised-beds in Cuba. According to the information provided on their website, the “La Finca Agroecologica”, the raised beds, together with the strategic use of plants and animals, enable them to not only produce an abundance of food for their family, but also operate a

restaurant (Green Nooz, 2012), meaning that, in their experience, the raised beds are more than capable of sustaining a family.

Would this practice be suitable for the Common Harvest Farm?

While it is arguable whether hügelkultur can feed an entire family or how efficient it is, this paper argues that this practice is worth trying on the Common Harvest Farm, for its supposed benefits could address some of the farm's challenges. First of all, as a farm situated in the mid-West, a region with rather long and severe winters, they are unable to produce some plants such as sweet potatoes, since they require long seasons. They could benefit from a practice which extends the time period during which soil can be used through the soil-warming properties resulting from wood decay. Considering that preserving the organic matter in the soil is the greatest challenge that the farm is facing, and that they are trying to address this issue by refraining from aggressive tillage and the use of chemical fertilizers, the features of hügelkultur, which increase the soil fertility and aeration as a result of decomposition, seem to fit in well with their view of the farm. Having in mind that the region in which the farm is located currently faces dry periods during every season, and that they are not able to irrigate the entire farm very quickly, hügelkultur beds that don't require watering or irrigation would be suitable, and considering that they can even make moisture available to the nearby plants (Miles, 2010), they could be very useful if placed strategically next to plants which require more water, or at locations which are not as easily irrigated. However, a thing to keep in mind is that, although hügelkultur would probably increase the amount of production per unit of land, it would require more labor (D. Guethner, personal communication, September 30, 2017).

How does hügelkultur compare to other practices?

There are two practices similar to hügelkultur and involving garden beds, both of which appear to be less effective. Hay and straw beds topped with mulch are used at the Garden Farme, a permaculture production collective located in Ramsey, MN. However, in comparison to the hügelkultur practice based on wood, rather than hay and straw, the beds used at Garden Farme most likely decompose faster, meaning that the benefits like water retention, warming of soil and the release of nutrients do not last as long (D. Guethner, personal communication, September 30, 2017). Another practice is so called char beds. Char or charcoal is a product created by burning woody vegetation, which when added to the soil would provide the same benefits, but for an even longer time. On the other hand, the practice of making the charcoal by burning the wood would release CO_2 in the atmosphere, which would be a symptom that the majority of the environmentalist, small-scale farmers would most probably reject, considering that the emissions of CO_2 contribute to global warming and climate change. (D. Guethner, personal communication, September 30, 2017)

How easy would it be to implement this practice at the Common Harvest Farm?

Considering that all of the material is easily accessible on the farm, it should be rather easy. There are branches and woody materials across the farm, compost is already being made and used, and there is space for at least some hügelkultur beds on the farm. The farmers' interest in the practice, as well as their openness to the idea of students conducting their research projects on the farm signifies that there would be no shortage of labor for the implementation of this practice. Additionally, the concept of hügelkultur could be taken even further by planting fast-growing trees on the marginal parts of the land, to utilize a resource that is currently not being used, as well as ensure the sufficient amount of woody debris for building the hügelkultur bed in a better planned manner.

Conclusion

The exchange of ideas from a different country to the United States, in this case from Germany using the practice of hügelkultur, could be proven useful, but there is a lack of scientific evidence to confirm it. Under the premise that the hügelkultur beds truly produce the benefits that the proponents praise it for achieving, such as increased fertility, water retention quality, soil temperature and soil aeration, hügelkultur would address some of the challenges that farmers of the Common Harvest Farm have, considering their desire to retain nutrients in the soil, till and irrigate less. It could even enable them to produce some of the plant types that they are currently not able to produce due to the weather conditions. As a way to further improve the hügelkultur model, it could be expanded to incorporate the growing of fast-growing trees on the marginal parts of the land, to provide a constant supply of wood and branches for the construction of hügelkultur beds. Having this in mind, this paper points out the necessity for further research on hügelkultur, as well as fast-growing trees suitable for the mid-Western region, which could advance the hügelkultur practice.

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Reintroducing Polyculture Cropping

Introduction

Agriculture in the United States of America faces an uncertain future. The post-World War II rise of large-scale, industrial farming led to higher yields and more food. Suddenly, more Americans could buy cheaper food than ever before. But the increasing production came at a cost. Both the land and society suffered.

The traditional, subsistence-based systems utilized mixed cropping strategies and strictly organic inputs. Those time-honored practices embraced sustainability and preserved soil fertility. Farming families could feed themselves, and still set aside some of their crop for the market. That soon changed, as the lure of export markets, synthetic inputs, and crop hybridization transformed agriculture into a purely commercial enterprise. Wealthy corporations muscled families out of the business. New, expensive technologies consumed vast resources while degrading the environment. In the Midwest, crop diversity declined. Today, corn and soybeans dominate the landscape, especially in Polk County (Guenther, 2005).

Located in Wisconsin's St. Croix River Valley, Polk County's situation reflects the general agricultural problems plaguing the U.S. In the early twentieth century, the principal crops of hay, oats, potatoes, and corn, were complemented by a variety of vegetables and dairy products. (Andersen, et al., 1996). As local farmer Dan Guenther observed, perennials and small greens once covered two-thirds of the land. Now, thousand-acre monoculture farms, filled with annuals like corn, are the norm. Before World War I, soil fertility relied on the energy of the sun. Nitrogen fixation occurred in the natural soil bacteria found in the roots of leguminous plants (Pollan, 2006). The Haber-Bosch process, which fixes nitrogen synthetically, cut out legumes and other species entirely, and allowed farmers to start raising only single crops. The resource-

intensive fertilizers require massive amounts of fossil fuels. After its application, the excess fertilizer infiltrates water tables, flows into bodies of water, poisoning ecosystems, and creating dead zones (Pollan, 2006). Though highly responsive to fertilizer, hybrid crops' productivity drops off in successive generations, trapping farmers in a constant purchasing cycle each planting season (Moseley, et al., 2013).

Growing in a monoculture setting immediately wipes out the gains of hybridization and genetically modified (GM) crops. Insect pests easily find and prey on monoculture hosts, forcing farmers to use chemical pesticides. The large-scale, industrial production of single crops significantly changed U.S. animal husbandry, with around 60 percent of a commodity corn bushel used to feed livestock (Pollan, 2006). The rise of concentrated animal feeding operations (CAFOs), made grazing chicken, pigs, and cattle on a diversity of cover crops, like hay and oats, unnecessary. Despite the environmental and economic consequences, federal subsidies continue to encourage farmers to grow monocultures, even as the environmental damage mounts.

In recent decades, a backlash emerged in the form of community supported agriculture (CSA). Common Harvest Farm, a forty-acre CSA farm founded in 1989 by Dan Guenther and Margaret Pennings, rejected the industrial status quo. On their 18 acres of tillable cropland, they utilize polyculture cropping strategies to grow 40 different vegetables and herbs, with a focus on carrots, tomatoes, green beans, and potatoes (Common Harvest Farm, 2012). Polycultures, a method of diversification in agricultural systems, entails growing two or more crop species and wild varieties within a field (Lin, 2011). Guenther and Pennings' devotion to responsible soil stewardship bears resemblance to traditional agriculture practices found in Latin American and African countries. The mixed record of transferring the United States' industrial agriculture to other countries calls for a new approach, and for the reverse to happen. The CSA model raises a

crucial question: How can the reintroduction of polyculture cropping, and the adaptation of foreign practices, occur in Polk County and the United States' agriculture? What benefits will it bring? The answer lies in an investigation of polycultures throughout the world.

Research Methods

In early September of 2017, Dan Guenther and Margaret Pennings invited us to tour Polk County and their own operations. Guenther explained how farm consolidation and corporatization contributed to the rise of monocultures in the upper Midwest, and squandered the natural fertility of the area. Common Harvest Farm, one of the few CSA sites in the County, lacks ideal soil conditions. And yet the couple's strict adherence to organic inputs, and avoidance of aggressive, unsustainable agricultural practices enables them to grow polycultures. Margaret Pennings described the daily operations of the farm, and meticulously recounted the difficulties and rewards of serving a community. Dan Guenther's intimate knowledge of the surrounding lands and their farmers' experiences provided us with essential information. He revealed the realities of U.S. agriculture, and the dangers of monocultures from both an ecological and financial standpoint.

For my research into U.S. agriculture's dismal current state I consulted various sources. Professor Moseley's work on human-environment geography and his many opinion articles proved invaluable. Michael Pollan's *The Omnivore's Dilemma*, gave an entertaining and informative view of U.S. agriculture's glaring contradictions. A few chapters deal directly with monocultures. I delved into academic articles and official reports on the polyculture and agroecological techniques of Latin American and African countries. The United Nations' Food and Agriculture Organization published many of the proceedings from their Rome workshops. The researchers analyzed major issues and concluded with sound policy proposals.

Findings, Analysis, and Discussion

In Polk County, small-scale farming is disappearing. The trend characterizes agriculture throughout the United States and the Global North. The total number of farms in the lower St. Croix valley peaked in 1935, with average sizes of just over 100 acres (Andersen, et al., 1996). According to Dan Guenther, in 2017, the largest farm in Polk County exceeds 4,000 acres. Less than two percent of the overall U.S. population works in agriculture.

In the Global South, small, family-owned plots of land still remain viable. Traditional agriculture, practiced by about 2.7 billion people, provides one-fifth of the world's food crops (Moseley, et al., 2013). While traditional systems encompass a wide range of strategies to grow food, they uniformly avoid high external inputs. Intensification might require less human labor, but the reliance on external inputs works against nature. Agroecosystems, which cover more than one quarter of global land area, take greater advantage of work usually done by ecological processes associated with higher biodiversity (Altieri and Koohafkan, 2004).

Western anthropologists and agriculture experts only recently started viewing traditional polycultures as an effective technology for managing agroecosystems. Paul Richards' 1985 book *Indigenous Agricultural Revolution* recognized the ingenuity and innovation behind West African peasants' farming experiences. The renewed attention given to traditional farming systems now extends to Latin American countries. For decades, development banks and international entities alike promoted the model of intensive agriculture. The World Bank, International Monetary Fund, and World Trade Organization all agreed that concentrating on higher yields of cash crops and monocultures brought prosperity (Moseley and Watson, 2016). Many developing nations abandoned their traditional agricultural practices altogether.

Academics and experts refer to the areas where the traditions endured as globally important ingenious agricultural heritage systems (GIAHS).

Billions of humans across the continents thrive off polyculture cropping. Despite the claim that only single-crop fields can feed humanity, polycultures constitute at least 80 percent of the cultivated area in West Africa, while in the Latin American tropics, even staple crop production occurs in polycultures (Altieri and Koohafkan, 2004). The dependence on mixed-cropping strategies makes sense. Plant diversity increases stability. In the U.S., since 1978, the decrease in crop diversity has made widespread crop failures more likely (Aguilar, et al., 2015). In Polk County, the demands of corn and soybeans sapped the soil of much of its organic matter, which originally stood at eight percent. Dan Guenther and the other CSA farmers stopped the downward spiral from becoming permanent, and stabilized the amount of organic matter. However, the percentage is still dangerously low. A number of studies show that greater plant diversity within agricultural plots can yield higher production, with some reporting polyculture yields surpassing monocultures by an average of 73 percent (Lin, 2011). In the Sahel region of West Africa, intercropping benefitted local farmers for generations. A practice long overlooked by outside researchers, government agricultural extension agents, and policymakers, intercropping with certain shrub and tree increased yields of millet and peanut by more than 50 percent (Winterbottom, et al., 2013). None of the farmers needed to utilize fertilizer inputs. On top of the greater crop yields, the shrubs stimulated microbial activity in the soil, augmenting nutrient cycling during the forbidding dry seasons (Winterbottom, et al., 2013).

The rise in organic matter also serves as a buffer to extreme climate changes. Monocultures' vulnerabilities to temperature and precipitation have crippled agriculture in the upper Midwest. The drought of 2012 exposed corn's weakness to drought, as the lack of rainfall

during its cross-fertilization period sealed its fate (Moseley, 2012). U.S. consumers might avoid the immediate consequences, but the rest of the world, especially countries in Africa, must endure steep rises in food prices. In Malawi, the traditional staple crops of sorghum and finger millet came under attack from both colonial and postcolonial governments. The government actively encouraged corn production, despite both grains' superior performance under drought conditions (Bezner-Kerr, 2014). Sorghum all but disappeared from Malawi, though currently some farmers are attempting to reintroduce it. Sorghum, grown in a polyculture setting with finger millet and other crops, suited the aridity of southern African, and provided insurance in the case of a climate catastrophe (Bezner-Kerr, 2014). Droughts are not the only problems that farmers deal with. Other extreme climatic effects, such as hurricanes, can devastate entire communities. In the aftermath of Hurricane Mitch, Central American peasant farmers who used sustainable practices like intercropping suffered less damage than their neighbors (Altieri and Koohafkan, 2004). Sustainable plots had 20% to 40% more topsoil, greater soil moisture, less erosion and experienced lower economic losses than the monoculture growing farmers nearby (Altieri and Koohafkan, 2004).

Industrial agriculture production depends heavily on pesticides. The natural balance between herbivorous and carnivorous insects collapses in a monoculture setting. With polycultures, herbivorous pests, which feed on the crops, are still beset by predators. Corn-bean-squash polycultures, found in the tropical lowlands of South America, suffer less attack by caterpillars, leafhoppers, and thrips, than corresponding monocultures, because such systems harbor greater numbers of parasitic wasps (Altieri and Koohafkan, 2004). In the Cauca valley of Colombia, larvae of *Spodoptera frugiperda* suffered greater parasitization and predation in the corn-bean mixtures by a series of Hymenopteran wasps and predatory beetles than in corn

monocultures (Altieri and Koohafkan, 2004). Without the need for constant pesticide use, the insects themselves don't build up a resistance. The pesticide treadmill, where the surviving insects pass on their traits to create a new generation of resistant insects, poses a serious threat to industrial agriculture (Moseley, et al., 2013). Eliminating the need for pesticides altogether renders the whole treadmill irrelevant. The spread of disease also becomes less likely with crop genetic diversity. Planting in mixtures may not stop the disease from occurring, but its transmission will slow and boost the agricultural system's overall resilience (Lin, 2011).

Conclusions

The many barriers of transferring traditional polyculture cropping methods to U.S. agricultural hotspots, like Polk County, seem insurmountable. Despite the challenges of converting an industrial model into one based on organic, sustainable practices, history shows it can be done. In the early 1990s, the fall of the Soviet Union and the loss of their primary export market forced the Cuban government to adopt sustainable agroecology. Labor recruitment skyrocketed, and sugar exports ceased as smaller-scale production of root crops, plantains and vegetables intensified (Woodhouse, 2010). With an 80 percent drop in fertilizer and pesticide imports, Cuban scientists and farmers turned to cultivating polycultures, producing compost, and developing biopesticides (Moseley, 2014). The increase in domestic production fed the entire nation.

In the United States, a shift to more labor-intensive agriculture could stimulate the economy and rejuvenate the agricultural sector. Hundreds of thousands, if not millions of new jobs would spring up on farms across the country. Already, economic incentives keep farmers stuck in the monoculture production cycle. Dan Guenther mentioned how cover cropping recently started to receive subsidies, $43 per acre for farmers to carpet bomb their fields with

seeds. Whether it works has yet to be seen. In the same way, a reconfiguration of incentives from the federal government could spark a shift to organic, mixed-cropping strategies. By selecting for diversity, and consciously targeting small-scale farmers, agricultural subsidies could promote more resilient agroecological systems. Funding for crop modeling, which allows researchers to simulate crop mixtures within a specific regional setting, should accompany farmers' on-the-ground expertise (Lin, 2011). The farmer remains the most important actor in transferring foreign, sustainable practices to U.S. soil. As Paul Richards' emphasized, indigenous science and innovation surpasses anything that outside researchers might propose. If the farmers of Polk County, Dan Guenther's neighbors, receive the support they need to grow polycultures and utilize sustainability, the dream of community supported agriculture could become more of a reality.

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3 October 2017

Origins of Farming Education and Methods: Hmong v. American Farms

Introduction

When I drive outside of the Twin Cities, I see miles upon miles of corn and soybeans dotted with occasional dairy farms and clumps of trees disguising houses. This landscape continues seemingly endlessly representing the fairly uniform trends among American farmers- monocultures and increasingly commercial farms cared for by few people and big machines. However, hidden in the midst of this expanse there are smaller farms such as the Guenthner farm that grow a wide variety of crops. They are an exception to the highly mechanized, monocropping farms masking their presence. While much of the Western world is pushing for the expansion of this model, not everyone is. Many farmers such as the Hmong continue to use radically different techniques which may be more sustainable and could offer insight into new farming methods to implement in the US. The Hmong are originally from China although have been repeatedly exiled by governments and many currently live in refugee camps in Thailand after escaping from persecution in Laos and Vietnam. Throughout this paper I will compare and contrast where American and Hmong farming methods in order to explore the ways that might Hmong farming techniques potentially provide solutions to challenges faced by many American farmers today. This research has the potential to highlight new avenues of information sharing amongst farmers to improve their work particularly around sustainability.

Research Methods

In order to research the differences between American farmers and Hmong farmers I used a variety of methods. First, I developed a basis through learning the language used and a policy overview from the textbook, classroom discussions and assigned readings. Second, to further my understanding of the farms I visited the Guenthner farm in Polk County, WI in addition to hearing Dan Guenthner's overview of the surrounding large farms. Finally, I studied the research conducted by Laura Kerr for her honor's thesis: "Resisting Agricultural Assimilation: The Political Ecology of Hmong Growers in the Twin Cities Metropolitan Area." Her work provided me insight into their methods of cultivation as a point of contrast.

All of my research was qualitative as it happened within a limited timeframe and large portions of it were based on anecdote. In addition, since the majority of my information comes from limited sources or from interviewee directed settings, my conclusions may reflect the limited and self-selected nature of information. Therefore there may be limitations on the variety of comparisons and a greater frequency of broad generalizations within both categories of farmers. It is difficult to fit all American farmers into one category. Rather I sought to use both average data and discussion on the variety of farms represented. I sought to note the extent of the diversity of farming methods within each group in addition to specific methodologies which held true across the entire group.

Findings

In a tour of Polk County, Dan Guenthner recognized that the majority of farms surrounding him plant 2-3 crops and are rapidly growing to consume smaller farms. He knew every farm in detail. Historically, these farms were many smaller farms which were consolidated. In order to manage such large tracts of land, farmers plant only one crop in a given field, employ inorganic fertilizer, and use heavy machinery to care for the crops

(Guenthner, personal interview, 2017). The crops themselves were bred to thrive on poor soil and to depend on the inorganic inputs (Moseley, et al, 2014, p. 263). Although this clearly improved the yields from individual fields, the overall cost of these farming ventures increased radically. Nevertheless the costs don't include the environmental cost of production since it is not directly calculated into the capitalist model (Moseley, W., lecture, 2017). Some of the costs unaccounted for by capitalism include the degradation of soils and pollution of the watershed according to Dan (Guenthner, D.). Dan continued to discuss that historically the soil in Polk county was around 8% organic matter, while it has now been reduced to about 3% on most farms. To compensate, the farms apply massive amounts of inorganic fertilizers which ultimately run off into water sources. The lack of organic materials and soil structure due to heavy machinery contributes significantly to the rate of erosion and runoff. He demonstrated the effects of large machines constantly working the soil with his own tractor and by manually demonstrating the forces that tractors place on the soil. Fracturing the soil structure makes it less hospitable for plants and more conducive to erosion since the soil structure is denser and the particles are more fine and uniform. Finally, commercial farms have begun using more and more vulnerable land. Vulnerable land may be sloped or close to bodies of water increasing erosion.

In addition, to these massive farming ventures there are also emerging market farmers. Dan discussed these as well during the tour. Emerging market farms fill many different niche markets such as the organic food market and farm tourism. The tour passed a Christmas tree farm, a vineyard, a prairie seed farm, and an organic farm. These farms operate on a radically different in model from the commercial farms. Oftentimes they also are more aware of their environmental impact. Emerging market farmers, not uniquely, constantly battle soil quality since they export many of the nutrients from their soils and

address it in many different ways (Guenthner, D.). Based on my observations with Dan, they are more likely to use smaller equipment and fewer inorganic inputs.

Dan's farm, a CSA, follows organic farming, but is not certified. Margaret Guenthner spoke about farming as a spiritual practice that brought her closer to nature. It is clear that soil stewardship and environmental protection were fundamental motivators in her farming choices, but the certification is expensive. Their market dependent on the idea of locally sourced, sustainable produce. Dan explained their methods of caring for the soil which involve intensive care and responsible use; as a result their soil has become better than the pre-existing soil since it has a higher percentage of organic matter, composition of silt, sand and clay, and a varied soil structure. They built up the soil through turning in cover crops, avoiding tillage, and using tiling techniques that allowed the soil to break more naturally in addition to inputting green and manure composts.

When asked about where he acquired his knowledge of farming, Dan told me about his local community of farmers. Farmers within Common Harvest's community meet together frequently to share ideas and useful techniques. Margaret also added that they often find new crop varieties and planting techniques from seed catalogues and consultants at a national or international scale. However, she was quick to bring up the challenges of consultants' distance from farming. Generally, they have no direct contact with soil but rather work in a lab or office meaning that their advice more textbook than based on an intimate understanding of soils and farming (Guenthner M, personal interview, 2017). Methods used on Common Harvest Farm can be traced across the world. They came from Australia, New Zealand, Europe, and Cuba mainly with a handful of other methods originating in East Asia (Guenthner D.). The dominance of European methods interested me as it they reflect the superiority of the Global North and rejection of traditional farming ideologies.

By comparison, Laura Kerr's honor's thesis examined 10 farms surrounding the Twin Cities. Her research subjects attributed their knowledge to their ancestors. As such many farms had also picked up techniques from the University of Minnesota Extension Services which played a large role in "educating" Hmong farmers. Nonetheless, the Hmong farmers tend to place enormous value on the earth and as such avoid depleting its soil, contaminating it, and continue to remain close to the earth through labor intensive farming (Kerr).

Traditionally, Hmong farmers use swidden cultivation more commonly known as the slash and burn method (Kerr). When used correctly it can be a highly sustainable method of farming. When the soil is fallow for extended periods it returns to its natural state (Moseley et al, 2014, p. 260-1). This is not possible in highly populated areas and requires a nomadic lifestyle, neither of which are possible in the US. As a result, Hmong farmers in the US have abandoned this method. However, they still practice farming in a very communal manner. Typically the entire extended family is involved in the production and distribution process; Kerr's research reported no hired hands. Their farming techniques are highly labor intensive and dependent on the communal culture. Even after being introduced to modern farming through the University of Minnesota Extension Program (80); Hmong farmers quickly abandoned pesticides and herbicides out of concern for their family member's well being. As a result of cost and incompatibility with their methods of farming, Hmong farmers have not adopted much mechanization- at most a small and older tractor. Unlike American farmers, the Hmong use intercropping and don't use rows in order to preserve the soil and combat pests and disease. Intercropping is a method of planting mixing types of plants within the same area since they can be mutually beneficial. For example, planting nitrogen fixing plants such as beans next to crops which depend on it like corn. Intercropping also disguises plants against disease and pests since they both attack plants indiscriminately, but only certain plant

species provide food for or are susceptible to a given disease or pest. In addition, intercropping allows for more continual ground cover and varied root depths which improve soil stability thereby protecting against erosion (Moseley W., lecture, 2017).

Analysis

I expected to find many places where American farmers could learn from scaling down their farming ventures and reintroducing labor-intensive practices rather than depending heavily upon machinery and inorganic inputs to produce food. I quickly found, however, that I was comparing apples to oranges and it is nearly impossible to generalize the American farming methods.

I quickly discovered that it is hard to compare the commercial ventures to Hmong farmers since they serve different markets. The Hmong farmers serve the organic markets and mainly sell at farmers markets. Thus, their produce sells at a higher price than that of the commercial farmers who use chemicals (Kerr 2007). Theirs is the majority market, though, and switching to organic, labor intensive farming would fundamentally change our market and price structures for food. Although I would argue this is a good model long term, it is not realistic due to governmental regulations and the capitalist model.

Nonetheless, we can compare the environmental impacts. According to Dan, these corporate farms partake in the pesticide treadmill and are creating super weeds and diseases. The pesticide treadmill is a phenomenon in which farms are using increasing amounts of pesticides in an effort to stay ahead of the pests adaptations and genetic immunities to these pesticides. One result is giant ragweed which had never existed prior to its selective development as a result of herbicide resiliency. Pests and diseases, too, are becoming resistant. Farmers' willingness to sacrifice the future and safety of our world for profit is a weakness in the profit driven system. Perhaps by becoming more intimately connected with

the environment as the Hmong farmers have by involving their families in farming, we would be motivated to address this environmental slippery slope. Although unlikely at any large scale, intimacy with the land is a priority for many green movements and encompasses some aspects of the CSA model. With change in demand, these farmers may be more willing to employ organic farming methods that prioritize the land over scale of ventures.

Common Harvest Farm, as with many organic farms, is far more similar to the Hmong farms in scale and philosophy. In addition to being beneficial for the environment, profit per acre is higher on many organic farms than the commercial. While the average farm in Minnesota produces $600/acre, the Hmong farms profited $1800/acre (Kerr, 2007, p. 69). Common Harvest Farm reports over twice the Hmongs' profit per acre (Guenthner, personal communication, 2017). The labor inputs involved in organic farming is substantial and Hmong farming even more which may be reflected in the profits.

As a result of their similar philosophies, the two groups could learn from each other. To experiment, I proposed intercropping to Common Harvest Farm since it appeared to be the most notable difference between the two operations. Hmong farmers use it to combat pests and disease in addition to replenishing the soil. Dan quickly explained that intercropping would not be a suitable because the increased labor necessary from not row-cropping and having a mixture of plants with varying methods of harvesting within the same plot. The increased labor was not available and too costly for them (Guenthner D.). The Hmong are able to sustain the additional demand as a result of the communal family nature of their farms and since most of their farms are side operations while a family member works in the Cities (Kerr, 2007, p. 52). Nonetheless, I would argue that intercropping was used on Common Harvest Farm for their cover crops since they planted corn, beans, and wheat together.

The only other potential candidate for information sharing that I discovered was the Hmongs' use of traditional hand tools on their farms. Since I couldn't find specific information about their tools, I couldn't make any inferences about their potential usefulness on Common Harvest Farm. However, these hand tools likely wouldn't have a place within any but the smallest American farming operations as a result of scale.

Discussion

Due to limited access to information about Hmong farming methods, I failed to find other clear candidates for cross introduction perhaps because of my limited understanding and my timeline for research. In a deeper study or a direct conversation between farmers, this may not be the case. Nonetheless, row-cropping and intercropping are often somewhat incompatible and may limit the extent of information sharing. It may even explain why so many of Common Harvest's methods came from European or more Westernized countries.

Conclusion

The American and Hmong farmers each had clear sources for their knowledge. They derived their knowledge from those around them whether from national, collegiate, or local sources for the Americans or from family and community ties for the Hmong. While I expected to find clear ways to proffer information sharing across farms, it quickly became clear that perhaps part of the reason that Common Harvest reported most of their farming techniques coming from Western countries was a result of information sharing among farmers with similar overarching philosophies. It is challenging for a profit oriented farmer to understand the values of a communal values farmer and vice versa. As a result, without the communal culture, Common Harvest could not adopt intercropping since it put demands on their labor sources that could not be resolved reasonably. Nonetheless, even without major farm overhaul there may still exist smaller ideas that could carry over between farms.

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Progress is a Relative Term

Introduction

Coming into the field of agriculture, there were a lot of things I didn't know. I didn't know any more about agriculture than an average person in American society would. When I imagined a farmer I would imagine exactly what walked into our classroom a view weeks ago, just like Dan from Common Harvest Farm, a white middle aged man. Even though I knew that there were women farmers in this country, I knew that I was missing a lot of the knowledge of who was farming in the world and wanted to research to see what was actually happening. I thought it was interesting to use what I was learning in other classes and apply it to this class. While agriculture has a lot of focus in sciences such as soil and other farming techniques, there is also a large aspect of social, political and legal factors that are involved. I chose this topic because I knew from the brief experience I have had in agriculture that the history and current situation of farming has a lot of unique challenges and strengths in the realm of gender. So, I decided to look into the topic of gender dynamics on multiple scales: international, national and locally in Polk County, Wisconsin. The question I answer in this paper is: Who is actually doing the farming in our world and why had these gender balances gotten this way. Comparing the situation of international women to women in America, and then specifically to the smallest scale of the women at Common Harvest Farm.

Research Methods

I started my research for this topic by going back to where I saw the topic of gender in farming first in an article by Moseley & Watson (2016), through that text I found my main resource which was cited in the section titled 'Role of Women in Agriculture' which was, the ESA Working Paper titled The Role of Women in Agriculture by The Food and Agriculture Organization of the United Nations. This report gave me a basis of knowledge of gender in regards to international farming. I learned how gender was balanced, or not balanced, in different regions in the world. I also learned a lot of the vocabulary I will be using in this paper. To learn about farming in America I looked at multiple sources from the United States Department of Agriculture. I looked at the Economic Research Service report summary and the highlights from the 2012 Census of Agriculture. After learning about international and national agriculture, I had a phone interview with Margaret from Common Harvest Farm and learned about her experience in farming. Because there are so many aspects and subsections to this topic the research is majority statistics. In this paper, I try to synthesize these findings but it has proven difficult due to the deep rooted systemic oppression of women in our world, which can't be simply solved with a simple policy proposal. So, the easiest way to keep everything factual is by providing mostly qualitative research, which is definitely a drawback of the data.

Data

International Farming

First when looking into the research of international farming, I tried to get the mass statistics of who is farming in the world. But, some obstacles came up when trying to find these statistics. There is no way to know exactly who is doing the farming, mainly because there is not

only one person contributing to each crop. Each crop has many steps, from tilling the soil, planting the seeds, weeding, harvesting the crop, and many in between. If there is a different person doing most of these steps then how does one state which gender did the 'farming'? However, some patterns have been established. Certain activities have been shown to be generally done by one gender such as weeding which is mainly female worldwide, and ploughing which is a majority male activity. Another example shown in the study is tomato contract farming in the Dominican Republic which is mainly done by females.

Agriculture gender statistics vary mainly by four factors: crop, production cycle, age and ethnic group. Because of this, depending on where you are researching the gender divisions are extremely varied. Overall, it is stated that women are doing 43% of agricultural labor in the world. Sub Saharan Africa has the leading amount of female farming with about 50%, while Latin America and the Caribbean has about 20%. (See Figure 1, Appendix p. 10)

A big focus of where women are in agriculture is with aquaculture. Research has shown that women have played a vital role in this task force of raising, catching, and selling fish. In West Africa, there are women referred to as "Fish Mamas" who have been known for their major role in the coordination of the fisheries chain. There is limited data found on this topic, but studies have shown that 80% of the aquaculture workforce in Vietnam is filled by women.

In Africa, women have an unbelieveable role in agriculture. Although this trend is not uniform throughout the continent there are many studies showing women's vital role in agriculture. Shown by 80% of Cameroon's agriculture done by women, and Northern Africa's female's active time in agriculture has risen from 30 percent to 45 percent, while most other countries have stayed constant.

By looking at age there is also a distinct trend of young women supplying a high percent of the labor in the age group. Women in Rajasthan are doing 60% of the timeshare from the age group of 14 to 19 years old. Women start working at a younger age and also do the most labor in regards to household prep. Typically, this is not considered a valued source of labor because it is unpaid. However, because of this labor required from women to keep the household running, they are unable to contribute as much time to farming and other high paying jobs. Women cannot have full time jobs and therefore cannot develop skills in order to receive a higher wage. These part time and often seasonal jobs also lead to women not receiving the benefits of a full time job such as health care. These statistics show the dedication women have to working. Women represent a high percentage of agriculture in the world, and yet do not receive many benefits compared to those of men. This shows how dedicated women are to being an equal part of the work force.

In addition, women are paid less in the work force, and that does not exclude the agricultural workforce. Women in the agricultural workforce have 62% low wage jobs, 20% medium and 23% high wage jobs, while 42% of men have low wage and 30% medium and high wage jobs. Research found that women are being paid less for the same amount of labor. From a study of fourteen countries the average was shown that women are paid 28 percent less than men in rural areas. Some examples are males in Ghana are payed 58% more than females, and men in Tajikistan are paid 61% more than women in rural areas. However, the major exception is in rural Panama where women are paid 11 percent more than men (See Figure 2, Appendix p. 10). Many studies showed that women led households typically rely on labor intensive, low-tech production techniques because of their lack of wealth and education in rural areas. This

continuous cycle of lack of resources causes them to gain less of a profit than men. An example is coffee farming, where men who have means to transport their beans to the city and sell their produce gain more profit than women who do not have the means to transport their beans to high paying consumers.

The idea of feminization is being discussed in the agricultural workforce. Feminization is the concept that women are quickly gaining more positions in agriculture. There are different causes as to why feminization is occurring in different places. The economic reform in Vietnam caused men to move to urban setting, leading more women to fill their positions of farming. This trend isn't evident everywhere but is also becoming prominent in Sub Saharan Africa, with more women becoming the head of the household, currently Southern Africa has 46.5 percent female headed households. In Niger, there are 133 women to every 100 men farming in the 20-24 age group (Mali Agricultural Census, 2004). Though statistics are not certain, there is a general trend of women becoming more represented in farming. This is due to more economic opportunities for women and social norms changing, granting women more freedom to work where they want. While this is not the trend affecting all women around the world, I believe even the use of this word in the agricultural workforce shows the direction farming is leaning in the realm of gender, a slow but hopefully steady sign of progress.

American Farming

After understanding the situation of farming internationally, I shifted my focus to within America. I looked at multiple reports from the Census of Agriculture from 2007 and 2012. I learned that 30 percent of farmers in America are women. There are states that have higher rates of women farms, such as Arizona where 45 percent of the farmers are women. I then focused on

the principal operators of farms in the US. When the Census of Agriculture started in 1978, 5 percent of principal operators were women, in 2007 that number had risen to 14 percent. Women own 6.9 percent of the farmland in America, but only make 3.3 percent of agricultural sales. In 2007, Only 5 percent of women-operated farms had sales of $100,000 or more. There have been a decrease in farmers in America from 2007 to 2012 by 4 percent, however women farmers decreased by 6 percent. The average age of a woman principal occupator has increased since 2007. The average age in 2007 was 58.8, and in 2012 had risen to 60.1 years old. While the average age of all principal operators in 2012 was 58.3 years old. There are 693,800 women secondary operators in America, with 96 percent of their principal operator being a man, almost always her husband. There is a concentration of most female principal operators in the east coast and west coast. (See Figure 3, Appendix p.11) However, the dark blue only shows 25 percent or higher, meaning the areas that are doing the best with gender balanced primary operators, still have ways to go. This concentration on the coasts may have to do with social norms of urban settings being more open to female farmers. The acceptance of female farmers leads to more economic opportunities and community involvement which is an important way to keep a sustainable farm business.

Local Farming - Common Harvest Farm

Finally, I talked on the phone with Margaret about her experience with farming. Margaret explained to me her upbringing which was based in a farm town, where most kids were ‘farm kids’ as she said. She then went off to college and became an English teacher. She lived in a small town in Central Minnesota and where she was a recipient of small agriculture but was not personally farming. She met her husband Dan and eventually he decided he wanted to start a

CSA farm, “it was the future” Margaret said about CSA farming. So, Margaret gave up her teaching job even though she loved it, to help with the farm.

In the farm she fills the secondary operator position. This means, she is a part of the 96% of women secondary operator who have a man as their primary operator, and that man being her husband. Margaret packs the boxes and delivers them to customers. She also cooks lunch every day from the fresh crops on the farm. In addition to all of this Margaret also does some work in the farm, she says her favorite activity is to hand weed. This relates to the research shared earlier, women overall doing more work because of their household responsibilities. Also stated was weeding as a primarily female associated task. Margaret said that she enjoyed doing this work because she felt she had a choice in the matter. So, while she does not feel oppressed into being forced to do these tasks, she is supporting almost all of the statistics found in prior research. I do wonder how much of Margaret’s responsibilities are a coincidence and how many have overlapped with the previously stated statistics because of growing up in a gendered society.

Conclusion

When I asked Margaret if she could even think of a time when she was discriminated against for being a woman in the workforce of agriculture she could not. I think Margaret’s story provides an interesting perspective. While she is supporting a majority of the research I found, she stated that she is completely autonomous in the decision of what labor she does. This brings up the question, what is the goal for all women farmers? If a woman enjoys cooking and other household responsibilities, why are we looking at these statistics negatively? Are we fighting to get household labor to be paid for? I think another perspective is important, is Margaret able to

say that she is completely autonomous in this decision while there are systematic oppressions that have led to these roles being gendered?

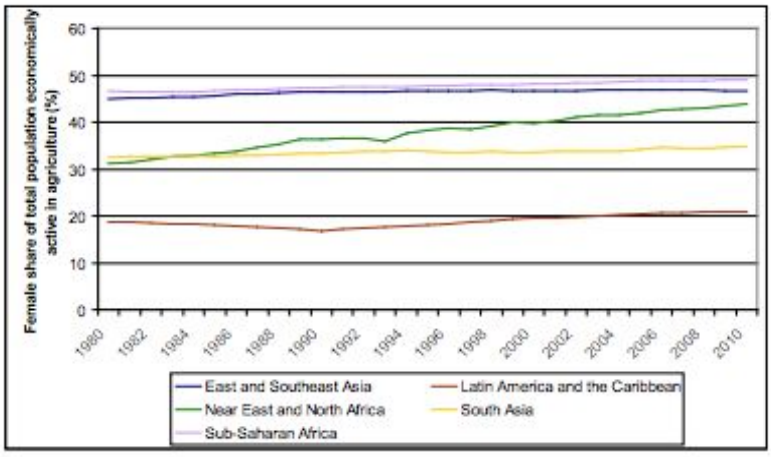
This issue of women in agriculture seems to be explained by the Matrix of Domination, a feminist theory introduced by Patricia Hill Collins. This theory states that "Additive models of oppression are firmly rooted in the either/or dichotomous thinking of Eurocentric, masculinist thought" (Hill Collins, 1990). Using this theory to relate to this phenomenon shows that women aren't purely not getting paid as much because they are women. The oppression of their social class and gender intertwined with the oppression of capitalism which only values certain kinds of labor creates this distinct new mode of oppression, which causes women to not earn as much money as men while doing more labor. Even if they do enjoy the work, they are still being oppressed through all these different modes of oppression. Looking at this issue in this light complicates the issue by explaining that you cannot see this issue as a women's issue but intertwined in so many other systems of oppressions that need to be torn down before this issue can be solved or even helped.

I don't see a simple policy proposal as possible in fixing this; but rather a shift in our systematic society. Society needs to value household work either shown through social norms or through societal action such as paying women more so they reach wage equality with men. I believe that women that are in part time positions because of household responsibilities should be paid more than they are in order to acknowledge the labor they are doing in the home as well. This would cause many values of our society to shift. But I do believe that it would promote progress in social equality and change social norms.

I don't believe there is a way to have a single conclusion from this research. While the amounts of women farming has increased in some places, women's wages and the amount of money their farm is producing is still extremely low. Some regions such as Sub Saharan Africa have higher rates of women farmers, while other places such as Ghana are facing hard wage gaps in rural areas. The idea of feminization has spread and the general trends are that women representation in farming has either stayed the same or is rising. In addition, this research looked at relatively recent years in terms of how long humans have been farming for. If the research started with the beginning of agriculture, I'm sure great strides would be seen. This does not excuse the lack of progress but maybe shows the potential for even more progress as the years go on. Hopefully, students writing this research in fifty years will have a clear conclusion of positive trends for women in farming all around the world.

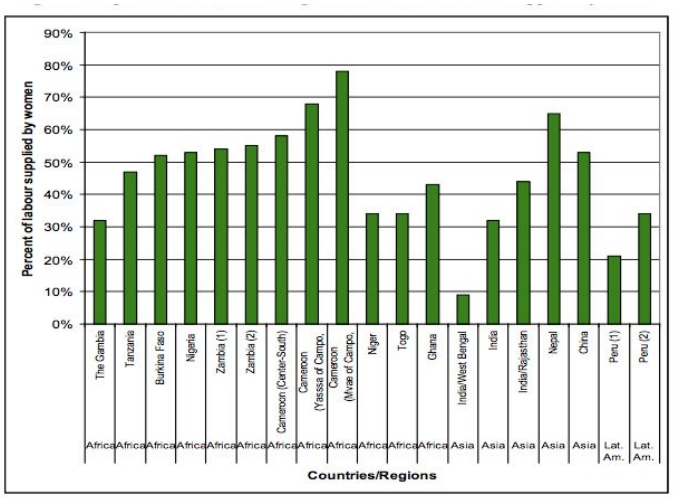
Appendix

Figure 1: Female share of the agricultural labour force



Source. FAOSTAT. Note: The female share of the agricultural labour force is calculated as the total number of women economically active in agriculture divided by the total population economically active in agriculture. Regional averages are weighted by population.

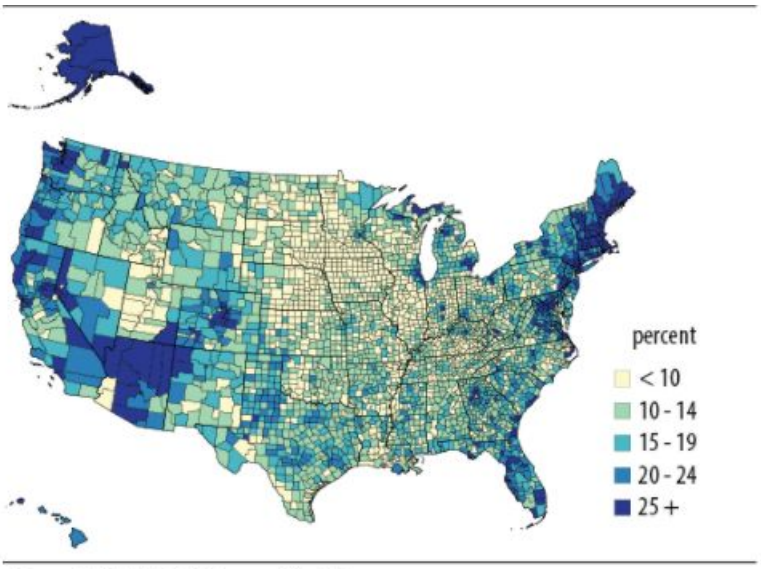
Figure 2: Proportion of labor in all agricultural activities that is supplied by woman



Sources and notes: Only the survey for India is nationally representative. Sources (from left to right): The Gambia: von Braun and Webb (1989); Tanzania: Fontana and Natali (2008); Burkina Faso: Saito, Mekonnen and Spurling (1994); Nigeria: Rahji and Falusi (2005); Zambia (1): Saito, Mekonnen and Spurling (1994); Zambia (2): Kumar (1994); Cameroon (Center-South): Leplaideur (1978), cited by Charmes (2006): Cameroon (Yasssa of Campo, Southwest): Charmes (2006) based on Pasquet and Koppert (1993 and 1996); Cameroon (Mvae of Campo, Southwest): Charmes (2006) based on Pasquet and Koppert (1993 and 1996); Niger: Baanante, Thompson and Acheampong (1999); Togo: Baanante, Thompson and Acheampong (1999); Ghana: Baananate, Thompson and Acheampong (1999); India (West Bengal): Jain (1996); India: Singh and Sengupta (2009); India (Rajasthan): Jain (1996); Nepal: Joshi (2000); China: De Brauw et al (2008); Peru (1): Deere (1982); Peru (2): Jacoby (1992)

Appendix (continued)

Figure 3: Farms with Female Principal Operator, by Country, 2012



Source: USDA NASS, 2012 Census of Agriculture.

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Phone Interview with Margaret from Common Harvest Farm, 9/30/17

Chapter 6:
What are the costs and benefits to particular approaches to more sustainable farming in the upper Midwest? What are the chances of some of these practices being incorporated into the forthcoming 2018 farm bill and how might they be implemented more broadly?

Findings of Research Group 4 (Samuel Jakshtis, Emma Heth, Vivian Bauer, Aubrey Arnt)

Samuel Jakshtis
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People, Agriculture, and the Environment
9/29/17

Tiling in Agriculture and the Environment

Introduction

Commercial farming's endless endeavor to feed society in the most efficient manner is rapidly destroying the environment. A majority of society has a comprehension of the dilemma, but fails to find a solution. The various practices incorporated into commercial farms—organic included—are subtly creating an inhospitable planet, while the government turns the other way because there are a scarce number of alternative methods. One such practice that is practical, but detrimental is tiling—used in most large agricultural fields to drain excess water from areas with a higher water table.

Tiling in American agriculture was invented in 1838 in Geneva, New York; John Johnston, a Scottish immigrant, was able to buy 112 acres at a remarkably cheap rate because people believed the land was too wet to cultivate. He remembered the clay tiles that had been used for such occasions in Scotland. Johnston negotiated with Benjamin F. Whartenby, a local potter, to have them reproduced. Once the style was satisfactory for Johnston, he installed them underneath his fields to redirect the water, and make the soil arable. John Robortella, writer for *Democrat and Chronicle* remarks, "Johnston installed Whartenby's tiles on a 10-acre plot—a swampy bog where only a mere five bushels of wheat per acre had been harvested previously. Those 10 acres produced 50 bushels per acre instead of five" (Robortella, 2015). A New York City Banker bought a tile production machine from London and contracted with Whartenby that one-quarter of all tiles produced would be his, while the remaining seventy-five percent could be sold on the free market. Tiling took off, and soon became one of the most common practices in agriculture.

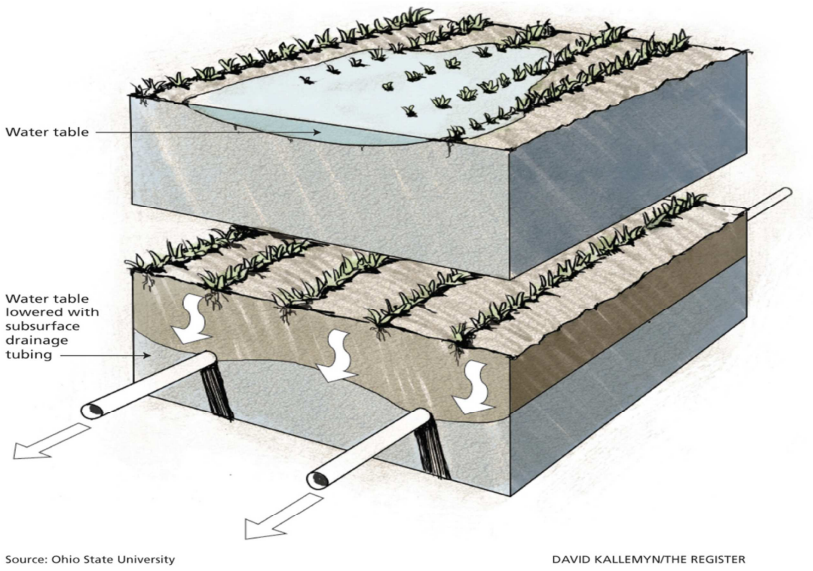
Every farmer has a powerful economic desire to make the most out of their land, gain the highest yields, an boast the best crops. However, not all land is meant to support crops. Tiling is one of the few practices that changed that mindset; farmers began to believe that even the harshest land, with sharp slopes, clay soil, and high water tables just needed to be manipulated for the benefit of the farmer. Drainage is one of the most crucial aspects to a respectable crop, and subterranean drainage is one of the most effective methods. Engineering a field to have small slope that directs the water to a ditch on the edge of the field is effective, but brings a list of negative effects.

Tiling is just a drainage method, but what it drains is contingent on what the farmer sprays, plants, and injects into their fields. Tiling condenses large areas that may not have a noticeably high concentrate of chemicals into alarmingly compact mixes of near-hazardous waste. The plants on the farm can withstand the chemicals for a couple of reasons: 1) they are genetically modified to do so, and 2) the chemicals are evenly spaced to harm only the natural plants (weeds). The drainage ditch is led to a stream, connecting to a river, which dumps into an ocean. Figure A represents the basic concept of tiling.

This problem has not gone unnoticed, in fact numerous lawsuits have been filed against counties for their leniency against the pollution associated with tile draining. Many have argued that the forthcoming 2018 Farm Bill needs to address tiling and pollution. However, there is a significant loophole; although tiling is primarily a practice used by farmers, and is directly related to farmers enhancing their yields, tiling—and drainage for that matter—has been deemed a water and pollution problem, not an agricultural one. Thus directing farmers to the Clean Water Act. The Clean Water Act is vague, misleading, and doesn't directly give regulations to drainage operation, giving farmers a free pass. In section 404 of the Clean Water Act states that it is “unlawful to discharge dredged or fill material into waters of the United States without first receiving authorization (usually a permit) from the Corps, unless the discharge is covered under an exemption” (section 404, Clean Water Act). Farmers abuse the exemption piece that doesn't

hold them accountable for their environmental damages. Communities and ecosystems continue to suffer from the exorbitant amount of chemicals, but farmers are not held accountable because their drainage is in the threshold of two of the most complex bills.

Figure A



Tiling in its simplest form is healthy and actually can be beneficial for the soil; but the pesticides that are inherent in agriculture are directed via tiling to natural ecosystems. America needs food, and farmers are willing to provide, but the negative externalities that are associated with commercial agriculture are straining the entire planet. Drainage might seem to be the least of the problems, but it's the connection between the natural ecosystem and the unjust farming practices. The question then becomes: what are the costs and benefits of tiling?

Research Methods

My research methods included both library research and field work. Field work was spent interviewing and touring Common Harvest Farm near Osceola, WI. Dan Guenther and his wife Margaret Pennings operate a vegetable CSA through their sustainable farm. I asked Dan most of the questions about tiling because he primarily focuses on the farming aspect, where margaret works with selling and distributing the CSA shares every other week. I saw the comparable sizes of farms, as Common Harvest Farm is surrounded by other farms varying from their sustainable forty acre farm to large industrial farms ranginging upwards of

5000+acres. My peers and I toured the area to get a feel for the land and saw first hand the size and practices of different farms. One couldn't tell if tiling was being used for the crops for some of the farms because it is underground, it usually lasts around twenty years or more so Dan might not have known if it were installed, and the drainage could have been to the back of the field away from the public eye. Dan had also given a lecture to the class before we visited the farm, and though he didn't really touch on tiling or the Farm Bill, much of what he said is still relevant.

My second form of research was utilizing library resources like lawsuit records, newspaper articles, general farm blogs, university research reports, and the Clean Water Act and the Farm Bill of 2013. Most of it was done online because it is not a heavily discussed topic and the turnover of scholarly work is not as recent as one would hope. I did also find lawsuits involving tiling. The lawsuits were found online, but can be found in the public records. The point of finding more resources than just interviewing Dan was to connect the lack of tiling on Common Harvest Farm to industrial farms and the problems that ensue.

Findings Analysis

Small Farms

“I wouldn't be farming if I installed tiling”. Dan Guenthner said after I asked him if tiling would be beneficial to his farm. Tiling is an enormous endeavor that many family farms cannot accomplish, especially under the financial strain inherently involved in the profession. Phyllis Coulter, writer for the Iowa Farmer today talks about the economic feasibility of tiling, “tiling would cost about $700 an acre with a 4 percent interest rate over the 50-year life of the tile”, she continues later in the article, “...in order to justify the investment, it means a farmer would need to get an extra $33 an acre in return, or what amounts to an increase of 9 bu./acre for corn or 3 bu./acre for soybeans” (Coulter, 2016). Adding tile drainage as an asset to a small farm is not

possible—nor necessary—for their production. In Dan’s case, he only needs to produce enough vegetables for his 200 shareholders.

Tiling also is not applicable for small farmers because of their diversification in plant life. Not going into the environmental benefits of multi-specie farms, tiling is usually used for singular crops to keep the water table at a constant place in the ground. Corn and soybeans for the most part take up a large portion of the tiling system in America—corn does better in drier soil. Nevertheless, small farmers are still farmers, whereas large farmers for the most part are more dedicated to business than utilizing the land in an appropriate fashion. Large farmers have incentives to boost yields to gain more subsidies and more subsidies mean they will continue to produce as much as possible because the price difference will always be funded by the government. This incentive hurts not only the government, not only the environment, but is most impactful on the family farms like Dan and Margaret's. They only supply their vegetables to families in and around the Twin Cities; no government subsidies or tax breaks. Of course they would be zealous to have the land produce an abundance of crops, but that's not always possible, and they don't have a net to fall into like large farms. Dan and Margaret also don't have the tile draining to significantly boost crop production, they only have top soil irrigation which comes with its own dilemmas.

Dan was very articulate and even did a little augering to about three feet into the ground to show the quick transformation of the soil, showing the route of the roots. The problem with topsoil irrigation, especially with the siltier soil on this particular patch on Dan’s farm, is that creation of a silt cap. Silt caps develop in particularly dry times and they act as a water barrier to the secondary and tertiary layers. Erosion of the soil is a small farmer's worst nightmare as the rains will strip away the nutrient rich topsoil that is a vital part to plant growth.

Obviously there are immediate benefits to tile irrigation, but the financial costs of the investment far outweigh the benefits. Regardless of the financial ability to install tiling, small farms pride themselves on their diversification of crops throughout their land. The gap between

small farmers and large farmers will continue to rise, and not only because the financial feasibility of installing a tiling system of irrigation, but also because of ideological differences. Dan and Margaret stressed “we are sustainable and have enough to survive” meaning they are not profit-hungry industrialists shaded in cloaks as farmers. The upcoming Farm Bill will most likely do nothing to close the gap because commercial agriculture hires lobbyists to affect legislation like the farm bill in their favor; small farmers have very little representation on Washington. For now, all Dan and Margaret (and many other family farms) have for irrigation is hoping for a long steady rain that will seep into the soil.

Commercial Farms

Farming has become less about the land and more about the profits. Large farms have turned into corporations that seem more like manufacturing businesses than farms. The sheer size and money that goes through these “farms” inherently separates them from small farms like Common Harvest. However, the nuances in everyday practice make large farms look like a an entirely different entity. Tiling is only one of the numerous practices that if implemented on smaller farms would financially destroy them. Large farms hire a number of accountants to cheat tax codes and utilize every subsidy and break to preserve as much money as possible. Tiling falls under section 127 that permits farms to depreciate assets from taxes. The tax breaks and depreciation incentivizing large farms to install tiling furthers the gap between sustainable farms and industrialized agriculture.

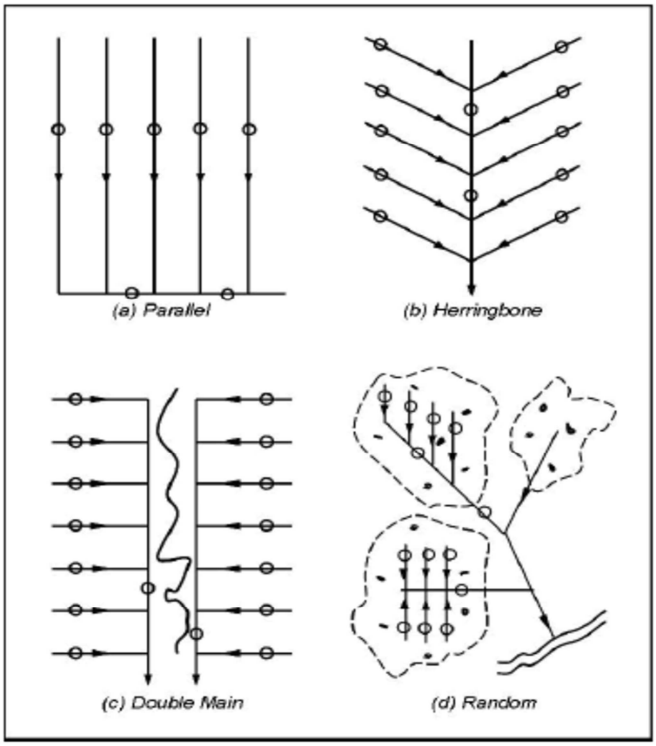
By separating themselves from the natural ecology of the landscape to follow high subsidies and more profits, commercial agriculture, tiling in particular, has done near irreversible harm to the environment. Of course it is the simplest method for draining water, and disregarding the pesticides and chemicals, tiling would prevent erosion and actually help the environment. There are many different ways tiling can be set up in a field, represented by Figure B. The truth is, if farmers are using tiling, they are most likely also using pesticides. Tiling drains

into a ditch on the side of fields then onto streams, rivers, ending in oceans. At the connection of the Mississippi River and the Gulf of Mexico is the dead zone, a place where there is very little oxygen in the water resulting in no ecological life. As Monika Bruckner, professor at Montana State University, writes “Most of the nitrogen input comes from major farming states in the Mississippi River Valley...Nitrogen and phosphorous enter the river through upstream runoff of fertilizers, soil erosion, animal wastes, and sewage” (Buckner, 2017). The dead zone is continuously growing through the abnormal amounts of nitrogen dumped into the rivers. Most of the pollution is related to the farmlands in Southern Minnesota and Iowa using tiling to control their water table—inherently intoxicating the waters. Destroying not only the dead zone, but habitats all along the way, and people have begun to notice.

Figure B: Subsurface

Figure B

Source: Iowa State



Source: Iowa State University Don Hofstrand

Lawsuits

The concentration of chemicals that is directed to the natural ecosystem through tiling is not only bad for the plants and animals of the natural environment, but it has a significant impact on the communities that rely on the environments affected. There have been numerous lawsuits, but two major legal battles that have defined the regulations, or lack thereof, of the negative externalities resulting from tiling.

One infamous lawsuit occurred in Iowa regarding the impact of the severe quantities of nitrates in the river that provided the community with drinking water. Columnist Donnelle Eller recounts the situation in the Des Moines Register: “The Des Moines utility sought to have the drainage districts, and indirectly farmers, regulated under the federal Clean Water Act as a ‘point source’ of pollution, much like businesses and manufacturing plants”(Eller, 2017). The Iowa water company is needing to invest millions in new equipment capable of handling the high levels of nitrates in the Raccoon River. The river provides clean drinking water to around 500,000 citizens and is having trouble handling an alarming rise in nitrates and phosphorus. However, Federal Judge Leonard Strand dismissed the case, writing “Drainage districts lack the broad police powers exercised by counties and other political subdivisions", he continued that the lawsuit brought up a "policy argument, not a constitutional one" (Strand, 2017). Drainage is not given a specific policy, and unless a single entity can be found as a ‘point source’ of pollution, they—commercial farms—will never be held accountable.

A second lawsuit that is worth noting is *Pacific Coast Federation of Fisherman’s Associations* (*PCFFA*) *v. Glaser*. The Fishermen argued that the exemption of the Clean Water Act from tiling is not applicable if the components draining are not a direct source for agriculture—i.e. Chemicals, and in this case the chemical selenium dwindling the fish population on the Californian coasts. However, Judge Mueller concluded that Congress, in enacting the CWA, clearly intended that “return flows from irrigated agriculture are not point sources of pollution” (Mueller, 2013). Stewart Fried and John Dillard, attorneys for Ollos, Frank, Weeda, Terman, Matz PC, co wrote an article in which they stated, “[t]his decision is a positive result for production agriculture because it confirms the proposition that owners of agricultural tile drain systems are not required to obtain an NPDES permit under the federal Clean Water Act. If the court held otherwise, thousands of farms would likely be required to obtain and comply with NPDES permits – a costly and onerous proposition”(Fried and Dillard, 2013). The decision is not positive, only detrimental. The case gives a get out jail free card for every farmer putting

hazardous amounts of pesticides in their fields that are destroying environments. The chemicals are so strong that the fishmen of California notice the population decrease, and are able to point to the problem: tiling. However, because farms skirt their way through both the Farm Bill and the Clean Water Act, the judicial system will continue to protect commercial farms from regulation.

Conclusion

What are the alternatives to tiling? Of course above ground drainage is most commonly used by small farmers, but that can create silt caps and erosion. Tiling is not hazardous, but the chemicals that are being drained through the tiling is destroying biomes. The commercial farms continue to avoid persecution because there is no explicit legislation banning the practice, nor the chemicals. The lawsuits that have involved tiling have highlighted the lack of governing for farmers using triling to divert chemicals to the natural environment. Small farmers like Dan and Margaret suffer from the ever-growing gap between sustainability and industrialism. Of course, the upcoming Farm Bill should address the dilemmas and harmful practices of large farms; however, the reality is the Bill will focus on the monetary aspects—subsidies and taxes—because lobbyists paid for by large farms will work to influence Congressman for the benefit of the few at the expense of the many. Few problems have one clear solution, and tiling is no exception. In my opinion, the best way to handle the negative externalities that are intertwined with tiling is to regulate the amount of chemicals permitted to be sprayed on a field if the farmer is using tiling. At least it will be a start, as right now there is no significant regulation for tiling. The issue needs to be extracted from the Clean Water Act, and incorporated into the Farm Bill, not only for relevance sake, but also so it becomes a farmer's issue that can handled and regulated properly. This situation proves to be dynamic as lobbying will severely hurt the chances of any regulation. In the end, it comes to America’s value as a nation to identify and solve the conundrum between sustainability and industrialism.

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Emma Heth
October 10, 2017
People, Agriculture, and the Environment
Alt Ag Paper

Diversifying America's Farmland: Integrated Livestock-Crop Farming

Introduction

Food, Inc., *Supersize Me*, and *Fast Food Nation* brought the reality of American meat production to popular culture. The publicity shocked many Americans into reconsidering their diets, and rightly so: American consumption is famously high in calories, low in nutrients, and filled with chemicals, preservatives, and additives. Many consumers focus on the demand side of the equation: eating less meat, becoming vegetarian, or only buying organic meat. While individual consumer decisions factor into the wider story of meat production, the supply side of the equation could offer a more effective solution to the problems caused by industrialized livestock farms. One option for raising more sustainable livestock is integrated crop-livestock farming, the modern term for what a century ago was called simply "a farm." Diversified farms have high potential for profitability, efficiency, and sustainability, especially in the upper Midwest. In this paper, I will investigate the following question: What are the costs and benefits to integrated livestock-crop farming in the upper Midwest, and how might it be supported in the upcoming 2018 Farm Bill and more broadly?

The two main ways to integrate crops and livestock are as a partnership formed between two farms or for spatial integration within one farm. Although farm partnerships, in which a livestock producer and a grain producer would trade manure for feed, contributes to regional diversity and a better use of resources, spatial integration restores important ecological benefits

on a small scale. Integrating livestock with crop rotation allows nature to self-regulate. Implementation could involve grazing on perennial pastures during the summer growing season and rotating livestock to graze on grain crop residues and cover crops from fall through early spring (Sulc and Tracy, 2007, p. 342). Cover crops are an essential component of diversified systems, but I will limit my discussion in this paper as one of my research partners Gaby Eck discusses them in depth in hers. Today, issues with soil health, animal health, human health, and ecology at large-scale feedlots and grain farms are leading many farmers to ask if chemicals can sustain stable and productive agriculture for generations to come. Economic and policy support for commodity crops have persuaded farmers to adopt unsustainable practices, but integrating livestock with crops substantially increases efficiency and sustainability for the environment, crops, animals, and farmer.

Research Methods

My research broke down into three major categories: academic literature, personal testimonies, and publications from national and regional organizations. Despite the high potential of integrated systems, especially in the upper Midwest, research is limited. One of my primary resources was research by Sulc and Tracy (2007), explore the costs and benefits of applying integrated systems in the U.S. Corn Belt. Much of my research comes from national and regional sustainability organizations, like the National Sustainable Agriculture Coalition (NSAC) and the Sustainable Farming Association of Minnesota (SFA). For a balanced perspective on the Farm Bill, I also read publications by the American Farm Bureau Federation. I also sought out personal testimonies: interviews with farmers from the Upper Mississippi River Basin, conducted by The Pasture Project and “Soil Health Stories” provided by the SFA.

Costs and Benefits

Adapting integrated livestock-crop farming in the upper Midwest offers significant environmental and ecological benefits, including natural pest control, diversity of animal species, increased organic matter in the soil, water infiltration, and healthier livestock and crops. With integrated systems, farmers require less use of fertilizers and pesticides by restoring wildlife and insect species crucial to the self-regulation of the ecosystem. Farmer John Mesko (2014) describes the return of dung beetles, earthworms, pollinators, and wildlife such as turkeys and pheasants to his farm. Managing the land as it was intended to be managed brings back the animals that naturally balance the ecosystem, without artificial inputs and mechanization. Livestock-crop integration does pose one environmental challenge, however: soil compaction. Although cover crops and manure improve soil health by protecting and fertilizing it, Sulc and Tracy (2007) find that animals may trample cropland and cause soil compaction, mainly in wet years (p. 342). Compaction can be managed by grazing animals on cropland when the soil is either dry or frozen. Because soil in the upper Midwest is frozen for much of the winter season, when livestock would graze short-season cropland, excessive soil compaction should not pose an issue in the upper Midwest. As long as grazing is managed properly, cropland can benefit from animal grazing. Manure from livestock increases the soil's organic matter. Farmer Paul Brown (2014) notes, "Organic matter levels on some of the fields were about 4% before we added the livestock and diverse cover crops, and within a matter of a couple years we were able to boost it a percent, percent and a half." Integrated methods take a conservation approach to soil health, while conventional methods exploit soil resources without replenishing them. With a properly managed livestock-crop system, ecological diversity, soil health, and crop and animal health all

improve. Integrating farming systems is more than a naive look at agricultural issues: more sustainable practices will be necessary in order to sustain our food systems for generations to come.

Diversification benefits extend beyond the environment to the management and financial stability of the farmer. That said, integrated farms require different and potentially challenging management practices, focusing on intimate interactions with the land rather than intensive machine labor. Running an integrated farm means the farmers could not specialize in only mechanized corn production; they must know how to row crop, raise livestock, and cultivate pastures or cover crops. Farmers must understand the particularities of their microclimate, and how crops and livestock interact with each other and with the land, rather than letting machines do most of the work. For example, as discussed above, farmers must manage grazing in pastures and cropland according to their particular climate and weather patterns in order to prevent soil compaction and erosion. On the other hand, allowing livestock to graze on cover crops could also mean less intensive work for the farmer. While land in conventional farming must be mechanically tilled and fertilized to remain productive, integrated systems enrich the soil naturally and save farmers from doing the work themselves. Livestock consume their feed directly, saving farmers the steps of harvesting or buying forage, and return manure to the land. Although farms must be managed more holistically and precisely, the farmer gains productivity, stability, a healthier farm and even economic gains.

Although diversifying could bring potential economic disadvantages, the economic benefits of investing in integrated systems outweigh the costs of multiple operations. Running, for example, dairy, row cropping, and pasture operations could accrue more management costs

than only growing corn. However, integrated techniques decrease input costs for fertilizers, pesticides, and livestock feed. Farmer Jon Nelson (2014) explains, "instead of spending the money on fertilizer and seed every year and lots of equipment, let cattle do the fertilizing and harvesting." In addition to saving on input costs in the present, shifting away from energy inputs is a cost-efficient investment in the future of the farm. Sustainable agriculture expert Dr. Fred Kirschenmann (2014) explains that in the next couple of decades, the costs of energy and fertilizer will increase, and "the more we can put production systems together that are more self-regulating and self-renewing...They're going to be the more efficient in the future as those costs go up." The financial burden, as well as environmental and health costs, of continuing artificial inputs makes diversified, self-fertilizing systems a practical way forward. Despite the intensive management, integrated systems show great promise for ongoing economic stability in the agriculture sector. Franzluebbers and Stuedemann (2006) conclude that "increased diversity of income and greater magnitude of economic return when cover crops were grazed by cattle should be key drivers for producers considering the adoption of such a management system" (p. 178). The labor and infrastructure increases associated with integrated farming systems will also diversify, and further stabilize, farmers' incomes. Adapting integrated techniques to the particular climate and agriculture conditions of the upper Midwest would be crucial in guaranteeing the economic stability of transitioning farms.

Implementation

Conventional farming practices view soil health and environmental health in the short term because those are the practices that agricultural policy supports. In their report "A 50-Year Farm Bill," Wes Jackson and Fred Kirschenmann (2009) emphasize the importance of a

longer-term agriculture vision from the government. Looking at agriculture in 5-year increments with the Farm Bill means ignoring the depleting "ecological capital necessary for food production" (Jackson and Kirschenmann, 2009, p. 2). Seeing the long-term effects of agricultural practices today will benefit the environment, farmer, crops, and livestock. The Farm Bill is the main piece of federal legislation that affects agriculture. Until 1985, the Farm Bill allocated $0 toward conservation, mostly supporting commodities like corn and grain, but today conservation programs receive over $5 billion per year (NSAC, Dec. 2016). Still, the Farm Bill disproportionately supports large-scale farms and wealthy farmers: according to the Environmental Working Group, "the wealthiest farmers collect over $1 million a year each in insurance subsidies," while "the lowest 80 percent of policy holders collect on average just $5,000 each" (Stewart, 2013). However, integrated farms made progress in the Farm Bill of 2014 with the new Whole Farm Revenue Protection (WFRP). Other crop insurance programs limited coverage to one crop, but now farmers with diversified farms can cover all crops and livestock under one insurance program. The WFRP gives farmers the risk-management tools to allow them to diversify their farms. The WFRP also includes livestock producers, who historically have received far less risk management support than commodity crop producers, despite their huge contribution to the U.S. economy.

Two other important programs for implementing sustainable practices are the Conservation Stewardship Program (CSP) and the Environmental Quality Incentives Program (EQIP). Both programs are in danger of budget cuts in the 2018 Farm Bill, which would be a mistake. Providing on-the-ground conservation training to farmers makes them more economically and environmentally sustainable. EQIP and CSP could be instrumental in training

farmers on the more complex management techniques required of integrated farms, and in educating farmers about the advantages to integrating livestock and crops. According to the NSAC, USDA's Natural Resources Conservation Service (NRCS) has been forced to turn away three-quarters of eligible applicants to EQIP and CSP due to limited funding and increasing producer interest (NSAC, March 2017). In 2018, Congress should increase funding for EQIP and CSP to meet producer interest and expand the WFRP to further support farms in diversification efforts. Supporting diversified farms in the Farm Bill is in Congress's best interest too: integrated techniques are inherently less risky than conventional methods (NSAC, Sept. 2016). Farmers gain more financial stability from integration, which creates less reliance on insurance and less spending for the insurance provider. In this case, Congress should see the potential economic benefits in investing in diversification.

In order to recommend integrating livestock and crops, researchers must rethink how research is conducted and shared by taking into account multifaceted costs and benefits of a diverse farm and farmer knowledge. Research often reduces a whole system into one or two variables, usually yields or productivity. Grazing and soil health expert Dr. Allen Williams notes a rush by university researchers to "discredit citizen science as it is based in observation rather than in the reductionist model practiced by university controlled trials" (Brown, 2017). For the best research on environmental, animal, plant, economic, and social variables, research teams must take on an interdisciplinary approach and involve farmers themselves. Only through holistic agroecology research will the benefits of diversified systems emerge. In addition to more interdisciplinary research, the agriculture sector should hold conferences for farmers to share their own region-specific findings with one another. Allowing farmers to be the agents of their

own research through farmer-researcher partnerships and farmer-farmer information sharing will expand the possibilities of new solutions to real problems. If research, education, and policy can become more holistic, shifting to integrated livestock-crop farming systems in the upper Midwest and elsewhere becomes a practical, viable alternative. Implementing diversified livestock systems must involve renewed investment from the policy and research sectors to increase profitability, efficiency, and sustainability.

Conclusion

Although transitioning to integrated livestock-crop agriculture includes some time, economic, and management challenges, a more natural farming technique allows the farm to benefit from nature's inherent ability to self-regulate. In returning organic matter to the soil, indigenous species to their environment, and animals to their forage, farmers will produce healthier crops and animals, cut costs, and secure the future of their farms. With a shift in incentives and research priorities toward comprehensive conservation, farmers can be encouraged to integrate their crops with livestock. Environmental and human health depend on the adoption of more sustainable agricultural practices. Recent documentaries and popular nonfiction rightly demonize conventional livestock production, but they offer few solutions to our agricultural dilemma. Although integrated livestock-crop farms may never make McDonald's a healthy choice, they may provide consumers with food that they are proud to eat.

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Sustainable Farming in the Midwest: Roundup Ready Crops and the 2018 Farm Bill

Introduction

The rapid growth of sustainable agriculture in the Midwest has sparked many debates on the best solutions to practicing agriculture. Sustainable agriculture is becoming more present because of environmental movements worldwide and in response to the growing population, addressing the issue on how can we feed the world while protecting it at the same time. Sustainable agriculture includes three main factors; environmental health, economic profitability, and social and economic equity (UC Davis). These three factors are not easy to achieve in unity. In this paper, I will discuss one specific proposed solution to sustainable agriculture specifically in the Midwest, GMO (genetically modified organisms) Roundup Ready crops. My sub-question to this paper is:

What are the costs and benefits of GMO (genetically modified organism) Roundup Ready crops to create more sustainable farming in the upper Midwest? What are the chances of GMO roundup ready crops being incorporated into the forthcoming 2018 farm bill and how might they be implemented more broadly?

Roundup Ready crops were introduced by Monsanto in 1996 and were attractive because of their lower prices, minimal use of pesticides, and high yield (Purdue, 2006) Roundup Ready crops are used in 90% of soybean crops and 70% of corn and cotton crops in the United States (New York Times, 2007). Other crops such as alfalfa and their development into Roundup Ready crops has created controversy because of their risky health impacts, relaxed policy and environmental impacts. The upcoming Farm Bill in 2018 will have a big influence on the future

of sustainable farming efforts across the United States. The Farm Bill is a piece of legislation that is passed roughly every 5 years and covers many programs and policies such as farm, food, forestry and rural (NSAC, 2017). Congress has already started discussing the Farm Bill that is expected to be finalized by 2018. In this paper, I will connect the upcoming Farm Bill to its possible influence on roundup ready crops in the Midwest.

Methodology

On September 16th my *People, Agriculture, and the Environment* class took a field trip to an Organic CSA Farm run by Dan and Margaret Guenther (see photo below). While their farm does not use Roundup Ready crops, Dan ran a bus tour throughout Polk County for us and pointed out many large-scale farms that do use Roundup Ready (glyphosate resistant) crops like corn and soybeans. Dan also mentioned the hazardous rise of horseweed which are resistant to the herbicide, Roundup (glyphosate). From there, I was able to conduct more research online about the history of Roundup Ready crops with its creator's website, Monsanto. I gained outside criticism on Roundup Ready crops through more online research with other organizations like NSAC (National Sustainable Agriculture Coalition). The NSAC also directed me towards Farm Bill blogs and provided a sustainable agriculture professional perspective. The NSAC website also uses many outside research reports and articles to back up their blog entries on current

sustainable farming issues. Other sources I used were research articles through schools like Purdue and UC Davis. These sources might have a lot of field work done by students and professors but don't include the professional farmer perspective that has been useful with the NSAC sources.

Findings, Analysis, and Discussion

Roundup Ready crops were introduced in 1996 by a modern agricultural company in the US called Monsanto (Purdue, 2006). Since then these GE (genetically engineered) seed have spread rapidly by Monsanto because they have many mostly short-term benefits to farmers in the US. These GMO Roundup Ready crops are not harmed from the spraying of roundup and because of that are more reliable for farmers because they produce the yield needed. Farmers don't have to worry as much about pests and disease towards the crops because of the glyphosate sprayed.

Touring Polk County with farmer Dan showed me how many of our large-scale farms in America and the Midwest depend on Roundup Ready crops to receive the most yield. Programs like crop insurance gives incentives for farmers to compete through yield and the best way to achieve their goals of yield and profit is through Roundup Ready corn, soybean, and alfalfa crops. All the large-scale farms use it to this benefit.

Another benefit to Roundup Ready crops is its ability to promote no till cropping systems. One reason tilling is done is to prevent the growth of weeds but has negative environmental costs because of loss of topsoil and runoff. Some argue that the use of Roundup Ready crops has promoted the no till practice since tillage is not as necessary when weeds are minimal. This is argued to greatly benefit the soil of the farm. An agronomist from the Natural

Resources Conservation Service states that "the use of no-tillage farming has grown sharply over the last decade, accounting for about 35 percent of cropland in the United States. For corn and soybean—where the use of GMO seeds now tops 90%—no-tillage has nearly doubled." (Genetic Literacy Project, 2017). Topsoil and organic matter within the soil are preserved and benefits the land and yield of crops. This benefits the agroecology greatly by conserving the land and gives environmental benefits towards the surrounding areas which will be exposed to less runoff, pollution, and degraded soil.

The benefits of Roundup ready crops seem to be mostly short term, since long term problems have recently arose with Roundup resistant weeds and lack of regulation leading to corruption. These weeds are very harmful to the agroecology because they can take over the land and encourage new pesticides that might have negative environmental impacts on the local area.

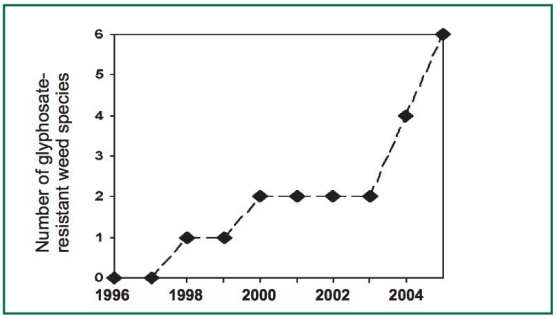
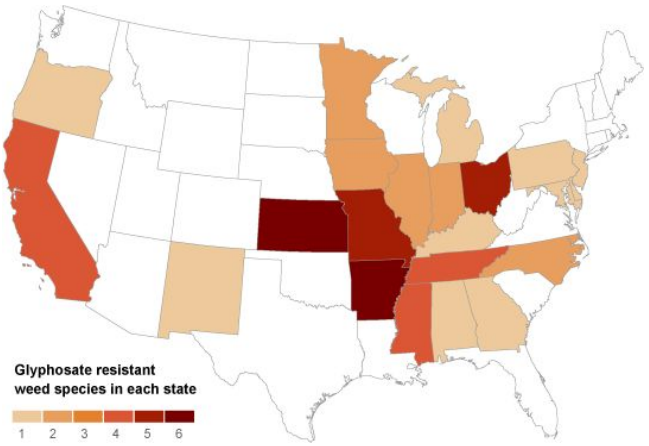


Figure 2. Glyphosate-Resistant Weed Species in the United States. *This graph shows the rising number of known glyphosate-resistant weed species in the United States since 1996.*

Farmer Dan talked about horseweed's rising presence in Polk County Wisconsin. Horseweed (marestail) was first reported in 2000 to be populated in 14 states including Wisconsin and Minnesota (Purdue, 2006). Other glyphosate-resistant weeds around the US have risen like Rigid rye grass, pigweed, Italian ryegrass, etc. Figure 2 above, shows the spike of glyphosate-resistant weed species since the development of Roundup Ready crops. These are forcing farms to lose yield, go back to tillage, and spend more money for more expensive weed resistant techniques leading to bankruptcy.

Monsanto's weed resistance manager, Rick Cole reaction is that "It's a serious issue, but it's manageable" (New York Times, 2010) Monsanto claims to continue to develop more GMO crops that are resistant to even more weeds but how to ensure its effectiveness in protecting farmer's yields is not clear. As dependence rises in Roundup Ready, glyphosate becomes very present within the soil which increases the risk of widespread weeds that are glyphosate resistant and decrease yield. As shown in the chart to the left, glyphosate resistant weed species are very present throughout the Midwest and will continue to pose a major threat to farmers.



Another major cost to Roundup Ready crops as an alternative to sustainable farming in the Midwest, is the controversy of lack of regulation. Roundup Ready Alfalfa caused a whole lawsuit with Monsanto against the USDA and EPA (Reuters, 2010). In "*Monsanto Company v. Geertston Seed Farms,* A California federal court had ruled that the USDA violated the law by approving the commercialization of Monsanto Roundup Ready GE alfalfa without preparing a full Environmental Impact Statement" (NSAC, 2010). The US has very little laws on GMO technologies which encourages lack of experimentation to create the most sustainable and effective GMO crops. Science based regulation is very important and the US cannot afford to make anymore mistakes through GMO crops that could damage soil and leave farmers helpless and bankrupt.

This is where the 2018 Farm Bill comes into play and could have a big influence on the future of sustainable farming and the role of Roundup Ready crops. The main issues being

presented for the farm bill deal with the conservation title which is "focusing in on working lands conservation, easement and land retirement programs and the linkage between conservation and crop insurance." (NSAC, 2017). The Conservation Reserve Program is interested in promoting more sustainable farming through the 2018 Farm bill through environmental protections and regulations. However, a lot is at stake and there are so many elements that are a part of this Farm Bill. Since Roundup Ready crops have turned into commodity crops and are so widespread the Farm Bill has to support them or the whole system could collapse.

However, the 2018 Farm Bill is looking to confront Climate Change issues like minimizing fossil fuel use and conserving land-use. Companies like Monsanto and Cargill are not as involved and more hesitant to see how Congress will act with these issues. (IATP, 2017) The House Committee for Agriculture which has been around since 1820 is in session and debating the many issues arising with farming but mostly dealing with crop insurance and climate change. However, research in GMO crops is being encouraged through this committee according to Representative Larry Combest stating that, “I have worked to pass an agricultural research bill that does more with our research dollars in a tight budget environment” (Agriculture House, 1997)

Research on GMO crops has been increasing which also increases controversy and exposes many of the negative consequences including the rise of superweeds. However, the Farm Bill seems to be on the side of major agribusiness companies like Monsanto who encourage Roundup Ready/Commodity crops so the future of shifting away from these GMO crops does not look too bright.

Conclusions

The future of Roundup Ready crops as an alternative to sustainable farming in the Midwest does not look so good because A basic view of Roundup Ready might make it seem like it's sustainable but in reality it's only sustainable in the short term with some no till practices and benefits. Roundup Ready is not helping the Midwest steer towards sustainable agriculture as originally intended. Glyphosate resistant weeds are a major issue and are increasing because of these GM crops encouraged by our capitalistic market in the United States. As glyphosate resistant weeds increase, so does the tendency to move away from Roundup Ready so that one does not go bankrupt due to lack of yield. While there has been some benefits to Roundup Ready like low tillage, research shows that these benefits are more short term as other weeds start to develop. However, this is not going to be an easy task for the Midwest and especially for all the large scale monocrop farms like the ones in Polk County Wisconsin that are so dependent on Roundup Ready crops.

All types of farmers face instability and insecurity including organic farmers like Dan and Margaret. To improve the lives and stability of farmers, "we badly need policy makers who have the courage to put politics aside to protect the environment, build community resiliency, protect farmers from climate risk and secure our food supply for the future." (IATP, 2017) Hopefully, the 2018 Farm Bill makers are thinking about supporting small farm-holders and include conservation acts that protect our land while producing the yield that's necessary. I admire Dan and Margaret's ability to stay away from monocropping and the use of GMOs because it's not easy especially in today's large agribusiness influenced society within the United States.

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10-03-2017

Alternative Agriculture

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The Costs and Benefits of No-Till Farming:
Why it Should be Incorporated into the 2018 Farm Bill

In the modern world, issues such as soil depletions, a growing population, lack of enough food to support the world's people, and wind or water erosion, have become more and more relevant in recent years. Scientists have discovered many sustainable methods that can improve these increasing problems, one being sustainable farming. The main goal of sustainable farming is to "meet society's food and textile needs in the present, without compromising the ability of future generations to meet their own needs" (Gail Feenstra, *What is Sustainable Agriculture? 2017*). There are many practices or methods that are commonly used by sustainable growers to "promote soil health, minimize water use, and lower pollution levels" (Feenstra, 2017). One method of sustainable farming is conservation tilling, or less broadly, no-till farming. Conservation tillage is a method of soil cultivation that reuses the previous year's crop residue (such as corn stalks or wheat stubble) in order to reduce soil erosion on runoff. To be more specific, no-till farming, a type of soil conservation, does not mechanically disturb the soil at all. All crop residue if left on the topsoil and the current year's crops are planted by slightly puncturing the ground to insert the seed. This aspect of sustainable farming is becoming extremely important in the modern society for several reasons. As the world population is

growing, the demand for food is rapidly increasing. In order to maintain healthy farmland, sustainable farming methods need to become more popular so the world does not deplete the rest of the soil and agriculture no longer is a thriving practice. No-tillage farming began to gain popularity in the late seventies, but has only slowly picked up stream since then. According to the U.S. Department of Agriculture (USDA), 25 percent of U.S. farms were considered fully or partially no-till properties (Jesse Hirsch, *No-Till Farming: What's the Deal? 2013*). Only ten percent are said to be continuously no-till farms, reported the USDA. Despite many cons to no-till agriculture, there are many more benefits that make it worthy of being incorporated into the upcoming Farm Bill, and it will need to be more broadly recognized if sustainable agriculture is attempting to thrive in today's society.

Research Methods

This research paper was mainly completed using information from online research and partly from in-class lectures. From online resources I was able to find more quantitative data and basic information about the definition or meanings, the history, and the costs and benefits of conservation tillage agriculture. I was also able to gain more knowledge about our nation's previous farm bills and the basics of the bill itself. Several articles I analyzed included *No-Till Agriculture Offers Vast Sustainability Benefits...Why do Many Organic Farmers Reject It(?),* by Nicholas Staropoli (2016), *No-Till Farming: What's the Deal (?),* by Jesse Hirsch (2013), *Conservation Tillage*, written by a group of editors at the Minnesota Department of Agriculture (2017), *What is Sustainable Agriculture(?),* by Gail Feenstra (2017), and a Farm Bill Campaign on the National Sustainable Agriculture Coalition website. All but one of the articles had very

little apparent bias, because they were all offering information about both the pros and cons of no-till farming practices and all the articles were found on reliable sources. Along with the Internet articles, I was able to receive information about sustainable agriculture from lectures given by Bill Moseley and Dan Guenther during my People, Agriculture, and the Environment course. Moseley provided our class with basic information about several types of sustainable farming (one being no-till agriculture), as well as describing a case study in Mali, West Africa about agricultural change of cotton crops. Guenther was able to offer me examples of his personal experiences with farming and basic information about the U.S. Farm Bill. After analyzing my resources and creating a drafted outline by following the prompt, I was able to begin drafting out my research.

Analysis: Costs and Benefits of No-Till

A key component to sustainable farming is having healthy soil. However, "one of the biggest contributors to land degradation is the simple process of plowing fields" (Hirsch, 2013). That is where the benefits of no-till farming arise. According to the Minnesota Department of Agriculture (2017), no-till farming "improves soil and water quality by adding organic matter as crop residue decomposes," which further leads to an open soil structure that lets water in more easily, reducing runoff. As stated in Nicholas Staropoli's (2016) article, *No-Till Agriculture Offers Vast Sustainability Benefits...Why do Many Organic Farmers Reject It(?)*, no-till farming drastically increases the amount of water infiltration and retention. The Natural Resources Conservation Service states that no-till farmed soils have been estimating water penetration rates of 5.6 inches per hour, twice as much as for conventionally tilled farmland. Water retention can

be extremely useful to farmers in drought-stricken areas. Soil erosion is also an increasing problem when land is tilled. Oxen-born plows, introduced during the colonial era, seemed to be a great invention that helped farmers lessen the labor intensity, however heavy plows lead to soil compaction and exposed the soil to intense erosion. As professor Bill Moseley describes in his lecture on October 3rd, 2017, in a case study in Mali, tillage was an easy step to take due to the demand for cotton. The land tillage led to the destruction of the healthy soil and to soil erosion, which forced many cotton farmers to move to new land and continue their destruction. Soil erosion can be easily eliminated by practicing no-till farming. According to Staropoli (2016), "The USDA National Resources Inventory credits the 43 percent reduction in soil erosion in the United States… to the increase in conservation tillage." If farmers start to rethink tillage farming, the detriments of this practice may fall from display and the Midwest can avoid going through hardships similar to the infamous Dust Bowl in the 1930s when topsoil erosion combined with windstorms ruined crops and farmland. One more obvious benefit to no-till farming would be the reduction in labor. Conventional tillage practices usually require "5 passes over the land with a plow," however when no-till farming is practiced, only a "single pass" is needed to plant the seeds (Staropoli, 2016). The reduction of plow usage is also said to reduce fuel usage on farms by as much as 80 percent. Purdue University calculated that farmers could save up to 225 hours of labor per year for roughly a 500-acre farm (Staropoli, 2016). Not only does no-till farming help the environment, but it allows farmers to possibly focus more time on growing sustainable food to feed our rising world population.

Unknown to common thought, no-till agricultural practices also have several downsides. The major argument (often argued by organic farm movements) against no-till farming is that it can increase the unwanted use of chemical herbicides and pesticides (Staropoli, 2016). If farmers

rely on herbicides for weed control, they can no longer directly adopt organic production system titles. Luckily, scientists have been working to reduce the need for the dependence on harmful pesticides, but until all are eliminated, a no-till farm cannot be an organic farm. Other possible cons to no-till sustainable farming include the jump in equipment costs. Startup costs that include new no-till equipment, such as a no-till drill, and new chemical herbicides can come at a significant expense. Besides an increase in tool costs, another con includes a risk of fungal diseases in crops and plants. According to Hirsch (2013), "elevated moisture levels in the soil can promote fungal diseases that were previously kept in check," so farmers will need to closely watch the increasing water amounts in their soil. The switch from conventional tillage farming to sustainable no-till farming will not be easy either. The shift between old and new practices is a major process that farmers are going to have to be dedicated to completing.

The United States Farm Bill has a tremendous impact on the farming livelihoods, what food is produced, and especially how it is cultivated, due to it being the primary agricultural and food policy tool for the government. No-tillage agriculture has been becoming more and more popular as the importance of healthy soil is increasing in our society. An abundance of healthy soil provides our society the chance it needs to feed the people. This practice has a good chance of being implemented into the upcoming 2018 Farm Bill because the advance of sustainable farm and food policies are already increasing in importance. In his book, *Dirt: The Erosion of Civilizations*, geologist David Montgomery states that "the world loses roughly 23 billion tons of good soil each year. At this rate, it will be all gone within 150 years" (Hirsch, 2013). Farmers and politicians need to begin to acknowledge the idea that despite the costs that arise when it comes to no-tillage agriculture, the benefits include staving off an impending hunger crisis. All available, healthy land will be needed to provide food for our growing population. Once

sustainable agriculture practices like this are implemented into the upcoming Farm Bill, the more available and healthy land our nation will have and keep.

Conclusions

Like any other standard sustainable farming practice, no-tillage farming has many costs and benefits to the farmers and the environment. Ranging from an increase in water conservation or the lessening of soil erosion, to the increase in chemical pesticides and a large jump in equipment costs, no-till agriculture has become highly popular when one thinks of sustainable practices. The upcoming Farm Bill affects the environment, local and national economies, and public health, so by implementing no-tillage farming as a requirement into the bill, hopefully it can affect these aspects more positively than before. The 2018 Farm Bill should address no-till farming as a proper solution to unhealthy soil. By directly recognizing that soil degradation is an apparent issue in the Midwestern society and by requiring farmers to act on this problem, the Farm Bill could prevent the health of the soil from degrading, lessen erosion, and save the future of farms throughout the United States.

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