Alternative Agriculture Futures in the Upper Midwest

A Collaborative Research Exploration between

Common Harvest Farm, Osceola, WI
&
Whetstone Farm, Amery, WI
&
The Students in Geography 232: Food, Agriculture and Environment

December 2024

Supervised by
William G. Moseley
DeWitt Wallace Professor of Geography
Director of the Interdepartmental Program in Food, Agriculture & Society
Macalester College, Saint Paul, MN 55105
Email: moseley@macalester.edu

Prologue and Acknowledgements

Farming has never been easy, but food systems in the upper Midwest have been especially rattled in recent years by environmental and economic shocks, including increasingly erratic weather patterns price inflation. This report seeks to better understand local farm operations and learn about the advantages and challenges of alternative and conventional farming in the region in 2024. While challenging circumstances are not to be minimized, sometimes they spur innovation and new ways forward.

The report represents the collective efforts of 23 students co-investigating food systems in and around the Twin Cities, MN in the September-October 2024 period. Students in Geography 232 (Food, Agriculture and the Environment) engaged in this collaborative research effort with Common Harvest farm in Osceola, WI and Whetstone Farm in Amery, WI. Following on ten previous years of collaboration with Common Harvest Farm, and an inaugural year with Whetstone farm, the course instructor and the owners of the farms developed a set of research themes that were of mutual interest and are the focus of this report. Students were divided into five research groups analyzing different dimensions of the local food system. The papers the students developed - working within their research groups - were shaped by the following themes and questions.

1) Climate change, weeds, pests and disease. Climate change has led to highly variable conditions in recent years in the upper Midwest, from extreme drought last summer to excessive rainfall this year. A particular challenge for alternative vegetable farmers was weed and pest control during such a wet summer. Animal farmers also face different disease challenges depending on heat and moisture conditions. How are weed, pest and animal disease dynamics impacted in the upper Midwest by wet, dry, warm or cool summers? What are the most effective alternative weed, pest and animal disease control measures under which conditions? What are the costs and benefits of some control methods versus others?

2) Vulnerability, resilience and transformation. Conventional and alternative farmers face different vulnerabilities when it comes to climate change. How do the vulnerabilities to climate change of these two different farming systems compare and contrast? Is one system more resilient than the other? Would a more hybrid model (mixing methods from both approaches) be more resilient? Is climate change likely to favor shifts towards one system versus the other?

3) Animal husbandry and sustainability debates. Animal husbandry is often portrayed as problematic in the sustainability literature. What are the pros and cons of animal husbandry from a sustainability perspective? Are there more sustainable ways to raise livestock? What are the pros and cons of mixed animal and crop farming versus specialization? Is animal husbandry a friend or foe of vegetarianism?

4) Marketing alternative agriculture. Multiple marketing approaches have been developed for alternative agriculture, from community supported agriculture (CSA), to farmers markets, to direct sales. What are the pros and cons of different strategies for alternative farmers? Are there new alternative agriculture marketing strategies that could increase access or expose new audiences to alternative agriculture?

5) Aiding and abetting revolution. Alternative agriculture in the Upper Midwest is still a niche category in the farming sector. Is it destined to remain niche or could it expand? What would it take to normalize or propagate this approach to farming? Is it about scaling up (getting bigger), creating the conditions for more small farmers, shifting subsidy structures, changing marketing arrangements and/or shifting consumer attitudes? Is such change a technocratic problem to be solved and/or a revolution requiring a broad-based social movement? Does climate change help or hinder the possibility of such change?

The class spent a full day visiting Common Harvest and Whetstone farms, as well as surrounding areas, on Saturday, September 28, 2024. The five groups then spent the following three weeks collecting and analyzing data for their respective research themes and questions. The students working in each of the research groups penned a report addressing a specific research question related to one aspect of their group's theme. These reports are included as sub-chapters, following each research theme, 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 farms, as well as the various individuals who were interviewed for this project. Some students have chosen not to publish their papers, some chose to do this anonymously, and others have done this with their name attached to the paper.

None of this would have been possible without the time, energy and intellectual input of the co-owners of Common Harvest farm, Dan Guenther and Margaret Pennings, as well as the co-owners Whetstone farm, Emily Hanson and Klaus Zimmerman. I am also grateful to my two teaching assistants, Meira Smit and Reece McKee, who supported the class in their exploration of these topics and helped edit this report.

Bill Moseley, DeWitt Professor of Geography, Macalester College

Table of Contents

Chapter 1

Climate Change, Weeds, Pests, and Disease

By: Will Rosenberg, Anonymous, Luca Schira, Ethan Zhu, and Anonymous

1.1 Sustainable and effective farming practices for pest and weed prevention in the upper Midwest

Will Rosenberg

Introduction:

The Upper Midwest has long had large deposits of organic matter compared to the rest of the United States. This has made it a hub for agriculture, both small and large scale. As farming has become more industrialized, it has also become unsustainable with its current practices. Especially in a time when finite resources are being used at rapid rates throughout the world. Sustainable agricultural practices are becoming a necessity to accommodate our current lack of sustainability. Pest and weed control are two dominant areas of agriculture that produce unsustainable practices within farming. Especially at the industrial level. Pesticides and herbicides contribute to vast environmental degradation. While the levels of organic matter and fertile soil are high, the Upper Midwest has challenges with short growing seasons compared to the rest of the United States. In this paper, the viability of two sustainable agriculture practices for the Upper Midwest at the industrial level will be examined. The question this paper will be answering is: How effective are cover crops and intercropping at preventing pests and weeds, and are they viable as a sustainable agriculture practice in the Upper Midwest at the industrial level the way they are currently constructed?

Methods:

This paper will use academic sources and literature to explore the viability of these two agricultural practices in the Upper Midwest. First, this paper will explain the practices of intercropping and cover cropping before taking a look at the abilities of pest and weed prevention. Then transitioning to the practicality of them at the industrial level. Accounting for the seasons, time consumption, and lastly resource consumption. Of course no matter what practice is used for sustainable agriculture, there will be issues of resource consumption. Especially on an industrial scale. The main questions at hand are, are these practices sustainable? Are they effective at pest and weed prevention? And are they viable in the upper midwest in an industrial agriculture context? These questions will also be answered through academic sources before the conclusions are made.

Intercropping and Cover Cropping:

Intercropping is an agricultural practice that has two or more crops grown together for a length of time. Contrary to monocultures, it utilizes two crops strengths to build off of each other for the shared benefit of both crops. This strengthens soils and makes it harder for pests to latch onto a single monocrop. It confuses pests when a growing area has multiple crops that are spread and evenly dispersed in a set area. Intercropping became a common term in agriculture in the early 20th century. It is said to be the natural plantings of nature. It's been a common practice in agriculture but has been long neglected since the advent of monoculturing in the United States at the industrial level. (Glaze-Corcoran, Hashemi, Et. All, 2020).

Cover cropping is when a crop is planted during the low season of another crop. It is beneficial for soil health and reduces the need for nitrogen and phosphorus based fertilizers when the growing season for the main crop comes around. "Cover crops, also known as 'living mulches' and 'catch crops' have been shown to reduce negative impacts of farming on the environment." (Hao, Najm, Et. All, 2023). Cover cropping is used as a natural way to deter and indirectly kill pests in a crop field. (Auriol, Grasset, Et. All, 2021).

Analysis:

According to scholarly works, both cover cropping and intercropping have positive effects on slowing down pests and weeds. Modern industrial agriculture relies a lot on chemicals and fertilizers that are deeply degrading towards the environment when they seep into other ecosystems and are taken by different forms of erosion. Whether it is rain or wind erosion, they both play different roles in garnering these toxic chemicals into the environment. (Glaze-Corcoran, Hashemi, Et. All, 2020). The usage of these pesticides and herbicides must be reduced if we are to stop harming our planet's ecosystems at unsustainable rates.

Starting with cover cropping, in a study about pest control and cover cropping a research group found that "Increasing the diversity of cover crops resulted in higher abundances of natural enemies in vineyards." (Auriol, Grasset, Et. All, 2021). Natural enemies of pests are a very good sustainable way to create pest control within a crop field. Growing crops that attract specific insects that attack other pests can vastly help in reducing the amount of unnatural pesticide usage on an agricultural space. However, the same study did find that "Cover crop diversity did not change the diversity nor the community composition of natural enemies." (Auriol, Grasset, Et. All). This is an important note because it does show that cover cropping can increase natural enemies in pests but with less diversity of natural enemies these helpful insects could turn into pests themselves due to overpopulation. It's why unnaturally introducing natural enemy pests into an environment has inherent risks. While eliminating one pest, another could be spawned. Cover cropping can also be a useful agent in suppressing weeds. According to another study, weed biomass and weed density were both decreased after the use of cover crops. This conclusion was found through the work of over 46 relevant studies with 36 conducted in North America, 6 in Europe, 3 in Asia, and 1 in South America. (Osipitan, Dille, Et. All, 2018). Cover cropping is another form of agriculture that doesn't require tilling. Typically no-till agriculture has higher amounts of weeds and other assorted organic matter because it hasn't been broken up or disrupted by the overturning of the soil. But with cover cropping, it lowers weeds and weed mass and allows for small yields of crops in lesser demand but that can still be used for consumption.

A dig on cover cropping by this study is that it did not produce greater overall yields for the main commodity crop. It simply lowered weed mass. "Use of cover crops for early season weed suppression did not affect grain crop yield, but improved yield of vegetable crops." (Osipitan, Dille, Et. All, 2018). Understanding the 6 pillars of food security, this would entail that production is already at sustained rates to where the planet already has is producing enough food. "Pillars of food security: availability, access'". (Clapp, Moseley, Et. All, 2022). Access is the issue, not availability. It's about being able to properly give accessibility to this food. So yield rates are not a dire issue at this point in time. Indicating that cover cropping could be used as a sustainable form of agriculture to help lower the amounts of pests and weeds in a crop field. Lastly, cover cropping is more difficult to do in the Upper Midwest because of short growing seasons. It's hard to get a productive long lasting cover crop in a region that is too cold for growing most crops 5 to 6 months out of the year.

Intercropping is easier to instill as a practice in the Upper Midwest because it doesn't require a second growing season unlike cover cropping. According to chapter 5 of "Understanding intercropping to improve agricultural resiliency and environmental sustainability" "Well-designed intercropping operations efficiently use natural resources, increase biodiversity, manage pests, and in many instances, enhance crop productivity and quality, and natural soil fertility with reduced consumption of off farm inputs." (Glaze-Corcoran, Hashemi, Et. All, 2020). Intercrops are less affected by pests in multiple different ways. Associated plants cause the main crop in an intercrop to be a less good host. They also divert the attacking pests from being able to lock onto the various crops. Lastly they also change the ecological environment around them due to the plant diversity which benefits natural enemies of pests in a crop field.

As a question of food yields may arise, intercropping is actually better at producing greater yields than monocropping and additionally uses less pesticides and other resources. "Intercropping results in higher crop yield at the system level (grain yield of species + grain yield of species two) and less yield variation than mon-cropping systems." (Ali Raza, Yasin, Et. All, 2022). So intercropping typically has greater yields than monocropping and culturing, and it requires less pesticides. But what about herbicides? In another intercropping study, the researchers were trying to find if weed suppression is common amongst intercropping and if it would lower herbicide usage in turn. After the study, they concluded "Increased plant density has already been reported to result in stronger weed suppression in pure stands. Hence, the positive influence of relative density total on weed suppression metrics in intercropping found in our study is consistent with previous work, confirming that increased plant density is an important cause for good weed suppression." (Gu, Bastiaans, Et. All). Lowering herbicides is another way in which intercropping would benefit the environment more in a longer context than monocropping. Less resource usage,

Conclusions:

Agricultural practices in the United States are extremely unsustainable the way they are currently being used. Particularly at the industrial level. If there are going to be any changes to the resource consumption of agriculture around the United States, they need to consider making some of these changes at the industrial level. Production is as high as ever, but so is environmental degradation. Yields can be lowered to ensure that sustainable practices and measures are being set in place. Industrial farming has taken monoculturing to the extreme and never looked back. This research has shown that it would likely benefit agricultural practices within the Upper Midwest to change from monoculturing to cover cropping and intercropping. As discussed earlier in the paper, cover cropping would be harder to institute as a mainstake agricultural practice compared to intercropping due to the weather patterns and growing seasons of the Upper Midwest. “Despite being generally accepted as a promising conservation practice to reduce nitrate pollution and promote soil sustainability, cover crop adoption in Midwestern U.S. agriculture is low.” (Plastina, Liu, Et. All, 2018). Analyzing this research, there is no reason to believe that industrial farming couldn’t transition into polycultures and intercropping as a solution to use less pesticides and herbicides. Yields of crops may not have to be lowered as well.

If intercropping naturally produces greater yields amongst crop fields without large-scale usage of pesticides and herbicides, it would be a positive financial investment for agriculture as well. Investing in restructuring monoculture cropping fields would be an investment that would benefit the environment and cut costs of pesticides, herbicides, and fertilizers amongst Midwestern Agriculture. Cutting out these fertilizers is a significant environmental factor that is important to maintaining the cleanliness of our ever deteriorating fresh water resources. “Row crop farming in the Midwest has been increasingly singled out as a major non-point source of nitrate pollution in waterways.” (Plastina, Liu, Et. All, 2018).

Industrial farming needs to change the way it thinks about production and expending resources. The rate at which we are expending our resources through agriculture is not something we can afford to continue doing. Intercropping is a viable agricultural practice that can be implemented throughout not just the Upper Midwest, but most of the United States considering its warmer climates. To make these changes, it will be up to the corporate leaders of industrial farming to insert these practices that will benefit our planet in the long run. If and when they decide to do that, remains to be seen.

References:

Ali Raza, M., Yasin, H. S., Gul, H., Qin, R., Ud Din, A. M., Bin Khalid, M. H., Hussain, S., Gitari, H., Saeed, A., Wang, J., Rezaei-Chiyaneh, E., El Sabagh, A., Manzoor, A., Fatima, A., Ahmad, S., Yang, F., Skalicky, M., & Yang, W. (2022, October 31). Maize/Soybean strip intercropping produces higher crop yields and saves water under semi-arid conditions. *Ecological, Efficient and Low-Carbon cereal-legume intercropping systems*, *13*. Frontiers. https://doi.org/10.3389/fpls.2022.1006720

Beaumelle, L., Auriol, A., Grasset, M., Pavy, A., Thiéry, D., & Rusch, A. (2021, July 13). Benefits of increased cover crop diversity for predators and biological pest control depend on the landscape context. *Ecological solutions and evidence*, *2*(3). British Ecological Society. https://doi.org/10.1002/2688-8319.12086

Clapp, J., Moseley, W. G., Burlingame, B., & Termine, P. (2022, January). Viewpoint: The case for a six-dimensional food security framework. *Food Policy*, *106*. ScienceDirect. https://doi.org/10.1016/j.foodpol.2021.102164

Glaze-Corcoran, S., Hashemi, M., Sadeghpour, A., Jahanzad, E., Afshar, R. K., Liu, X., & Herbert, S. J. (2020). Chapter Five- Understanding intercropping to improve agricultural resiliency and environmental sustainability. *Advances in Agronomy*, *162*. https://doi.org/10.1016/bs.agron.2020.02.004

Gu, C., Bastiaans, L., Anten, N. P.R., Makowski, D., & Van De Werf, W. (2021, December

1). Annual intercropping suppresses weeds: A meta-analysis. *Agriculture, Ecosystems & Environment*, *322*. ScienceDirect. https://doi.org/10.1016/j.agee.2021.107658

Hao, X., Najm, M. A., Steenwerth, K. L., Nocco, M. A., & Daccache, A. (2023, February 25). Are there universal soil responses to cover cropping? A systematic review. *Science of the total environment*, *861*. ScienceDirect. https://doi.org/10.1016/j.scitotenv.2022.160600

Hendriks, S. L. (2015, April 24). The Food security continuum: A novel tool for understanding food insecurity as a range of experiences. *Food Security*, *7*.

Mousavi, S. R., & Eskandari, H. (2011). A general overview on intercropping and its advantages in sustainable agriculture. *Journal of applied environmental and biological sciences*. Osipitan, O. A., Dille, J. A., Assefa, Y., & Knezevic, S. Z. (2018, November 1). Cover crop for early season weed suppresion in crops: Systemic Review and Meta-Analysis. *Agronomy journal*, *10*(6). Macalester college dewitt. https://doi.org/10.2134/agronj2017.12.0752 Plastina, A., Liu, F., Miguez, F., & Carlson, S. (2018, April 29). Cover crops use in midwestern U.S. agriculture: perceived benefits and net returns. *Renewable agriculture and food systems*.

Shipanski, M. E., Barbercheck, M., Douglas, M. R., Finney, D. M., Haider, K., Kaye, J. P., Kemanian, A. R., Mortensen, D. A., Ryan, M. R., Tooker, J., & White, C. (2014, March). A framework for evaluating ecosystem services provided by cover crops in agroecosystems. *Agricultural systems*, *125*. ScienceDirect.

https://doi.org/10.1016/j.agsy.2013.11.004

Trenbath, B.R. (2003, July 1). Intercropping for the mangement of pests and diseases. *Field Crops research*, *34*. ScienceDirect. https://doi.org/10.1016/0378-4290(93)90123-5

1.2 Effects of Climate Change on Organic Pest Control

Anonymous

Image 1: a picture of eggplant at Common Harvest Farm. Eggplant is one crop that can be affected by the Colorado Potato Beetle.

Introduction

Climate change, caused by human greenhouse gas emissions, has affected agriculture in the American Midwest because some of the effects include warmer winters and summers and varying amounts of summer rainfall. This is leading to greater quantities of insects on organic farms because more insects are surviving winters and developing faster during hotter summers, and geographic ranges of insects are changing as temperatures of different regions change. Organic farmers have found that natural pest control methods have gotten significantly harder in recent years, because methods like planting after an insect's feeding period is over is harder when the timing of the insect's life cycle has changed. Climate change is causing greater overwintering survival, which means more insects are becoming resistant to biological pesticide sprays. This paper asks to what extent the climate crisis has changed the efficacy of organic pest control methods and how organic farmers are adapting to these changes.

Methods

Much of the information in this paper about pests and pest control methods on organic farms comes from interviews I conducted with Dan Guenther, an owner of Common Harvest Farm, and Emily Hanson, an owner of Whetstone farm. In these interviews, they both talked about how they try to manage pests, and they both described methods like row cover, organic insecticides, and timing planting times with insect life cycles. They also both talked about how those pest control methods have been challenged by climate change. Other information comes from observations on visits to Common Harvest Farm and Whetstone Farm, both of which are Community Supported Agriculture farms in Northwest Wisconsin. As recommended by Farmer Dan, I also consulted websites and catalogs that sell organic seeds and biological insecticides. Multiple studies have already been conducted on the effects of climate change on insect life cycles, which support the observations Dan and Emily have both made.

Findings

Multiple studies have shown that climate change is benefitting many insects by allowing greater overwintering survival. Some insects cannot survive winters below a certain temperature, such as the Emerald Ash Borer, which cannot survive below 30 degrees below zero (Minnesota

Department of Natural Resources). A study by Schneider et. al. found that increasing "winter and spring minimum temperatures thus usually favours pest outbreaks, particularly in temperate regions" (Schneider et al., 2022). According to this study, this means that "Temperate regions are generally more likely to face an increase in pest attacks" (Schneider et al., 2022). Organic farmers are already noticing the effects of increased amounts of pests. Emily said that she has noticed more pests than usual this summer, and that while normally Whetstone Farm has to use row cover only when crops are young and cannot compete with pests, this summer "we couldn't get away without row covering everything," because there were more insects than usual.

According to Farmer Dan, one of the main ways that organic farmers try to combat harmful pests is by understanding their life cycles and planting crops around those life cycles. He will plant crops when pests are not feeding, so the plants will not be preyed on when they are young and most vulnerable. For example, he told me that when he is planting crops that are normally preyed on by the flea beetle, which mostly causes cosmetic damage to crops, "if we know that that adult feeding stage is roughly three weeks, we can either delay planting, using different successions, so maybe we're hedging our bets, so we put out 500 and then a week later we put out 500 and then a week later another 500" so that not all of the crops are planted during the flea beetle's feeding stage. This means that the flea beetles may eat some of the crops but they will not be able to eat all of them. However, as summers are getting warmer, the life cycle of the flea beetle is changing, so organic farmers have to adapt their planting schedule to the beetle's new life cycle.

Both Dan and Emily said that one of their biggest problems is the Colorado Potato Beetle and that climate change has exacerbated this problem in recent years. The beetles have built up in both point to the point where Common Harvest did not grow potatoes at all last summer and Whetstone Farm grew fewer potatoes than normal. During the summer of 2023, when it was hot and dry, Whetstone Farm got four generations of potato beetles, which is more than they would have during a normal summer. According to Dan, "it used to take 15 to 18 days before we started seeing the first [potato beetle] eggs hatch, in 2021 when the first week of June was a heat wave, the first eggs hatched in like 7 days." Multiple studies have found that rising temperatures are changing the habitats and life cycles of the potato beetles. A study by Hall et al. on the Colorado Potato Beetle found that "with an additional temperature increase, a shift towards an earlier date of completed development can be expected" (Hall et al., 2014). A study by Wang et. al. also found that "the global distribution of suitable habitat for CPB will be substantially affected by climate change" and so the beetles will eventually move north as their habitat changes (Wang et al., 2017). Potato beetles are hurting organic farmer's yields because they are developing faster due to rising temperatures.

Climate change is also making crops less healthy, which makes them more vulnerable to pests. Farmer Dan also said that "if you have healthy soil and healthy vibrant plants they can compete and outgrow insect populations," but when plants are stressed or unhealthy, "insects respond to that," and prey on those unhealthy plants more. One of the effects of climate change in the Upper Midwest has been variations in rainfall during the summers. There was a drought during the summer of 2023, so plants were stressed from not getting enough water, while the summer of 2024 was the third wettest recorded summer in Minnesota, so crops were also stressed from too much water (Sundgaard, 2023; Matz, 2024). This stress leaves the plants vulnerable to insects, when otherwise they would be able to outgrow the insect populations. Effects of climate change like varied rainfall are harming plants, which makes organic crops vulnerable to the increased numbers of pests that organic farms have.

Studies have also found that climate change is leading to increased pesticide resistance. A study by Ma et al. on pesticide resistance in diamondback moths found that as insects' overwintering range increases, insects are able to stay in a permanent place in that larger overwintering range, rather than migrating. Permanent insects are able to build up higher pesticide resistance because those insects are mostly exposed to one pesticide. The study found that “Mean resistance in the permanent overwintering sites was 158 times higher than that in the non-overwintering (transient) sites and five times higher than that in the marginal belt” (Ma et al, 2021). Increased pesticide resistance is a problem for both organic and commercial farmers because it means that farmers must keep adapting pest control methods or using increased amounts of pesticides, which can harm both farmers and the environment.

Increased pesticide resistance is also making biological pesticides less effective. Both Common Harvest and Whetstone have used biological sprays that kill larvae to manage pests like the Colorado Potato Beetle, but they have both found that sprays are getting less effective. Whetstone Farm used to use Entrust, a biological potato spray, but according to Emily they “stopped two or three years ago because we noticed it wasn’t effective anymore,” and there have not been any good replacements. Instead of spraying, Whetstone Farm has started planting fewer potatoes, which means they are no longer able to sell potatoes wholesale and instead they can only put potatoes in subscribers’ boxes a few times. Dan also said that spraying, which is also very expensive, is becoming less effective. Common Harvest Farms was not able to grow potatoes at all this year so that the beetles will move on when they have no food source, but this means that Common Harvest was not able to give their subscribers any potatoes this year. Increased pesticide resistance is affecting organic farmer’s yields.

New biocides are not being developed at the same rates that insects are developing resistance, which makes it harder for organic farmers to adapt. Farmer Dan said that he is worried that new products are not being developed quickly enough because “if organic farmers don't represent a statistically large enough market share, it doesn’t make sense to develop new biological products, and it can take a lot of time to develop new biological products," and companies are not interested in investing much into organic sprays. Organic sprays are not Dan's first choice for pest control, because some of them are powerful enough to kill all insects, but he does use some biocides. However, organic sprays are becoming a less effective tool because pests are becoming resistant and there are no replacements available.

Conclusions

Climate change is affecting insects in ways that are making organic pest control methods less effective. Warmer winters are allowing more insects to survive overwintering and develop pesticide resistance, which is reducing the efficacy of row covering and biological sprays. Hotter summers are causing insects to have faster life cycles, which means that farmers have to adapt their crop planting schedules to avoid the feeding periods. Colorado Potato Beetles are becoming a worse problem for organic farmers in Northwest Wisconsin, because more beetles are able to survive overwintering and they are becoming resistant to organic biocides.

Because climate change is making pest control less effective, organic farmers are adapting, but these changes can also cause problems for farmers. Because the Colorado Potato Beetle has built up at both farms, Common Harvest and Whetstone are now both planting fewer potatoes or not growing potatoes at all, which means they are unable to wholesale their potatoes. Organic farms are also using more row cover than they used to, which has environmental consequences because row cover is a polyester product. Other methods are extremely time and labor intensive. Emily told me that to combat "a really intense cutworm issue," they "wound up replanting watermelons with little paper towel tubes around each plant," which she described as an "insane" amount of work to put in.

As temperatures continue to rise, pest problems are likely to get worse on organic farms, because more insects will be able to survive the warmer winters. This makes it very important for organic farmers to have access to new, more reliable, pest control, since biological sprays are becoming less effective and are not being developed as quickly as insects are adapting. While organic farmers are not trying to kill off every insect on their farms, because they do not want to also kill beneficial insects, the lack of effective pest control methods leads to pests building up at organic farms. Pest control methods need to be adapted for climate change to prevent insect build up and reduced yield on organic farms.

Works Cited:

D. Guenther, personal communication, October 7, 2024.

E. Hanson, personal communication, October 10, 2024.

Hall K, Jönsson AM, Linderson ML, Pulatov B. (2014) Effect of climate change on the potential spread of the Colorado potato beetle in Scandinavia: an ensemble approach. *Climate Research, vol 62,* 15-24. https://doi.org/10.3354/cr01259.

How cold is too cold for Emerald ash borer? (n.d.). Minnesota Department of Natural Resources. Retrieved October 9, 2024 from https://www.dnr.state.mn.us/invasives/terrestrialanimals/eab/winter.html.

Matz, C. (2024, August 8). *Minnesota weather: 2024 is the 3rd wettest on record to date in the Twin Cities*. Fox 9. Accessed October 9, 2024 from https://www.fox9.com/weather/minnesota-weather-third-wettest-twin-cities.

Ma, CS., Zhang, W., Peng, Y. et al. (2021). Climate warming promotes pesticide resistance through expanding overwintering range of a global pest. *Nature Communications, Vol 12*, 5351 https://doi.org/10.1038/s41467-021-25505-7

Pest Control Supplies, Beneficial Insects, and Weed Control Products. (n.d.). *Peaceful Valley Farm Supply*. Retrieved October 9th, 2024 from https://www.groworganic.com/collections/weed-and-pest-control?srsltid=AfmBOoqRL4j Ak2c3J6ZJHbBpo-Zoth4l93O9dpVVXVtth38TFk1QjQP6.

Schneider, L., Rebetez, M., & Rasmann, S. (2022). The effect of climate change on invasive crop pests across biomes. *Current Opinion in Insect Science, Vol 50.* https://doi.org/10.1016/j.cois.2022.100895.

Sundgaard, S. (2023, December 29). *Minnesota's wild weather year*. MPR News. Accessed October 9, 2024 from https://www.mprnews.org/story/2023/12/29/minnesotas-wild-weather-year-top-10-weathe r-climate-stories-for-2023.

Wang, C., Hawthorne, D., Qin, Y. *et al.* (2017). Impact of climate and host availability on future distribution of Colorado potato beetle. *Sci Rep* 7, 4489 https://doi.org/10.1038/s41598-017-04607-7.

1.3 Weed Control in Small Scale Organic Farming

Luca Schira

Introduction

As climate change increases the variability of weather every year, farmers have to suffer through unpredictable years, putting their livelihood on the line. The changing climate has made weeds, pests, and disease more prevalent (Ziska et al. 2016) and thus more difficult to control. A particularly wet year caused by climate change can have an entirely different effect on a farm than a dry year which could come right after it. This forces farmers to constantly adapt in the face of climate change. For the many farmers who are in debt, failure to adapt could mean the loss of their livelihood. In this paper, I focus on challenges that weeds pose to farmers and the weed control methods organic farmers have available to them.

Weeds are one of the largest challenges for farmers, they compete with crops for nutrients and spread with ease. In traditional agriculture in America, farmers use herbicides. The relative efficiency of herbicides and pesticides has made them the method of choice for most large scale farmers (Bridges 1994). However, as more herbicides are used, weeds become resistant, requiring more herbicides and driving up the cost for farmers. This, in addition to environmental concerns with herbicides, causes concern over how traditional agriculture fights against weeds. In contrast, organic farming is a form of alternative agriculture that doesn't use synthetic chemicals for pest or weed control. Organic farmers use more biological and mechanical methods for farming instead of chemical solutions to their problems.

After visiting two farms and talking to an organic farmer, I came up with six methods that these specific farms have found most useful. These methods are cover cropping, planting plants that outcompete weeds, crop rotation, tilling, occultation, and other general mechanical methods. Some of these methods also have drawbacks that have to be considered by the farmer when using them. Even with all these methods available to them, organic farmers can't expect to eradicate weeds on their land entirely and must understand how to coexist with weeds while keeping them at bay.

Methods

In order to understand how organic farmers fight against weeds, I visited two small organic farms in Wisconsin and toured the local farmland. The two farms I visited were Whetstone Farm and Common Harvest Farm which is a community supported agriculture (CSA) farm. CSA farms rely on members to pay a monthly price for a package of produce every month. I supplemented my in person research with some online research on the weed control methods that I learned about during my visit to these farms. I also held a semi-structured with Dan, one of the owners of Common Harvest Farm. The questions I asked during the interview were focused on clarifying the things I noticed on the farm. I mostly focused on weed control and understanding exactly why Common Harvest Farm uses the methods it does to control weeds and not others. Because I only interviewed a farmer from Common Harvest Farm, this paper mostly focuses on the practices specific to that farm.

Weed Challenges

A plant is generally considered to be a weed if it is growing somewhere where humans don't want it growing. On the tour of the area surrounding Common Harvest Farm, I noticed a soybean field interspersed with tall weeds. Dan later told me that it was possible those were probably old corn crops that were resistant to herbicides. Even plants like corn can be considered weeds in circumstances like that.

Different weeds pose different challenges usually related to their ability to spread and the difficulty of removing them. Perennial weeds typically have large root systems, making them much more difficult to remove and harder for crops to compete with. At Common Harvest Farm, Dan showed how smallflower galinsoga, an annual weed, spreads. Each flower on the plant has a bunch of tiny seeds attached. These seeds attach themselves to farmers' clothes and farm equipment when there is dew on the ground, this makes it a very difficult weed to prevent from spreading.

Climate change causes a few problems in terms of weeds. First of all, weeds from warmer climates have the ability to spread to more temperate areas as the Earth gets warmer. Weeds are also much more resilient than crops due to the fact that they are so diverse. Weeds will be able to outcompete crops in a changing climate much more effectively than crops could adapt. There is also the increased possibility of natural disaster, which in its wake would bring more weeds; again because of their resilient nature (Amare 2016).

Weed Control

Out of all the weed control methods on Common Harvest Farm, cover cropping stood out the most to me. This was because of how many ways it benefits the farm. Cover cropping is simply planting a crop that grows in place of a crop that was just harvested. At the time of my visit, Common Harvest Farm had planted mustard as a cover crop. Cover crops absorb the nutrients in the soil, preventing them from being carried away by water. More importantly to this paper, they make it harder for weeds to grow, shading the soil and outcompeting most weeds.

If cover cropping is so useful, why isn't it used for every field of crops? The problem is how long the land is productive. Many crops stay productive for a long period of time, shortening the window of planting cover crops. For some crops, by the time they are no longer productive, it is already too late to plant cover crops.

It seemed like climate change overall had affected the cover crops themselves. The drought in the region combined with the warmer temperatures dried out the soil resulting in the cover crops being somewhat unsuccessful. Dan said that the "heat accelerates the life cycle of certain plants" making weeds go to seed faster which makes it more difficult to stop them from spreading. In this area it has been abnormally hot for typical fall temperatures making this a serious problem.

Some crops have a similar ability to outcompete weeds themselves. Crops with wider canopies can deprive weeds growing under them of the sunlight that they need to grow. Obviously, not all crops do this, but for the crops that do, it is an extra form of weed control built in. At Common Harvest Farm, the field of eggplant was an example of this. They were planted in close proximity to each other and had broad leaves that prevented sunlight from reaching the ground. These sorts of crops are generally lower maintenance than other crops. Dan explained that for plants without this natural weed prevention ability, they "have to dedicate more time to the weed control. More hoeing, [and] hand weeding." Peppers, a plant with very little canopy, were hoed 3 times while cauliflower and broccoli were hoed once.

Hoeing and other mechanical methods of weed control such as tilling and hand weeding were the last methods I saw used at Common Harvest Farm. These methods, especially hoeing and hand-weeding, require much more physical labor but are necessary for keeping weeds at bay.

All of the other methods available will not fully remedy the problem, so when weeds show up the farmers have to manually get rid of them.

Tilling, another form of mechanical weed control, is different from hoeing and hand weeding in that it is done before planting the crop. Tilling consists of breaking up and turning over the soil with machinery. It has multiple purposes but for weed control, it breaks up the root systems of any weeds in the soil and kills them. It works as a way of clearing the land for crops to be planted. The problem with tilling is that it leads to severe soil erosion because of how much it disrupts the soil. This inevitably raises the question: how much tilling should an organic farmer do if it is harmful to the land? Dan believes there isn't much of an option for organic farmers "because [they] can't use synthetic sprays, [they're] sort of left with mechanical solutions." Minimizing the amount of tilling and using more direct mechanical methods like hoeing and hand weeding is important but it is only something that can be done if there is enough labor available.

One thing I found very interesting about Dan's work with controlling weeds is his ability to "read the vegetation." It seems like over time, as a farmer, you become familiar with the land enough to understand what certain things mean. Whether it's what weeds are growing where, the height of certain crops, or by using cover crops, Dan can recognize where there might be a problem and what possible solutions are available. This knowledge of the land is something that is probably more prominent with organic farmers rather than large scale farmers due to their proximity to the land and the constant work they do to maintain it. As Dan said, "in organic farming we tend to do more observing."

A method Dan mentioned which the farm had more difficulty with was crop rotation. Crop rotation is the practice of changing which field you grow certain crops in after a certain amount of time. Typical monoculture farming encourages the growth of certain weeds that are adapted to grow alongside the crop. Generally, if a weed has similar needs to a crop, it will be more likely to grow near it. This is where crop rotation and intercropping can help. Crop rotation disrupts this process of weeds by changing the conditions of the field each rotation. Intercropping, which is just the practice of planting multiple crops in the same field, has the same effect. Disrupting weeds' adaptation to certain crops. This isn't to say that these methods eradicate weeds, because they can always adapt to different conditions, but they do seem to reduce the amount of weeds (Liebman 1993).

The difficulty with crop rotation at Common Harvest Farm is that there is not enough space to rotate crops effectively. On a small organic farm, you usually can't rotate crops far enough away for it to make enough of a difference. It is possible to do this by not growing a crop the following year but the CSA model makes it harder to do this because there are some staples that people expect to receive in their box every year. For Common Harvest Farm, economically, not producing some crops every year would be a bad decision.

During my time at Whetstone Farm, I saw another method of weed control that wasn't used at Common Harvest. Some of the rows were covered with plastic tarps, a practice called occultation that is meant to kill weeds under the tarp. Dan explained that occultation both encourages weed seeds to germinate and subsequently kills the weeds because there is no sunlight. The reason seeds will germinate below the tarps is because of the warmth that the tarps provide.

Dan told me that Common Harvest Farm doesn't use occultation for a few reasons. One of the reasons is Dan doesn't feel great about using large amounts of plastic on the farm. Organic farms especially have to weigh the option of using plastic even if it is a good form of weed control. The other reason Dan gave is because it is expensive to cover a large amount of land with enough tarps. Overall, it is a personal choice for different organic farmers whether or not it should be used, however it has proved itself quite effective under certain conditions (Birthisel 2018).

Conclusion

As the variability of the climate continues to get worse, organic farmers face worse weed problems than in the past due to weeds' diversity and ability to outcompete crops in a changing climate. And with conditions like drought worsening, certain weed control methods such as cover cropping have become less effective. Organic farmers must have a deep level of understanding of their land and crops to be able to effectively fight back against worsening weed problems. The methods laid out in this paper are what I saw in practice in order to control weeds on organic farms. Mechanical methods such as tilling, hoeing, and hand weeding are the dominant form of weed control and are very effective if timed correctly. Cover crops have many benefits to the farm and help outcompete weeds but can be susceptible to climate change as we have seen with the example at Common Harvest Farm. Some crops have more natural defenses against weeds and require much less weed control. Crop rotation and intercropping, similar to cover cropping, are very natural defenses against weeds and can disrupt the niche that weeds find in monocultures. However, organic farms with a small amount of land can struggle to put crop rotation into practice. Finally, occultation seems to be a promising form of weed control that might be a moral problem for some due to the large amount of plastic but can be quite effective if used properly. Some of the more sustainable weed control methods described here, such as cover cropping and crop rotation need to be supported more directly by the government in order to make organic farming a more sustainable practice. Especially in the case of crop rotation, there needs to be something in place that provides organic farmers with more land such as a land lease program that could be beneficial to both parties and subsidized by the government. Overall, organic farmers have a lot of weed control methods available to them. They just need to know when, where, and how to prescribe them in order for them to be successful

Sources

Amare, T. (2016). Review on impact of climate change on weed and their management. *American Journal of Biological and Environmental Statistics*, *2*(3), 21-27.

Birthisel, S. K., Gallandt, E. R., & Cunha, A. E. S. (2018). Solarization and tarping for weed management on organic vegetable farms in the Northeast USA. *Organic farming*

Bridges, D. C. (1994). Impact of weeds on human endeavors. *Weed Technology*, *8*(2), 392-395.

Liebman, M., & Dyck, E. (1993). Crop rotation and intercropping strategies for weed management. *Ecological applications*, *3*(1), 92-122.

Ziska, L., Crimmins, A., Auclair, A., DeGrasse, S., Garofalo, J. F., Khan, A. S., ... & Walls, I. (2016). Ch. 7: Food safety, nutrition, and distribution. *The impacts of climate change on human health in the United States: a scientific assessment*, *2016*, 189-216.

1.4 How does the amount of precipitation affect the spread of disease on plants?

Ethan Zhu

Introduction:

After a summer with abundant precipitation (Klister, 2024b), farmers in Wisconsin are facing several challenges related to excessive water. One of the key issues is the spread of plant diseases. During a field trip to Common Harvest, a vegetable farm in Wisconsin, farmers reported outbreaks of plant diseases following heavy rainfall. In light of this, it is important to examine the correlation between precipitation and the spread of plant diseases. This raises the research question: **"How does the amount of precipitation affect the spread of plant diseases?"**

To investigate this research question, a combination of research methods will be employed to explore the relationship between precipitation and plant disease from multiple perspectives. The findings will be presented in one section and subsequently compared with existing literature. After analyzing the results, the conclusion will summarize the findings and offer recommendations for managing plant disease outbreaks.

This topic is critical because it can help farmers address the challenges posed by excessive rainfall more effectively. This essay aims to provide an overview of the relationship between water and plant disease, offering guidance for managing plant diseases linked to precipitation. Additionally, by comparing findings with existing literature, the study will offer strategies to mitigate disease outbreaks and improve agricultural practices.

Research Method:

As mentioned in the introduction, this essay will employ a combination of research methods to answer the research question. These methods include fieldwork, interviews, and library research.

Fieldwork research will be conducted through a visit to Common Harvest, a vegetable farm located in Wisconsin. During this half-day trip, two farmers, Dan and Margaret, will discuss their farm and the challenges they face, including plant disease outbreaks. Real-life examples of plant diseases will be observed, and photographs will be taken to document the findings.

Interviews with the farmers will take place during the field trip and later through email, using a question-and-answer format. These interviews will provide insight into the farmers' understanding of the relationship between water and plant diseases. Additionally, the email interviews will allow for the discussion of other disease examples that may not be covered during the field trip due to time constraints.

Library research will involve reviewing literature on the relationship between precipitation and plant diseases, identifying diseases spread by water, and exploring strategies to manage these issues. Additional sources will be consulted to explain the mechanisms behind the diseases. Reports on weather conditions in Wisconsin will also be included to show precipitation trends.

Findings:

According to the weather summary from the Wisconsin State Climatology Office, the amount of precipitation this summer has been excessive. From June to August, the accumulated precipitation in many areas, including the location of Common Harvest, deviated from the normal range by 0 to 6 inches (Klister, 2024b). A diagram from this weather summary will be included to visually illustrate this data.

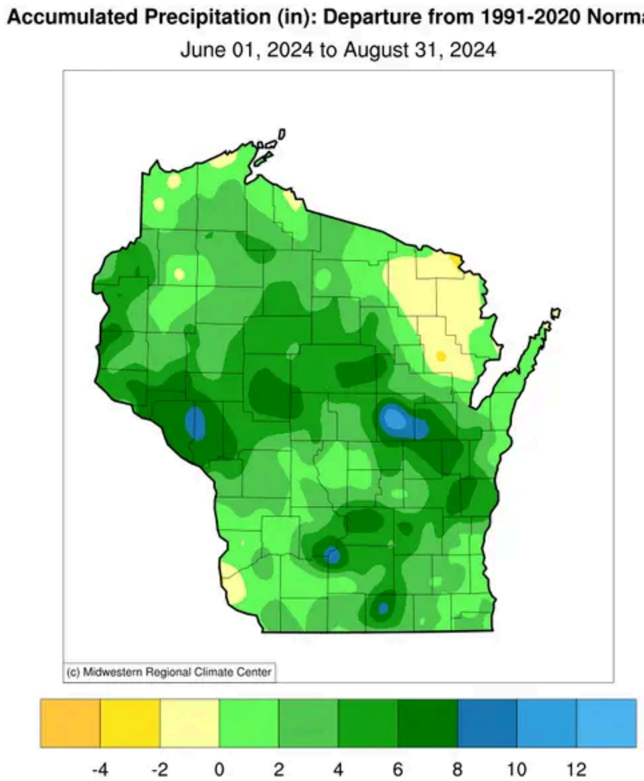

Figure1, Total summer precipitation departure from normal (Klister, 2024b)

During the field trip, farmer Dan discussed a plant disease called black rot, which is caused by fungi or bacteria that spread during and after periods of heavy rainfall. This disease primarily affects vegetables such as broccoli and cauliflower. The fungi or bacteria damage the leaves, reducing the plant's ability to photosynthesize, eventually leading to the plant's death. A photo taken during the field trip will be attached to illustrate this.

Figure 2, picture of black rot on cauliflower leaf taken during fieldtrip.

Additionally, a short interview conducted via email provided further examples of plant diseases that rely on water for their spread. By combining the findings from the fieldwork with examples from the interview, a table will be created listing the plants and their associated water-dependent diseases.

Example of vegetables	Related diseases
Onions	purple leaf blotch
Squash	powdery mildew
cauliflower	black rot

Table 1, a summary of example of vegetables and their related diseases.

The literature findings focus on analyzing the basics and common causes of plant diseases. One journal identifies three main types of phytopathogens (the agents responsible for diseases): viruses, bacteria, and fungi (Nazarov et al., 2020). Among these, moisture plays a significant role in enabling phytopathogenic fungi to penetrate plant tissues (Rowlandson et al., 2015), while drier conditions can promote the spread of bacterial diseases (Nazarov et al., 2020). For instance, with an annual increase in average summer temperatures of 3–4°C, the prevalence of bacterial diseases has been shown to double (Nazarov et al., 2020).

Additionally, information from websites helps clarify the causes of the diseases mentioned in the interviews and listed in the table. For example, purple leaf blotch is caused by a fungus called *Alternaria porri* (Utah State University, 2024), and powdery mildew is another disease caused by various types of powdery mildew fungi (Newman & Pottorff, 2024).

Discussion:

In this section, I will integrate findings from the three research methods to examine the relationship between precipitation levels and the spread of plant diseases caused by different phytopathogens.

I'll begin by discussing the connection between precipitation and fungal diseases, as all three diseases identified fit within this category. From a broad perspective, scientific knowledge about fungi aligns with farmers' observations of disease outbreaks. While farmers notice an increase in disease symptoms, scientific research confirms that all three diseases are caused by fungi. Furthermore, research shows that fungi can germinate more quickly in wet conditions, as moisture helps them attach to plant leaves (Rowlandson et al., 2015). Considering that moisture influences fungal spread, we can use weather data to explain the outbreak of fungal diseases on the farm. Due to the excessive rainfall, the environment becomes wetter, creating ideal conditions for fungal growth and reproduction, leading to the spread of fungal diseases. By combining findings from all sources, we can conclude that higher precipitation positively affects the spread of fungal diseases. Conversely, reducing moisture could inhibit fungal germination, negatively impacting the spread of fungal diseases as precipitation decreases.

However, the effect of precipitation on specific fungi varies. For example, powdery mildew remains problematic even in dry, warm conditions because it does not require water on the leaf surface for infection, though it still needs moisture for germination (Newman & Pottorff, 2024). On the other hand, black rot spreads rapidly in high-moisture environments (Marsden, 2018). Therefore, the same level of precipitation can have different effects on various fungi.

When it comes to bacteria- and virus-related diseases, the impact of precipitation is less clear than with fungi. Bacterial diseases are more temperature-dependent, thriving as temperatures rise. Although reduced water could potentially promote bacterial outbreaks due to increased evaporation, there is no strong evidence in the literature to support this claim. Additionally, farmers did not report bacterial diseases during the rainy period, suggesting that precipitation has little influence on the spread of bacterial diseases. The same reasoning can be applied to virus-related diseases. This indicates that precipitation impacts fungi-related diseases more significantly than bacteria- or virus-related diseases.

Given the spread of fungal diseases, it is important to propose solutions.
The simplest way to address the issue is through chemical fungicides. While this method could be used in extreme cases to maintain crop yields, it has significant downsides, including

environmental damage that could make the land more vulnerable to future challenges.

A more sustainable approach is to build plant resilience to these diseases. One journal introduces the concept of "ten principles of agricultural practices," which include soil, nutrition, water, seed, population density, plant protection, field management, machinery technology, light, and air (He et al., 2016). By monitoring these elements, farmers can create conditions that promote healthy plant growth while suppressing disease. For example, reducing the amount of water on plant surfaces can limit fungal reproduction. Since fungi often thrive on wet leaves, using drip irrigation could prevent water from lingering on leaves and stems. Additionally, breathable covers could be placed over fields to keep precipitation from settling on plant surfaces. These practices would help reduce environmental moisture, making conditions less favorable for fungal growth.

Although this method has drawbacks, including time-consuming processes and the need for research support, it is a practical solution. While difficult to implement on a large scale, complex systems like this have been successful in controlling rice blast (*Magnaporthe oryzae*) and tungro (*Rice tungro virus*) on a large scale (He et al., 2016). Thus, this approach offers a feasible way to address the issue.

Conclusion

By analyzing and discussing the results from the three research methods, I have identified the following key findings:

1. Plant diseases can be categorized into bacterial-related, fungi-related, and virus-related diseases. Precipitation levels have different effects on each category.
2. For fungi-related diseases, increased precipitation generally promotes their spread. Conversely, reducing precipitation can slow down the spread. This finding extends to the role of standing water, which has a similar effect on fungal disease spread as precipitation.
3. Within the fungi-related category, different fungi respond differently to the same amount of precipitation.

4. Precipitation has a significantly smaller impact on bacterial- and virus-related diseases compared to fungi-related diseases.

These conclusions are drawn from a combination of literature review and farm observations, making them closely aligned with existing research.

A recommended approach to controlling the spread of fungi is to monitor the farm as an ecosystem, following the "ten principles of agricultural practices." By creating conditions unfavorable for fungal growth—such as using drip irrigation or employing field covering techniques—the spread of fungi can be managed to some extent. While this method may be labor-intensive, the long-term benefits are likely to outweigh the efforts required.

References

HE, D., ZHAN, J., & XIE, L. (2016). Problems, challenges and future of plant disease management: from an ecological point of view. *Journal of Integrative Agriculture*, *15*(4), 705–715. https://doi.org/10.1016/s2095-3119(15)61300-4

Klister, E. (2024a, June 30). *June 2024 Climate Summary | Wisconsin State Climatology Office*. Wisconsin State Climatology Office. https://climatology.nelson.wisc.edu/june-2024-climate-summary/

Klister, E. (2024b, August 30). *August and Summer 2024 Climate Summary | Wisconsin State Climatology Office*. Wisconsin State Climatology Office. https://climatology.nelson.wisc.edu/august-and-summer-2024-climate-summary/

Marsden, C. (2018, February 28). *Black Rot of Crucifers*. Wisconsin Horticulture. https://hort.extension.wisc.edu/articles/black-rot-crucifers/

Nazarov, P. A., Baleev, D. N., Ivanova, M. I., Sokolova, L. M., & Karakozova, M. V. (2020). Infectious plant diseases: etiology, current status, problems and prospects in plant protection. *Acta Naturae*, *12*(3), 46–59. https://doi.org/10.32607/actanaturae.11026

Newman, S., & Pottorff, L. P. (2024, May 13). *Powdery Mildews - 2.902*. Extension. https://extension.colostate.edu/topic-areas/yard-garden/powdery-mildews-2-902/

Rowlandson, T., Gleason, M., Sentelhas, P., Gillespie, T., Thomas, C., & Hornbuckle, B. (2015). Reconsidering Leaf Wetness Duration Determination for Plant Disease Management. *Plant Disease*, *99*(3), 310–319. https://doi.org/10.1094/pdis-05-14-0529-fe

Utah State University. (2024). *Purple Blotch*. Usu.edu. https://extension.usu.edu/planthealth/ipm/notes_ag/veg-purple-blotch

1.5 Looming Plague and a Rotting Breadbasket: How climate change will facilitate the spread of disease in the American Midwest

Anonymous

The American agricultural ecosystem is one of the most complex industries on the planet. Together the systems of planting, irrigation, harvesting, supply chains, and sellers all connect to bring food to over 330 million people. This production is spread out over 879 million acres of farmland ("How Will Climate Change Affect"), an area four times larger than the nation of Nigeria. Within this system, one of the most important regions is the Midwest, roughly defined as the 10 states between the Missouri and Ohio Rivers. The region accounts for about 80 percent of total U.S grain production and 27 percent of total agricultural output (Ates 2023).

This vital element of American food security does, however, face several threats that will likely have significant consequences for the nation. One such threat is economic. The combination of increasing costs and softening crop prices have contributed to rising farm debt. For example, data from the USDA show that farm debt in Illinois has been increasing since 1991. A number would be usefulThose same economists project 2024 farm incomes will be 25% lower than in 2023 ("2024 Farm Sector").

Despite the impact of these economic factors, they do not pose as great a threat as climate change, which poses an existential threat to Midwestern agriculture. Therefore, it also poses a threat to the livelihoods of millions of farmers and the food security of millions more. The major forms of climate change affecting the Midwest include earlier first/last frost dates, changing rainfall patterns and rising average temperatures. The result of these factors is an increase in the habitable range and virulence of plant diseases and pests–a potent threat.

Before analyzing the effect on farmers and the agricultural industry, it is important to answer two questions: (i) how much has the temperature actually changed and (ii) how does it affect the broader population of the Midwest? The air temperature has increased by more than 1.5 degrees fahrenheit (0.83 degrees celsius) since 1900 (EDF How Will Climate). The rate of this increase is accelerating and the belief is: “there will be more days over 95 degrees fahrenheit and less days below 65 degrees.” said Minnesota DNR climatologist Kenny Blumenfeld during a lecture at Macalester College. This average rise is likely to accelerate energy demand as more people and industry require air conditioning.

Additionally, the upward trend in average temperatures is causing a longer pollen season, contributing to air pollution. Rising temperatures in the Midwest are also exacerbated by the effects of El Nino: an event where Tropical Pacific surface temperatures increase causing more rapid evaporation of seawater. The North-Midwestern states, namely Minnesota and Wisconsin, are especially disturbed by this effect. El Nino’s influence on the Midwest heavily affects the winter and will be an important factor in the future.

Another factor contributing to the vulnerability of American agriculture to climate change is the reliance on a small number of crops. The “star-player” in the US, and particularly in the Midwest is corn, which alone makes up about 28% of the total crop area harvested (Ates 2023). This near-monocultural system allows diseases to spread rapidly across fields without needing any adaptations to kill the crops. According to Wisconsin farmer Dan Guenthner, one of the pests that has proved a challenge to Midwestern farmers is the Colorado Potato Beetle. This insect and its larva consume the leaves of a potato plant, cutting off the crop’s source of photosynthesis and killing it.

Pathogens are also a major difficulty for farmers. The two main types of crop diseases are abiotic, which are non-infectious, and biotic, which are infectious. These categories are based on if the pathogen is external, caused by environmental factors, or if it came from another plant. Corn and another Midwestern staple, soybeans, both suffer from a wide range of diseases, such as red root rot and white mold respectively. The threat of disease and infestation are significant, and climatic shifts only increase that risk (Nix 2024).

Although considered by most as a detriment to plants, farmers recognize freezing temperatures as a vital part of the success of the following growing season. This is because, not only does frost act as an important trigger for the lifecycle of many plants, such as members of the allium family (onions, garlic, shallots), it also serves as a means of purging the local environment of diseases and weeds. Bacterial pathogens in particular have a hard time surviving prolonged periods of freezing temperatures. Many diseases, and especially viruses, are resilient to cold temperatures due to adaptations. In this case, cold winter temperatures slow down their spread by denying them hosts as most crops haven't been planted or germinated yet. Mold, another major scourge of fields, stops releasing spores over the winter, curbing its spread (Nix 2024). Unfortunately for farmers, the main mold colony survives.

Finally, insects serve as one of the most efficient ways for disease to spread from field to field; the cold kills off mature insects as well as any larva. Insect eggs, buried underground, often survive the cold, not hatching until temperatures rise. This is where the issue of rising temperatures and a shorter frost season becomes a significant problem. If the first frost comes later in the year, insects have more opportunities to live out another life-cycle, spreading more eggs. If the last frost date is earlier in the growing season, it can interact negatively with the annual January thaw that occurs in some Midwestern states. January Thaw is an event that occurs in northeastern states, where for roughly a week in mid to late January, temperatures rise briefly. If this period grows longer due to increasing temperatures, crops could potentially sprout. When the temperature dropped again after the thaw, the plants would either be killed or left vulnerable to disease. Frost, although detrimental in some ways, also has a host of benefits for farmers.

Another double-edged sword in the agricultural world is precipitation. Rain is obviously vital as it alleviates some of the need to irrigate and deplete natural sources of water. Standing water, however, does pose a risk to plants since it acts as a breeding ground for a variety of bacteria. Additionally, it can be a major stressor for plants, weakening their ability to fight off diseases, or simply begin rotting the root system. Farmers have several strategies to avoid water collecting near crops, such as avoiding building with solid surfaces and having lagoons for the water to flow into (Hoidal). These strategies are being undermined by a worrying shift in Midwestern precipitation patterns. The light spring rains have been replaced with fewer, but more intense downpours ("Climate Impacts on"). These bursts of precipitation "overload" the previous strategies and cause water to begin pooling again. Water full of bacteria isn't only a threat to plants, it is a danger to livestock and humans as well. One of the most prominent barnyard pathogens is Escherichia Coli, more commonly known as E. Coli. Often found in manure, it quickly replicates in water and can be a serious illness, especially to swine, where it can kill piglets (Margarida, Castro, Et. al 2023). Manure lagoons, pits where excess waste from animals is dumped, risk flooding and pouring over into pastures or worse, freshwater reservoirs. Similarly to bacteria, mosquitoes also thrive around still water. They lay their eggs on the water's surface in small groups (Hoidal 2024).

Despite the long list of dangers excess rain can provide, there are a few disease related threats a dry season can bring. The main concern is the weakening of the potential host plant. Dry seasons place significant stress on a plant, forcing it to close its stomata (pores) to conserve water, which halts gas exchange and therefore food production. Stressed plants are more susceptible to being infected by a disease and have a worse reaction to said infection. In conclusion, precipitation needs to strike a fine balance for healthy crops. This, however, is unfeasible, and farmers need to adapt to a more extreme climate.

A non-precipitous form of water that carries diseases is dew. Dew drops act as a medium for crop-killing agents, fungi in particular, to move around entire regions. Fungi reproduce by expelling their spores into the air, where they attach to microscopic moisture droplets. These infected droplets then condense on leaves, flowers, and fruits, spreading the fungus to a location potentially hundreds of miles away. This coincides with climate change because warmer air has a greater capacity for carrying moisture, which can condense into dew drops. El Nino (the cyclical warming of the Tropical Pacific) also has a significant effect on humidity because the event releases and moves massive amounts of moisture. Warmer temperatures not only hold more moisture in the air, but they also increase the rate of evaporation, leading to stronger El Nino related events. This cannot be prevented with the technology currently available, and leaves farmers with little choice. The development of crops that are immune to diseases and inconsistent or extreme weather is an expensive investment in both time and money, two things that are in short supply for America's farmers..

Similarly to the effects of standing water, warmer air temperatures aid the survival of invasive insect species further north. This means a greater variety of crop pests, as well as an increase in already present populations. Environmental journalist Christiana Jansen stated that "Under current greenhouse gas (GHG) emissions, it is estimated that half of all insects will advance their distribution range by 50% by 2100" (Jansen 2023). Species in the United States that could see the greatest population growth are: Colorado potato beetles, corn borers, and corn rootworms (EOS Data).

With all of this information, the odds seem overwhelmingly stacked against the Midwestern farmer. There are, however, several options farmers can mitigate these climatic effects. One solution is greater crop rotation, a concept developed and adopted as early as 6000 BCE. One of the many benefits of crop rotations is reducing pests and crop diseases. By rotating crops, pathogens with a limited host range will be unable to survive and reproduce.

Another option is the development of climate-resistant crops in order to "future-proof" American agriculture. They produce a greater crop yield, but more importantly these plants are less susceptible to extreme heat and drought (Morrison 2024). Crop research is time consuming and expensive. It can take several years for new plant varieties to move from the lab to the field. Therefore, farmers cannot be expected to fight these battles alone.

Food production is vital not only to the survival of millions, but also to the everyday political stability we take for granted. Therefore, external sectors and parties such as biotech, meteorological and manufacturing are all needed to build a more sustainable agricultural society. Early detection systems for extreme weather, and engineered crops that do not grow an inferior product are only two examples of ideas that could save thousands of farms. Federal and local governments, of course, must continue to take a major role in food security. Researching, forming, and enacting bills that benefit farmers as well as the environment. For instance, incentivizing polyculture by giving subsidies to farmers who move from growing one crop to multiple ones.

Climate change is a global crisis. If the current predictions of warming, sea level rise, and weather severity are correct, not a single person on the planet will be unaffected by the changing climate, including those who produce our food. Farmer's face a host of environmental threats, including inconsistent winter freezing, unpredictable and extreme weather, and expanding habitats for crop and livestock threatening species. Frost is one of the most vital and defining factors for farmers, no matter their size. The cold down period acts as a staging ground for the coming war against pathogens, fungi, and insects. As this sub-freezing period gradually shrinks, farmers lose time in which they can plant early year crops and plan rotations to keep the soil rich and the parasitic threat starved. Moving on to weather patterns. Shifts in precipitation have replaced gentler, absorbable showers with intense and inconsistent downpours. Standing water was already a hazard to livestock, humans and plants; but mixed with bacteria found in animal waste it becomes an even more potent threat. Finally, increasing air temperatures raise concerns of new pests and diseases being introduced alongside the more efficient spread of pre-existing ones. As previously mentioned, however, there are a myriad of options to brace farmers for what seems like a potentially unavoidable struggle. The responsible deployment of genetically engineered crops and weather alert systems would give a necessary advantage to farmers around the world, not just in the American Heartland. In conclusion, resilience and persistence are the key to success and to survival in the face of devastating environmental change.

Research Summary:

It is important to divulge the research methods used in this paper. The majority of my sources were online articles, published both by government agencies and independent websites. Of the public and government sources those from the USDA, EPA, and University of Minnesota were especially important; as they contained both general and regional data. The American Midwest is a massive region, so a blend of broad and specific sources allowed me to form a more universal and cohesive argument. As for the independent websites, Earth.org was instrumental in my solutions paragraph, with clear examples of possible or already implemented solutions. Finally, I also had the pleasure of receiving two in-person lectures from Dan Guenthner, a farmer from north-western Wisconsin, and Kenneth “Kenny” Blumenfeld, a senior climatologist at the Minnesota Department of Natural Resources.

Work Cited:

2024 farm sector income forecast. USDA ERS - Farm Sector Income Forecast. (n.d.). https://www.ers.usda.gov/topics/farm-economy/farm-sector-income-finances/farm-sector-income-forecast/

Ates, A. M. (2023, December 21). *Feed grains sector at a glance*. USDA ERS - Feed Grains Sector at a Glance. https://www.ers.usda.gov/topics/crops/corn-and-other-feed-grains/feed-grains-sector-at a-glance/

Barros, M. M., Castro, J., Araújo, D., Campos, A. M., Oliveira, R., Silva, S., Outor-Monteiro, D., & Almeida, C. (2023, March 30). *Swine colibacillosis: Global Epidemiologic and Antimicrobial Scenario*. Antibiotics (Basel, Switzerland). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10135039/#:~:text=Porcine%20infection%20caused%20by%20Escherichia,urinary%20tract%20infection%20%5B1%5D.

Crop diseases: How to identify, control, and prevent. EOS Data Analytics. (2024, May 10). https://eos.com/blog/crop-diseases/

"El niño" is coming. What might that mean for Minnesota's weather? Minnesota Department of Natural Resources. (2024a, February 22). https://www.dnr.state.mn.us/climate/journal/el-nino-oct-2023.html#:~:text=In%20Minnesota%2C%20El%20Ni%C3%B1o%20conditions,inches)%20in%20the%20Twin%20Cities .
Hoidal, A. N. (n.d.). *Preventing plant diseases on farms*. UMN Extension. https://extension.umn.edu/vegetables/preventing-plant-diseases-farms#:~:text=Manage%20weeds%20in%20and%20around,and%20no%20rain%20is%20forecasted.

How will climate change affect the Midwest?. Environmental Defense Fund . (n.d.). https://www.edf.org/sites/default/files/content/regional_releases_midwest.pdf

Jansen, C. (2023, August 28). *Bioengineering climate-resilient crops to safeguard global food security*. Earth.Org.
https://earth.org/bioengineering-climate-resilient-crops-to-safeguard-global-food-security /

Morrison, R. (2024, June 6). *11 ways farmers are adapting to climate change*.
Earth.Org.
https://earth.org/11-ways-farmers-are-adapting-to-the-unpredictability-of-climate-change /#:~:text=Many%20farmers%20are%20adopting%20high,demand%20and%20conserve s%20natural%20ecosystems.

Nix, J. (2024, August 27). *5 soy crop diseases: Ensuring crop health in the midwest USA*.
Biome Makers.
https://biomemakers.com/blog/soy-crop-diseases-ensuring-crop-health-in-the-midwest-u sa

US EPA. Climate Impacts in the Midwest | Climate Change Impacts | US EPA. (n.d.).
https://climatechange.chicago.gov/climate-impacts/climate-impacts-midwest#:~:text=Th e%20Midwest%20has%20gotten%20warmer,more%20than%201.5%C2%B0F.

Chapter 2

Vulnerability, Resilience, and Transformation

By: Zach Marshak, Zhijun He, and Riley Pearce

2.1 Creating Resilient and Sustainable Agriculture Through Hybrid Conservation Methods

Zach Marshak

Introduction:

The Farm Bill was introduced in 1923 to address the economic and environmental effects of the Dust Bowl. Since then, it has been updated approximately every five years. It sets budgeting and policy for agriculture in the United States. In this essay, the author sets out to find the impacts of the Farm Bill and the programs it has created on sustainable farming. Furthermore, it investigates how it can be improved to support sustainable agriculture, yet is still relevant in today's ever-changing environment and economy.

Historically, the Farm Bill has created policies and programs that have supported farmers while also helping conserve the environment. One of the critical issues before the Farm Bill was to stop the overproduction of crops and to create a stable economic environment in which family farms could survive. However, as the bill has developed, it has shifted towards subsidy-focused farming, benefiting large industrial farms at the cost of small family farms. Additionally, while Farm Bill conservation programs have helped with soil erosion, water quality, and nutrient management issues are still widely prevalent. The Farm Bill has helped the United States out of agrarian crises before, and it's the key to doing so again. However, we must learn from past mistakes to provide a sustainable and resilient future.

Methods:

To find solutions to promote sustainable agriculture that is economically and environmentally resilient, it is necessary to look at the issues that past and current federal policies and programs have caused and what can be learned from them. Introductory, scientific, and advanced sources that reviewed the Farm Bill's overall impact and the programs it has created were used to examine those issues. The author then looks at potential solutions for these problems. The primary source of research for this paper came from an overview of scholarly articles from academic journals accessed online.

Overview and Critiques of the Farm Bill*:*

The Farm Bill was legislation born from the Great Depression and the Dust Bowl. Its original purpose was to help revive American agriculture and provide a sustainable future for the "Farm Family." Economically, it sought to fix overproduction and farm bankruptcy(Graddy-Lovelace & Diamond, 2017, p. 76). While environmentally, it sought to protect soil health and curb soil erosion(Medina, Isley, Arbuckle, 2021,p. 174). Historically, supply management and subsidies have been used to develop agricultural and conservation programs. However, there has been a heavy shift towards subsidy-focused farming in recent decades. The 1933 Agricultural Adjustment Act was one of the first supply management methods to come out of the Farm Bill. It set price floors for high-value crops such as corn, and it "aimed to keep prices in a narrow band that would balance the interests of farmers and consumers."(Graddy-Lovelace & Diamond, 2017, p. 76) This worked in tandem with subsidies to offer farmers loans at set prices, and if the prices dropped, farmers would forfeit their crops in return for repayment. However, as time passed, policy shifted away from supply management policy and more heavily towards subsidies. Graddy-Lovelave and Diamond argue that the death of supply management techniques came from the 1996 Federal Agricultural Improvement and Reform Act. Stating it pushed forward " a radical shift in U.S. farm policy: the twin pillars of price supports and production controls had been significantly weakened by the 1990 Farm Bill, but in 1996 were done away with completely."(p. 77). More and more money was given to growers, leading to one of the critical issues with the United States subsidy-focused agriculture policies.

While the Farm Bill was initially meant to help small "farming families," it has drastically shifted away from that; it has now created an unsustainable agriculture system heavily influenced by massive corporations and mega-farms. Many critiques of the Farm Bill stem from its now subsidy-focused policies, which incentivize the growth of certain crops such as corn and soybeans. While supporting agricultural systems may seem like a good idea, it has consolidated the market. E. C. Pasour describes this consolidation of production as cartels, "acting together to restrict competition"(Pasour, E. C., 1980, p. 29). Big farmers restrict the resources, or subsidies, to a select few, which comes at the expense of small farmers. This comes at a cost to producers and consumers, as it limits their agency. When production power is mainly in the hands of only a few, it limits consumer choice, as these "cartels" often affect the price of goods. Furthermore, Graddy-Lovelace and Diamond argue this consolidation from mega-corporations takes power away from farmers but puts all the risk on them(Graddy-Lovelace & Diamond, 2017, p. 73-74).

Subsidy-focused policy has also led to environmental problems, which have created a more vulnerable environment for growth. The 1996 Farm Bill based support prices by the bushel, while acreage restrictions were meant to limit overproduction. However, this meant producing the same yields on smaller land(p. 76). Often, practices to achieve such as GMOs, pesticides, and chemical fertilizers heavily damage the environment. Additionally, the Farm Bill has incentivized the growth of certain crops, leading towards a heavy focus on monocultures. William Eubanks argues that the overshadowing of local polycultures has created an “unbalanced agricultural system that pollutes our air and leads to serious public health concerns.”(Eubanks, W. S., 2009, p. 39) Monocultures are both resource intensives as they require heavy amounts of chemical fertilizer and are quite vulnerable. The subsidization of them makes both the economy and the environment more vulnerable. The Farm Bill must move away from monoculture-focused farming toward more sustainable and resilient agriculture.

Solutions:

One of the solutions to conservation in the Farm Bill is to integrate conservation efforts into risk management policy. Farm Service Agency director Jonathan Coppess offers the idea of hybrid conservation, allowing multiple farming systems to exist simultaneously. These aren’t strict measures that require all farmers to follow set rules; instead, they benefit farms that follow good land stewardship practices. He suggests incentives for good land stewardship should be placed in risk management programs subsidized by taxpayers. Additionally, Taxpayers would benefit from this in the form of environmental benefits, such as cleaner water. Coppess presents the Best Management Practices(BMP) as a way to support crop sustainability and nutrient loss. He notes that, in the current state, the cost of such practices puts farmers at a disadvantage as the only support for its cost share and crop insurance program is only triggered by low crop prices(Coppess, 2016, p. 3). He lists three support methods through which BMP practices could be incentivized. First, through price and revenue guarantee programs, BMP practices would have an estimated cost added to the benchmark price. Therefore, farmers who practice BMP trigger early payment and “receive larger payments for the same level of decline”(p. 3-4). He also offers increased payments based on base acres, crops eligible for enrollment in federal risk management programs, for those who adopt BMP. BMP farmers would receive payments based on a higher percentage of their crops. He also offers higher subsidy rates towards crop insurance premiums for those who adopt(p. 4). Coppess contends that the vital point of this proposed solution is that it is adjustable. It can still promote conservation methods while still helping "farmers with the risks inherent in production via the counter-cyclical and risk-based features of existing farm programs," and it provides an opportunity to reach more acres of land compared to current conservation support(p. 4). Furthermore, Coppess presents issues with his proposed solution. He notes that it is limited by budget constraints, stating the key to future Farm Bills lies in the "obscure Federal budgeting process" and "estimates created by the Congressional Budget Office"(p. 5).

Coppess's proposal offers an attractive market-based solution to the environmental issues inherent in modern industrial farming. One issue farmers face is the cost of sustainable practices, but incentivizing them gives farmers agency in how they conduct their practices while still emphasizing sustainability and conservation. The idea of hybridity offers a step toward more sustainable farming while still keeping the needs of farmers in mind. It creates a more robust support system for sustainable agriculture, making it more economically viable and resilient. It could be argued that this may be too small of a step toward sustainability in agriculture, as it doesn't fully enforce conservation practices, and that industrial farming methods may still be cheaper on a large scale. However, this solution can offer a lifeline for small farms and allow them to be sustainable without being economically disadvantaged. A hybrid market-based solution could be a viable way to make sustainable agriculture more resilient economically.

Another possible solution is expanding current conservation programs. The Farm Bill includes four critical conservation programs: the Conservation Stewardship Program (CSP), the Environmental Quality Incentives Program (EQIP), the Crop Reserve Program (CRP), and conservation compliance. Gabriel Medina, Catherine Isley, and J. Arbuckle interviewed farmers and environmental organizations in Iowa to see how the programs, as mentioned earlier, could be improved. These stakeholders believed these programs positively impacted farmers and the environment; however, they mentioned that minor tweaks could make them stronger(Medina, Isley, Arbuckle, 2021, p. 180). It is also important to note that such programs in the past have promoted systemic racism through disproportionate access to the mentioned programs by a majority of white landowners(Graddy-Lovelace, Diamond, & Ichikawa, 2017, p.354). In general, they mentioned how programs need to be more flexible so that more farms can be included in such programs and to allow farmers more room to adapt to changing conditions. One of the changes stakeholders mentioned was increased funding for CSP to make the program available for more farms. Furthermore, farms mentioned fewer strings attached to the program, while environmental groups wanted more targeted goals and similar ideas were mentioned for EQIP programs. Farmers also mentioned that CRP programs were too restrictive and that the marginal land still had use for certain activities such as grazing(Medina, Isley, Arbuckle, 2021,p. 184-185). On Conservation Compliance, groups were in-between on great flexibility to account for "extreme weather" and more stringent enforcement of conservation policy. Still, there was agreement on "resuming enforcement and systematic spot checks to some degree."(p. 185). There were mixed feelings about how current programs could be adapted, but a mixture of stricter regulation and more flexible goals could be a step in the right direction.

The feedback from stakeholders in Iowa farming shows conflicting viewpoints on how to approach conservation in agriculture better. On the one hand, the idea is that programs should be expanded through increased funds and fewer strings attached for farms, as this would allow more farms to join programs. However, some argue that while increased funding can benefit, broader goals can make programs less effective. This ties into Coppess's idea of hybridity in such a system. There can't be a one-size-fits-all solution, as there needs to be a balance between farmers' livelihoods and the environment's health. While specific targeted goals are the end goal, smaller steps must be taken before that is reached, and one way to do so is to provide flexibility in conservation programs. However, progress checks must be necessary to ensure progress towards a significant and specific end goal.

Conclusions:

Many agree that in its current state, the U.S. agriculture system is not sustainable and is vulnerable to vastly changing economic and environmental conditions. It is a crucial point where something must be done to change agricultural policy approaches. In the past, the Farm Bill offered a way out of agricultural crises. However, it is now creating a deeper hole. While it initially provided a way to promote conservation in farming and help support the "farming family," it now supports the interests of mega conglomerates that have a grasp on production. They have done this through the government's backing through subsidies, which have promoted higher yields and supported monocultures. This consolidation has made the market more fragile as, essentially, these "cartels" depend on subsidies. Furthermore, the support of monocultures has made ever-so-fragile environments even closer to collapse. The use of chemical pesticides in tandem with monoculture has led to the issue of massive nutrient runoff, which has poisoned the water and eroded the land.

There are many solutions to how the Farm Bill can create and support a resilient and sustainable system, but this issue is that there is no one-size-fits-all solution. Farms' livelihoods and the conservation of the environment must be balanced. While many seek to farm sustainably at this moment, it is not economically viable for most small farmers. Coppess offers the idea of a hybrid system that incentivizes sustainable farming methods. Additionally, Medina, Isely, and Arbuckle offer adjustments to current conservation programs. While these solutions don't offer vast, overwhelming change, they provide a starting point. They serve as a middle ground between farmer livelihood and environmental sustainability. Broad change and specific set goals for sustainability can not come immediately; they must be built upon, and hybrid farming systems offer a way to provide a stepping stone towards a more viable and sustainable future.

Works Cited

Coppess, Jonathan. "The next farm bill may present opportunities for hybrid farm-conservation policies." Choices 31, no. 4 (2016): 1-8.

Eubanks, W. S. (2009). The Sustainable Farm Bill: A Proposal for Permanent Environmental Change. Envtl. L. Rep. News & Analysis, 39, 10493.

Graddy-Lovelace, G., Diamond, A., & Ichikawa, N. F. (2020). Contextualizing the Farm Bill: questions of food, land, and agricultural governance. Renewable Agriculture and Food Systems, 35(4), 352-357.

Graddy-Lovelace, G., & Diamond, A. (2017). From supply management to agricultural subsidies—and back again? The US Farm Bill & agrarian (in) viability. Journal of Rural Studies, 50, 70-83.

Medina, G., Isley, C., & Arbuckle, J. (2021). Promoting sustainable agriculture: Iowa stakeholders' perspectives on the US Farm Bill conservation programs. Environment, Development and Sustainability, 23(1), 173-194.

Pasour, E. C. (1980). A critique of federal agricultural programs. Journal of Agricultural and Applied Economics, 12(1), 29-37.

2.2 Climate-Resilient Infrastructure and Food Security: A Case Study of Common Harvest Farm in the Upper Midwest

Zhijun He

Abstract

This paper examines the impact of climate-resilient agricultural infrastructure on smallholder farmers' adaptive capacity, economic outcomes, and contribution to food security in the Upper Midwest, focusing on Common Harvest Farm in Osceola, Wisconsin. Through a case study approach, including field visits and in-depth interviews, the research explores how targeted infrastructure investments and decentralized governance models can enhance farm resilience and viability. This paper will examine how climate-resilient infrastructure investments affect smallholder farmers' adaptive capacity, economic outcomes, and food security contributions while also exploring the role of decentralized governance in these processes. The study finds that investments in climate-smart technologies, diversified farming practices, and community engagement improve adaptive capacity and economic stability, contributing to multiple dimensions of food security.

1 Introduction

Climate change challenges agricultural production and food security in the Upper Midwest of the United States. Increasing weather variability, from severe droughts to excessive rainfall, threatens crop yields, livestock health, and farm viability, particularly for smallholder farmers in the region (Moseley 2012). In this context, investment in climate-resilient agricultural infrastructure has become crucial for enhancing the adaptive capacity and economic outcomes of small-scale producers while also ensuring food security. This paper explores the role of climate-resilient agricultural infrastructure in supporting smallholder farmers in the Upper Midwest, with a focus on Common Harvest Farm in Osceola, Wisconsin, addressing the following research question:

How does investment in climate-resilient agricultural infrastructure affect smallholder farmers' adaptive capacity, economic outcomes, and contribution to food security, and what role can decentralized governance

1

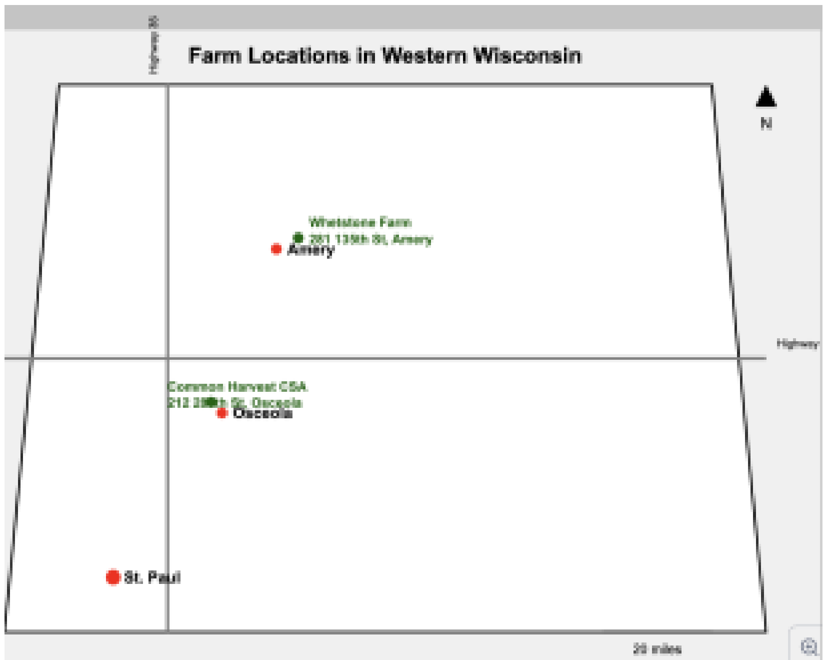

Figure 1: Farm Locations in Northwestern Wisconsin.

play in prioritizing and implementing these infrastructure projects?

By examining this question, the paper aims to assess the potential for targeted infrastructure investments to improve small-scale alternative agriculture's resilience, viability, and food security contributions in the Upper Midwest. It will consider the impacts of infrastructure on farm operations through the lens of the six dimensions of food security: availability, access, utilization, stability, agency, and sustainability (HLPE 2020).

Food security has evolved since its initial focus on food availability in the 1970s. By the 1980s, it had expanded to encompass access, utilization, and stability (FAO 1982; World Bank 1986). This broader understanding recognizes that hunger is not only a product of food supply but also of socio-economic condi tions that shape demand and people's ability to access Food

(Burchi and De Muro 2016)Foodre recently, the High-Level Panel of Experts on Food Security and Nutrition (HLPE) proposed adding two more dimensions: agency and sustainability (HLPE 2020). This six-dimensional framework provides a more comprehensive approach to addressing food security challenges. For smallholder farmers, who produce a significant por tion of the world's Food but often face Food insecurity, Climate-resilient infrastructure, such as improved irrigation systems, weather-resistant storage facilities, and farm-to-market roads, can help smallholder farm ers adapt to changing climate conditions while improving their food security outcomes and address all the six dimensions. Also, investments in renewable energy for agriculture and information and communication technologies can enhance farmers' agency and contribute to the overall sustainability of food systems (FAO 2018; Lipper et al. 2014).

Dimension	Description
Availability	Sufficient quantities of Food available on a consistent
Access	Having sufficient resources to obtain appropriate foods for a nutritious diet
Utilization	Appropriate use based on knowledge of basic nutrition and care, as well as adequate water and sanitation
Stability	The ability to obtain Food over time
Agency	The capacity of individuals or groups to make their own decisions about what foods they eat, what foods they produce, how that Food is produced, processed, and contributed within food systems, and their ability to engage in processes that shape food system policies and governance
Sustainability	Food system practices that contribute to the long-term regeneration of natural, social, and economic systems, ensuring the food needs of the present generations are met without compromising the food needs of future generations

Table 1: Six Dimensions of Food Security

The analysis draws on a combination of literature review and field research, including visits to two alternative farms in northwestern Wisconsin. These case studies provide on-the-ground insights into the infrastructure challenges and opportunities facing regional smallholder producers and local governance dynamics that influence infrastructure development.

2 Research Methods

This study employed a rigorous case study approach, focusing on Common Harvest Farm in Osceola, Wis consin, to examine the multifaceted impacts of climate-resilient agricultural infrastructure on smallholder farmers' adaptive capacity and economic outcomes. The research methodology was designed to capture comprehensive, contextual information about the farm's experiences with climate change adaptation and infrastructure investments.

2.1 Data Collection

Data collection comprised an extensive field visit to Common Harvest Farm and an in-depth, semi-structured interview with Farmer Dan Guenthner, the owner-operator. The field visit facilitated direct observation of the farm's infrastructure and operations, providing invaluable insights into the practical implementation

3

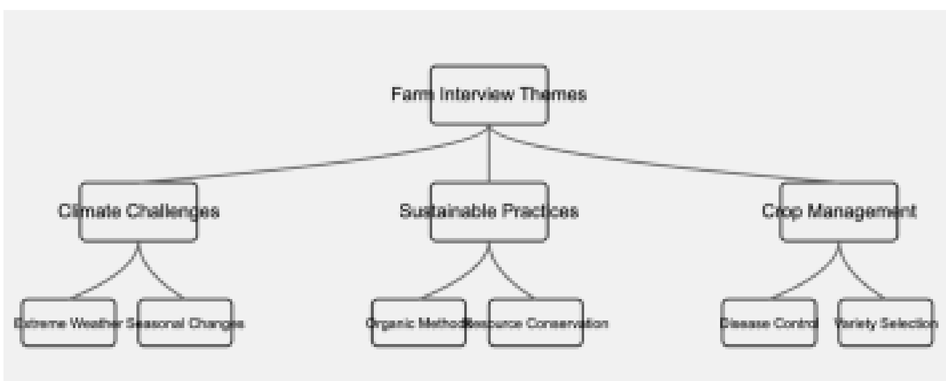

Figure 2: The Proposed Interview Structure for Farmer Dan

of climate-smart agricultural practices. The interview, conducted on-site over three hours, covered various topics, including the farm's historical development, current operational practices, challenges, and future strategic plans.

The interview protocol was developed based on a comprehensive literature review of climate-smart agri culture, smallholder farming systems, and resilient infrastructure (Altieri et al. 2015; FAO 2013). Questions were crafted to elicit detailed information about specific infrastructure investments, their impacts on farm operations, and the role of community governance in decision-making processes. The interview was audio recorded and transcribed verbatim for subsequent analysis.

2.2 Data Analysis

As Braun and Clarke (2006) outlined, data analysis followed a rigorous thematic approach. The interview transcript and field notes were coded to identify key themes related to infrastructure investments, adaptive capacity, economic outcomes, and governance. These themes were then analyzed in existing literature on climate-resilient agriculture to identify patterns, contradictions, and novel insights. The Dedoose qualitative data analysis software was utilized to ensure systematic and comprehensive coding.

2.3 Validity and Reliability

Member checking was employed to enhance the validity and reliability of the findings (Creswell and Poth 2018). A detailed summary of the initial analysis will be shared with Farmer Dan for review and feedback, allowing for clarification, additional insights, and correction of potential misinterpretations. Additionally, triangulation of data sources, including field observations, interview data, and literature review, was used to strengthen the credibility of the findings.

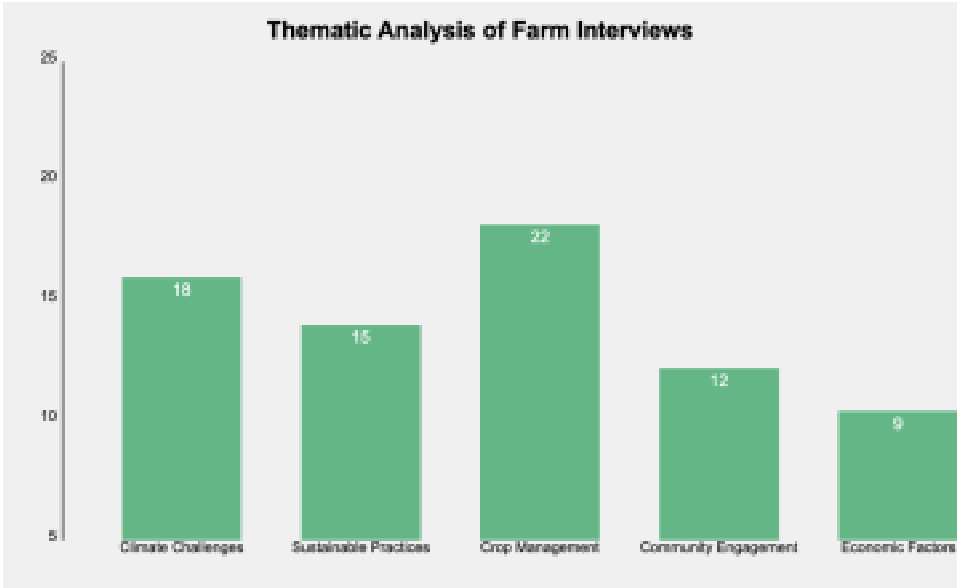

Figure 3: Qualitative Analysis of Farm Interview by Dedoose(Preliminary)

2.4 Ethical Considerations

The study adhered to strict ethical guidelines. Farmer Dan gave informed consent before the interview and was informed of his right to withdraw from the study at any time. All data was anonymized to protect the privacy of the farm and its members.

3 Findings, Analysis, and Discussion

3.1 Climate-Resilient Infrastructure Investments

Common Harvest Farm has made substantial investments in climate-resilient infrastructure, with three key components emerging as impactful: a greenhouse with a wood-fired boiler system, a solar panel system, and an electric tractor conversion. These investments represent a holistic approach to enhancing farm resilience and sustainability.

The greenhouse, equipped with an innovative wood-fired boiler system, has extended the farm's growing season. Farmer Dan reported, ”We can start seedlings in late February, a full month earlier. This increased our overall yield by about 20% and allowed us to offer a wider variety of early-season crops to our CSA members” (Guenthner 2024). This substantial yield increase aligns with findings from Lamont (2009), who demonstrated that season extension technologies can increase vegetable yields by 10-30% in northern climates. Using a wood-fired boiler system also represents a sustainable approach to heating, utilizing locally sourced, renewable biomass.

5

Figure 4: CSA Products Waiting to be Delivered to Members

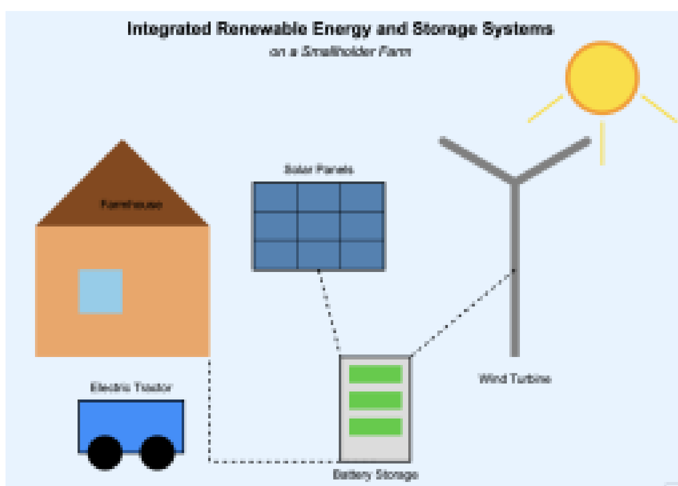

Figure 5: Solar Energy Model Chart Created by Zhijun

The solar panel system, installed in 2020, has reduced the farm's energy costs and increased its resilience to power outages. ”We've cut our electricity bills by about 70%,” Farmer Dan noted, ”and during the last major storm, we were able to keep our cold storage running when the grid was down for three days" (Guenthner 2024). This experience supports research by Mohanty et al. (2017), which found that on farm renewable energy systems can enhance smallholder farms' economic and environmental sustainability. Maintaining cold storage during power outages is crucial for preserving harvest quality and reducing post harvest losses, a critical factor in farm profitability and food security.

While still in its early stages, the electric tractor conversion has shown promising operational efficiency and cost savings results. Farmer Dan explained, "It's hushed, which makes operating much more pleasant.

6

Figure 6: Farmer Dan and His Electrified Tractor

The slow speeds are perfect for precision work in the fields, and we're seeing about a 40% reduction in energy costs compared to our old diesel tractor" (Guenthner 2024). His words align with recent studies on electric agricultural vehicles, which have demonstrated potential energy savings of 30-50% compared to conventional diesel models (Mariasiu et al. 2012). The quieter operation also contributes to improved working conditions and reduced noise pollution, factors often overlooked in agricultural technology assessments. These infras tructure investments contribute to multiple dimensions of food security: availability through increased yield, stability through resilience to power outages, and sustainability through reduced energy consumption.

3.2 Effects on Adaptive Capacity

Infrastructure investments and diversified farming practices have enhanced Common Harvest Farm's adap tive capacity. The farm grows over 40 crops, a strategy Farmer Dan credits with improving their resilience to climate variability. ”In 2022, when we had that severe drought, our deep-rooted crops like tomatoes and squash performed well, while in 2023, with all the excess rain, our leafy greens thrived. Having a diverse crop portfolio means we're never wiped out completely,” he explained (Guenthner 2024). This observation aligns with research by Lin (2011), which demonstrates that crop diversification can buffer against climate-related risks in agricultural systems.

The farm's pest and disease management approach has also evolved in response to changing climate conditions. Farmer Dan described their struggle with the Colorado potato beetle. This pest has become more problematic as winters have warmed: ”We've had to get creative. We now use a combination of crop

7

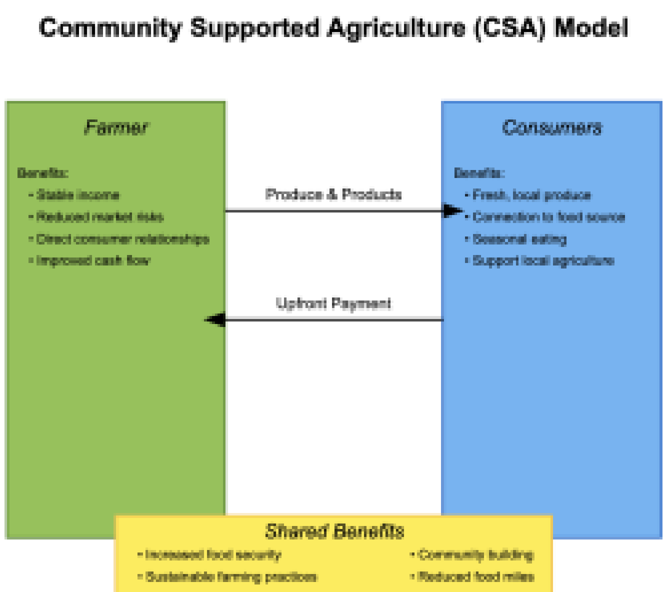

Figure 7: Community Supported Agriculture Mechanism Chart by Zhijun

rotation, companion planting, and targeted organic sprays. It's more complex than before, but it's working" (Guenthner 2024). However, implementing effective crop rotations on a small acreage presents ongoing challenges. ”With limited space and the need to meet CSA member expectations, it's a constant puzzle to balance soil health, pest management, and production goals," Farmer Dan admitted (Guenthner 2024). This challenge is well-documented in the literature on smallholder farming systems (Rapsomanikis 2015).

Common Harvest Farm has implemented a comprehensive soil health management program to enhance adaptive capacity further. This implementation includes regular soil testing, cover cropping, composting, and organic amendments. ”Healthy soil is the foundation of resilience," Farmer Dan emphasized. ”It improves water retention during droughts and drainage during heavy rains" (Guenthner 2024). By enhancing the farm's adaptive capacity, these strategies contribute to the stability dimension of food security, ensuring consistent food production despite climate variability.

3.3 Economic Outcomes

The Community Supported Agriculture (CSA) model has provided Common Harvest Farm with a stable income source, buffering against market fluctuations and climate-related production variability. Farmer Dan reported, ”Our CSA members commit to sharing the risks and rewards of farming with us. This stable income base has been crucial in allowing us to invest in climate-resilient infrastructure" (Guenthner, 2024). This phenomenon aligns with research by Brown and Miller (2008), which found that CSA models can provide economic stability for small-scale farmers.

A cost-benefit analysis of the farm's infrastructure investments reveals promising long-term economic benefits. The solar panel system, for example, is expected to pay for itself within eight years, after which it will provide significant energy cost savings. ”We're projecting about $5000 in annual savings on electricity once the system is paid off," Farmer Dan noted (Guenthner

2024). This aligns with studies by Schelly and Letzelter (2020), which found 5-10 years payback periods for on-farm solar installations in the Upper Midwest.

Market diversification has also contributed to the farm's economic resilience. In addition to its CSA program, Common Harvest Farm sells produce to local food shelves and farmers' markets. ”Having multiple market channels helps us optimize our crop utilization and provides a buffer if one channel underperforms,” Farmer Dan explained (Guenthner 2024). This strategy reflects recommendations by Jablonski et al. (2011) for enhancing smallholder farm viability through diversified marketing approaches.

Common Harvest Farm has developed value-added products, such as preserves and dried herbs, utilizing excess produce and extending the selling season to strengthen its economic position. ”These products help us capture more value from our crops and provide additional income during the off-season,” Farmer Dan noted (Guenthner 2024). This strategy aligns with research by Alonso (2011) on the potential for value-added products to enhance farm profitability and resilience.

3.4 Role of Decentralized Governance

The CSA model at Common Harvest Farm has facilitated a form of decentralized governance, with members actively involved in specific decision-making processes. For example, CSA members were crucial in funding the solar panel system through an innovative ”Solar Share” program. ”Our members pre-purchased their vegetables for the next five years to help us finance the solar installation. It's a win-win - they get a discount on their shares, and we get an interest-free loan,” Farmer Dan explained (Guenthner 2024). This type of community-based financing aligns with emerging models of civic agriculture described by Lyson (2004).

Member input also influences crop planning decisions concerning pest and disease pressures. Farmer Dan provided an example: ”When we were struggling with potato beetles, we surveyed our members about potentially reducing potato production. Their feedback helped us make an informed decision about crop allocations” (Guenthner, 2024). This participatory approach to farm management reflects principles of adaptive co-management described by Armitage et al.

(2009).

Common Harvest Farm has also developed strong community relationships beyond its CSA membership. Partnerships with local food shelves provide an additional market for produce and serve an important social function. ”We donate excess produce and offer educational tours for food shelf clients. It’s part of our

mission to improve food security in our community,” Farmer Dan stated (Guenthner 2024). This approach aligns with research by Allen (1999) on the potential for alternative food initiatives to address community food security.

However, scaling this decentralized governance model presents challenges. ”As we’ve grown, it’s become more difficult to maintain the same member involvement level in decision-making. We’re constantly looking for ways to balance efficiency with participatory governance,” Farmer Dan admitted (Guenthner 2024). Common Harvest Farm has implemented a tiered membership structure to address this challenge, allowing for different levels of involvement in farm decision-making. ”We’ve created opportunities for members who want to be more involved in farm operations and decision-making while maintaining a more traditional CSA option for those who prefer it,” Farmer Dan explained (Guenthner 2024). This innovative approach to member engagement reflects emerging research on hybrid governance models in alternative food networks (Forssell and Lankoski 2015).

3.5 Future Challenges and Opportunities

Looking ahead, Common Harvest Farm faces several challenges and opportunities related to climate change adaptation. Shifting frost dates and growing seasons require constant adjustments to crop planning. ”We’re seeing our last frost date move earlier and our first frost date move later, but it’s not consistent year to year. It makes planning tricky,” Farmer Dan noted (Guenthner 2024). This observation aligns with climate projections for the Upper Midwest (Pryor et al. 2014).

Balancing technology adoption with farm economics remains an ongoing challenge. While investments in climate-resilient infrastructure have paid off, the upfront costs can be significant. ”We have to be strategic about which technologies we adopt and when. It’s a constant balance between improving resilience and maintaining financial stability,” Farmer Dan explained (Guenthner 2024). This equilibrium reflects broader challenges in technology adoption among smallholder farmers, as Docume et al. (2021).

See documented diversity and sourcing, which present both challenges and opportunities. ”We’re always looking for varieties that perform well in our changing climate, but it’s getting harder to find certain heirloom varieties,” Farmer Dan reported (Guenthner 2024). This concern echoes findings by Bellon et al. (2015) on the importance of crop genetic diversity for climate change adaptation. Common Harvest Farm has initiated a seed-saving program in collaboration with other local farms to address this challenge. ”We’re working together to preserve and adapt local seed varieties to our changing climate,” Farmer Dan explained. ”It’s not just about maintaining diversity; it’s about selecting traits that perform well under new conditions” (Guenthner 2024).

Finally, Farmer Dan sees potential in regional farmer collaborations to enhance resilience. ”We’re starting to talk with other farms about seed sharing, equipment sharing, and even coordinated crop planning. I think this kind of cooperation will be crucial as we face more climate uncertainties,” he stated (Guenthner 2024). This aligns with research by Knickel et al. (2018) on the potential of farmer networks to enhance adaptive capacity in the face of climate change. To formalize these collaborations, Common Harvest Farm is exploring the formation of a regional farmer cooperative. ”We’re looking at ways to pool resources, share knowledge, and increase our collective bargaining power,” Farmer Dan explained. ”It’s about building a more resilient local food system, not just individual farms” (Guenthner 2024).

4 Conclusion

This case study of Common Harvest Farm demonstrates that investments in climate-resilient agricultural infrastructure enhance smallholder farmers' adaptive capacity by diversifying crop portfolios and extending growing seasons. These investments improve economic outcomes through cost savings and market diversification while contributing to multiple dimensions of food security. The CSA's decentralized governance model has played a crucial role in prioritizing and implementing these infrastructure projects, ensuring they meet both farm and community needs.

My study highlights the importance of targeted infrastructure investments, diversified practices, and com munity engagement in enhancing small-scale agriculture's resilience and viability. Common Harvest Farm's success illustrates that with appropriate support and resources, smallholder farms can play a crucial role in building climate-resilient, food-secure communities, offering valuable insights for enhancing agricultural sustainability in climate change.

4.1 Future Research Directions

Further research is needed to understand the broader applicability of these approaches. 1.

Compare multiple farms across the Upper Midwest to identify common success factors and challenges.

2. Assess long-term economic and environmental impacts of climate-resilient infrastructure through lon gitudinal studies.

3. Further explore the effectiveness of different governance models in implementing climate-resilient in frastructure in various smallholder farm contexts.

4. Examine how policy environments influence the adoption of climate-resilient practices. 11

References

[1] Guenthner, D. (2024, September 28). Personal communication and Field Investigation.

[2] Moseley, W.G. (2012, August 8). The Silver Lining in the Drought. New York Times. Retrieved from https://www.nytimes.com/2012/08/08/opinion/the-droughts-alert-for-corn.html?ref=opinion

[3] HLPE. (2020). Food security and nutrition: Building a global narrative towards 2030. A report by the High-Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. Rome.

[4] FAO. (1982). World food security: A reappraisal of the concepts and approaches. Director General's Report. Rome.

[5] World Bank. (1986). Poverty and hunger: Issues and options for food security in developing countries. Washington DC.

[6] Burchi, F., & De Muro, P. (2016). From food availability to nutritional capabilities: Advancing food security analysis. Food Policy, 60, 10-19. https://doi.org/10.1016/j.foodpol.2015.03.008

[7] FAO, IFAD, UNICEF, WFP and WHO. (2018). The State of Food Security and Nutrition in the World 2018: Building climate resilience for food security and nutrition. Rome, FAO. License: CC BY-NC-SA 3.0 IGO.

[8] Lipper, L., Thornton, P., Campbell, B. M., Baedeker, T., Braimoh, A., Bwalya, M., ... & Torquebiau, E. F. (2014). Climate-smart agriculture for food security. Nature Climate Change, 4(12), 1068-1072.

[9] Altieri, M. A., Nicholls, C. I., Henao, A., & Lana, M. A. (2015). Agroecology and the design of climate change-resilient farming systems. Agronomy for Sustainable Development, 35(3), 869-890.

[10] Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psy chology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

[11] Mohanty, P., Muneer, T., & Kolhe, M. (2017). Solar photovoltaic system applications: A guidebook for off-grid electrification. Springer.

[12] Mariasiu, F. (2012). Energy Sources Management and Future Automotive Technologies: Environmental Impact. International Journal of Energy Economics and Policy, 2(4), 342-347.

[13] Rapsomanikis, G. (2015). The economic lives of smallholder farmers.

10.13140/RG.2.1.3223.9440. 12

2.3 Working With Nature: A Look at Rotational Livestock Grazing

Riley Pearce

Introduction:

As climate change's effects become more intense and apparent over time, our agricultural systems become increasingly vulnerable to collapse, raising urgent questions about sustainability and resilience. For livestock grazing in particular, continuous grazing practices are widespread within the Midwest and highly unsustainable in a changing climate. I chose livestock grazing as a topic to hone in on due to my prior experience with my grandparents running cattle in Central Texas. Looking at their farm they have dealt with drought for numerous years running and are required to spend money on multiple different feeds like alfalfa, cottonseed, and sourcing hay from out of state just to feed their cattle. They practice continuous grazing, and it is evident in July and August when the grass is stubble. I saw this as unsustainable early on and wanted to research alternative, more sustainable, and resilient systems of livestock management. Ultimately I came across rotational grazing, seeing how it mimicked natural processes and effectively worked with the environment. This led me to ask the question: In the face of climate change, how can rotational livestock grazing be a more resilient system than conventional continuous grazing practices within the Upper Midwest? In this paper, I will first detail the methods used to answer this question. I will then discuss my findings relating to ecological processes, continuous grazing, and rotational grazing. Finally, I will conclude my findings and discuss the future outlook of livestock management and grazing.

Research Methods:

A variety of research methods were used to answer the research question presented. Firstly, existing literature on rotational and other grazing practices from online sources collected through Google Scholar was heavily consulted within the paper. Another method utilized was attending a class field trip to two Polk County, WI farms. The second farm we visited, *Whetstone Farm,* and the information gleaned there is the most pertinent to this paper, as they practice rotational grazing with their livestock. I will be using specific examples and observations of the methods used. At *Whetstone Farm,* we went on a tour of the farm itself, which was led by the owners, Emily and Klaus. I was able to see the sheep firsthand, learn about the practices used to raise them, and learn about the benefits of rotational grazing and the challenges faced when raising livestock.

Following the tour of the farm, I conducted an interview over the phone with Klaus. Topics covered included the lambing season timeline, parasite resistance, managing multiple species of livestock on pasture, conversion of mono-cropped fields to pasture, and general discussion about sustainable alternative agriculture. Additionally, at the first of the farms, *Common Harvest,* we got a tour of the surrounding area and learned about the different farming practices used for growing vegetables while being able to ask questions directly to Farmer Dan. Geographically, this paper will refer to continental climates, specifically Minnesota, Wisconsin, and the Upper Midwest.

Findings, Analysis, and Discussion:

Before examining the research question's answer, it is important to introduce some relevant ecological context of the upper Midwest's prairie ecosystem as it relates to livestock grazing.

The tallgrass prairies of the upper Midwest originally hosted a variety of grazing animals, the most important of which was the bison, but also included elk and whitetail deer (National Park Service, n.d). These ruminants were vital to the health of the prairie, providing numerous biological benefits. American bison were a keystone species of prairies; increasing nutrient availability through the spread of their dung and urine, and triggering plant nitrogen uptake which leads to increased above-ground plant growth (Knapp et al., 1999). Additionally, bison selectively grazed different grasses and forbs, promoting biodiversity, and their migratory existence allowed patches of grass to rest for long periods, resulting in higher forage yield (Knapp et al., 1999). The bison and the prairie ecosystem have evolved together over thousands of years, subject to and shaped by numerous natural processes. Prairies having existed this way for so long can tell us something about how grassland and pasture should be managed sustainably. Equipped with this knowledge, we will be able to see how the naturally occurring grazing processes of wild ruminants can be imitated and leveraged while managing livestock.

In addition to the ecological context, we must define and understand the conventional practice of continuous grazing and its associated issues. Continuous grazing is a simple system and involves livestock grazing a single pasture for an extended period of time, with very little rest for the plants and grasses within the pasture (University of Kentucky Martin-Gatton, n.d.). This has some benefits such as lower fencing cost, lower management requirements, and can be effective when forage is plentiful, but is not very adaptive to variable weather conditions like drought, as plants are already highly stressed due to being grazed constantly (University of Kentucky Martin-Gatton, n.d.). While at Whetstone farm, Klaus said that livestock can also be highly selective when continuously grazing a pasture, often targeting the most desirable forage first, which can lead to the encroachment of weeds and invasive species. While continuous grazing can be effective at the right stocking densities provided with enough forage, often farmers place too many animals within one pasture which can lead to overgrazing and grass reduced to stubble (University of Kentucky Martin-Gatton, n.d.). This does not work with the environment and soil can be negatively impacted by overgrazing. In summary, continuous grazing can be effective in certain situations, dependent on conditions and stocking rate, but is generally not environmentally sound, or able to withstand periods of drought and slow forage growth.

Looking back at the patterns of the bison and their migratory interactions with the prairie, it can be seen that continuous grazing can be an unproductive system that works against nature. Rotational grazing on the other hand is a livestock grazing system that can effectively work with nature, and benefit the farmer. Rotational grazing involves the subdivision of pasture into multiple paddocks and the frequent movement of livestock through the paddocks onto fresh grass (USDA Climate Hubs, n.d.). Temporary electric fencing is often used, being moved daily, and was observed at Whetstone farm. The frequent movement of livestock allows rest time for plants to regrow to desirable grazing height while livestock graze on the other paddocks (USDA Climate Hubs, n.d.). This mimics natural processes, and is exactly what happens when bison would move on from patch to patch of grass. Grazing lengths and rest periods vary, depending on the ecosystem and climate as well as other components. As Klaus explained over the phone, numerous factors affect this, including animal stocking densities, species of livestock, precipitation in a certain season, and parasites. Rotational grazing can be very challenging to implement with increased startup costs for the farmer, like fencing costs and time required to move livestock, but when practiced correctly can have numerous benefits both environmentally and economically for the producer.

One of the greatest benefits of rotational grazing is the improvement and maintenance of healthy soils, and its related ability to sequester carbon. Rotational grazing and the positive effect it has on soil can create a positive feedback loop over time. Increased forage production due to rest time from grazing can lead to improved soil structure (more aeration) and a more diverse microbiome (Spratt et al., 2021). Healthier soil can in turn lead to even better forage production and improved animal health and nutrition (Spratt et al., 2021). Consequently, with higher forage production, fewer inputs are needed in the system like hay and other supplementary feeds. At Whetstone farm, Emily explained that the sheep are only fed hay and other feed in the winter and graze strictly on grass for the remainder of the year. Whetstone farm also practices no-till planting and their pastures consist of perennial grasses and plants. This can be highly beneficial as they do not die off every year and grow deeper roots which help to aerate the soil and store more carbon (MIT Climate Portal, n.d.). The use of no-till and perennial plants can also lead to the recolonization of native plants within a pasture. While visiting Whetstone farm, common milkweed, New England aster, and goldenrod could be seen within the pasture. With the addition of native plants will come native insects and other life, only furthering the ability for soil to regenerate.

Another very significant reason that Whetstone farm utilizes rotational grazing is to combat parasite issues with the livestock. Klaus explained that life cycle of one of the parasites they deal with affecting sheep goes as such: the sheep ingest parasite larvae while consuming forage, the larvae develop into adult worms within the sheep’s gastrointestinal tract, adult worms lay eggs that are then shed in the sheep's feces, the eggs develop into larvae, and the cycle repeats when another sheep ingests the larvae. Rotational grazing can mitigate the parasite issues faced by moving the sheep constantly. The sheep are not consistently grazing the same grass and coming into contact with their feces, but are being grazed on fresh grass every day. Additionally, grazing multiple livestock species can be beneficial in this aspect as they are not afflicted by the same parasite species. At Whetstone, cattle, horses, and sheep are all grazed rotationally. Managing this is done through an application called Herd Boss. Klaus stated that the application is very useful as you can track how long a pasture has been resting, whether sheep or cattle grazed it last, and can take notes on different paddocks. Due to the many benefits provided by rotational grazing in parasite reduction, Klaus said that they have rarely used dewormers, vaccinations, or other inoculations with livestock. In this sense, rotational grazing can be effective in reducing input costs for farmers.

Rotational grazing is also heavily resistant to variable weather conditions and can remain in a relatively stable state through both extremes; times of drought and heavy rainfall. With a diverse plant community, rotationally grazed pastures can be more efficient in water retention, reducing runoff (Spratt et al., 2021). This is due to the deep, expansive root networks of perennial plants, which can increase soil water storage capacity to absorb heavy rains and reduce erosion, sediment runoff, flooding, and be more resilient in times of drought (Spratt et al., 2021). With a changing climate, intensified weather events will only increase. NASA states that heat waves, severe flooding, heavy rains, and longer droughts are all becoming more frequent and intense over time (NASA Science, n.d.). Rotational grazing employs many different strategies to remain resilient in the face of these challenges and can be a solution to many commonly faced problems in livestock grazing.

Conclusion:

In the face of climate change, rotational grazing presents a truly viable and sustainable alternative for livestock grazing in the Upper Midwest. By examining the practices used at Whetstone farm and the insights obtained from the existing literature it is clear that rotational grazing can provide benefits to both the environment and the farmer. Rotational grazing enhances soil health, promotes biodiversity, and is more resilient against extreme weather.

Forage productivity is improved, even with reduced chemical and feed inputs, an outcome of aligning with natural grazing processes like that of the American bison. All of these characteristics combined show that rotational grazing is a highly resilient system.

The benefits are clear, yet the proper support and assistance to transition to rotational grazing are not currently present. More government subsidies need to be put into place to promote rotational grazing and other sustainable practices, and less towards corn production that just further degrades the solid and landscape. There are some in place already, however.

Klaus explained that Whetstone farm receives a subsidy from the Natural Resources Conservation Service (NRCS) which is a branch of the USDA, to help with fencing costs. He said that it is rather minimal compared to other subsidies and does not offset many of the other startup costs associated with rotational grazing like conversion of farmland to pasture. Klaus also mentioned the lack of transportation infrastructure around small farms in transportation to the consumers. We discussed the need for an overhaul of transportation, shifting away from a system that favors large-scale farms, to one that also takes into consideration the needs of small-scale farms. There are many challenges involved with making rotational grazing mainstream and additional government support and encouragement is needed until it can become widely adopted.

References:

A Complex Prairie Ecosystem—Tallgrass Prairie National Preserve (U.S. National Park Service). (n.d.). Retrieved October 18, 2024, from https://www.nps.gov/tapr/learn/nature/a-complex-prairie-ecosystem.htm Bison by the Numbers. (n.d.). *National Bison Association*. Retrieved October 18, 2024, from https://bisoncentral.com/bison-by-the-numbers/

Extreme Weather—NASA Science. (n.d.). Retrieved October 18, 2024, from https://science.nasa.gov/climate-change/extreme-weather/

Knapp, A. K., Blair, J. M., Briggs, J. M., Collins, S. L., Hartnett, D. C., Johnson, L. C., & Towne, E. G. (1999). The Keystone Role of Bison in North American Tallgrass Prairie. *BioScience*, *49*(1), 39. https://doi.org/10.2307/1313492

Rotational Grazing for Climate Resilience | USDA Climate Hubs. (n.d.). Retrieved October 18, 2024, from https://www.climatehubs.usda.gov/hubs/international/topic/rotational-grazing-climate-re s ilience

Rotational vs. Continuous Grazing | Master Grazer. (n.d.). University of Kentucky, Martin-Gatton College of Agriculture, Food, and Environment. Retrieved October 18, 2024, from https://grazer.ca.uky.edu/rotational-vs-continuous-grazing

Soil-Based Carbon Sequestration | MIT Climate Portal. (n.d.). Retrieved October 18, 2024, from https://climate.mit.edu/explainers/soil-based-carbon-sequestration

Spratt, E., Jordan, J., Winsten, J., Huff, P., Van Schaik, C., Jewett, J. G., Filbert, M., Luhman, J., Meier, E., & Paine, L. (2021). Accelerating regenerative grazing to tackle farm, environmental, and societal challenges in the upper Midwest. *Journal of Soil and Water Conservation*, *76*(1), 15A-23A. https://doi.org/10.2489/jswc.2021.1209A

Chapter 3

Animal Husbandry and Sustainability Debates

By: Ezra Cohen, Arin Moua, Claudia Taylor, and

Anonymous

3.1 Exploring Solutions to the Environmental Crisis of Industrial Beef

Ezra Cohen

Introduction:

We are what we eat. And today, as Michael Pollan explains, in *The Omnivore's Dilemma,* we, as humans, eat more food, and less diversity than ever. Changes to the livestock industry–specifically, the rise and development of cheap corn feed–drastically reduced the price of beef in grocery stores and restaurants worldwide. Unsurprisingly, this meant one thing: humans ate more of it.

While this price reduction seemed like a boon for the consumer, the mostly well-hidden hidden environmental costs of the beef industry began to take a toll, as demand for cow meat increased. This paper explores solutions for three of the largest environmental impacts of the industrial beef industry: methane emissions, excess manure, and land degradation. While each solution is in itself flawed as this paper will demonstrate, their implementation would greatly reduce the environmental impacts of the livestock industry overall.

Methods:

In attempting to discern the most impactful solutions to the environmental crisis that is the industrial cattle industry, it is critical to first understand the largest, and most negative environmental impacts that it inflicts on the environment. Using both scientific and beginner-friendly sources found online, the author first describes these impacts. Next, the author explores the potential solutions to these problems. This is the main thrust of the paper, and is written using research taken from multiple scholarly articles first published in various journals, and accessed online. Following this, the author explores the negative impacts that are present even in the "solutions." As with most problems, there will always be trickle-down effects of large-scale change, such as these solutions propose, and it is critical to understand them if one is to see the big picture of the beef industry. Again, the author uses scholarly sources found online. Lastly, the conclusion sums up the problem, the solutions, and takes a brief look towards what actual changes lie ahead for this industry.

Environmental Problems:

With the great increase in beef consumption, the environmental impacts of these massive numbers of cows are increasingly being acknowledged. There are at least three direct impacts that the cattle industry has on the environment, and undoubtedly many more that generally fly under the radar. The most infamous of these impacts is methane. Methane has a short lifespan, but is 28 times more potent in causing climate change than carbon dioxide (Quinton). And cows produce a lot of it. The stomach of a cow has millions of bacteria called methanogens which aid in the digestive process. As a byproduct of digestion, these methanogens produce methane, which is burped out by the cows (Livestock Methane and Nitrogen Emissions). The proliferation of cattle today has catapulted them to the no. 1 source of agricultural greenhouse gas emissions worldwide, with a single cow emitting approximately 220 pounds of methane in its lifetime (Quinton). Practically, this means that cows currently account for 37% of U.S. annual fossil fuel emissions–a staggering amount (Yes, Cattle is the Top Source).

In addition to methane, cow manure has multiple negative environmental effects. As Pollan explains, due to the highly concentrated levels of nitrogen in this manure, it is unfit to be used as fertilizer, and is instead, dumped in ever-growing manure pits that are unfriendly to most life. But the problem goes beyond these stinking masses of feces. Inescapably, some of this manure seeps into the groundwater, and then into rivers such as the Mississippi. Besides the plethora of diseases that this toxic flow brings into the water, and into the humans that drink it, vast amounts of manure build up causing algae blooms that such all oxygen from the water. The vast “dead zone” at the mouth of the Mississippi River in the Gulf of Mexico is due to this algae, which comes from manure, which comes from the millions of cows that humans consume (Pollan).

An environmental catastrophe much more readily observed is that of deforestation and land-degradation as a method to increase production of cattle. The average American has probably heard in the news of rampant deforestation of the Amazon to make more pasture for cows. However, many don’t realize the extent of the destruction closer to home. When taking into account the pasture and feedlots that cows live on, as well as the extent of agricultural land dedicated solely to growing food to feed them, cows take up around 35% of land in the U.S (Jacobs). That land was formerly tall-grass, or short-grass prairie with bountiful biodiversity. Now, it has been transformed into a monoculture of cows, and corn.

Solutions:

This paper explores two solutions to the environmental disaster created by cattle, and the cattle industry in general: Intensive production, and Integrated Crop-Livestock systems. Although they are not the only solutions currently being tested or explored–and they both have notable negative impacts themselves– they both reach all corners of the industry, which is why they were chosen for this paper. Each targets some of the problems more heavily than others, but together, they encompass them all.

Intensive Production is self-descriptive; it involves raising cattle quicker and more efficiently than ever in increasingly confined areas. This method shortens the time it takes to fatten cattle to market weight, by using “highly concentrated feeding levels” heavily reliant on grain, and specifically corn. (Vas Portugal). A second facet of Intensive Production is the confinement of more cattle to smaller areas. Together, these two aspects address (superficially, at least) the problems of methane emissions, and land-degradation. With shorter life-spans, cattle have less time to burp up large quantities of methane. And the more confined nature of the feeding areas mean that less land is being impacted (The Environmental Impacts of Intensive and Extensive Systems).

Of the two solutions, Intensive Production is the least ambitious, and would only involve tweaking the current methods of beef production. Supporters of this solution point to the fact that it would be difficult to fully change the industry, and instead it should focus on adapting to be as environmentally-friendly as possible without implementing overarching changes: “Sustainable intensification of beef production systems is likely the only way to achieve this goal and will require precision feeding, additives that improve efficiency and advanced molecular techniques, like gene editing, to accelerate genetic progress” (McAllister et al). However, many environmentalists would be quick to point out the many flaws with this purported “solution.” Grains, which are critical to helping cows fatten and mature quickly, often negatively impact the digestive systems of cattle, causing frequent outbreaks of disease. As a practice, the industry pumps cattle with antibiotics as a preventative measure, but over time, this leads to widespread ineffectiveness of those antibiotics (Pollan). Moreover, some of these antibiotics are frequently used in humans, and their overuse in animals can lower effectiveness for people as well (Pollan).

Additionally, the problem of manure is not solved by the Intensive Production solution. Farms utilizing this method still have to deal with enormous amounts of cow defecation, and more often than not, it is dumped in manure lagoons, or into rivers. But perhaps the largest negative impacts of Intensive Production come as a result of the very food used to grow cattle so quickly: corn. Although Intensive Production is touted as being more environmentally friendly, its reliance on the 91 million acres of corn in the U.S. alone should cause one to do a double-take. Corn has all but eliminated biodiversity in vast swaths of the country, and cultivating it at this scale requires huge amounts of pesticides and fossil fuels. While Intensive Production does indeed reduce land degradation, and reduces methane emissions by shortening the lifespan of cows, its reliance on corn seems to offset these benefits, making it an overall ineffective solution to combat climate change (McAllister et al).

Integrated Crop-Livestock Systems (ICLS) on the other hand, would involve drastically overhauling the livestock, and agricultural industries, and is much more effective in mitigating environmental impacts overall. At its roots, ICLS promotes the combining of livestock and agriculture, which can be mutually beneficial to each other, and to the climate (Franzluebbers). In fact, before the 20th century, this method of farming was common. But with the advent of industrial agriculture, it was tossed by the wayside (Franzluebbers). However, the benefits abound. Firstly, ICLS uses natural resources much more efficiently than when agriculture and livestock are separated. Cattle graze the plants, and their manure enriches the soil. This means that excess manure never becomes the large-scale problem that it is in other methods of livestock raising. Additionally, pest numbers are greatly reduced, due to trampling and grazing, and weeds are kept under control, allowing the native plants to flourish. Lastly, manure and regular trampling is natural for the soil, and contributes to improved soil structure, and soil fertility. Taken together, ICLS goes a long way towards reducing the environmental impacts of cattle.

Land-degradation is nearly nonexistent, as the land would already be used for agriculture. The manure problem is eliminated, and becomes a welcome addition to enriching the soil. And methane is reduced, as cows eating their natural diet of grass don't see the high levels of indigestion that their grain-fed relatives do (Franzluebbers).

In many ways, ICLS is too good to be true. While from afar it appears to be the perfect solution, zooming in reveals the practical and economic liabilities that it presents. Currently, there is almost no infrastructure in place to support the ICLS system (Franzluebbers). And it seems likely that, at least in the short term, overhauling the ingrained systems of agriculture and livestock production in the US would be expensive, and therefore unpopular. Regardless, it would involve a huge amount of data collection, buy-in and collaboration by farmers, government bodies, and consumers. Even if, improbably, all of these moving parts fell into place, it is unclear whether there is a large market for grass-fed beef Franzluebbers). Currently, it is more expensive, and viewed more as a food for the rich, so this would take another fundamental shift from consumers.

Conclusions:

Most agree that the cattle industry, and the meat industry in general has to change. Worldwide, meat consumption has quadrupled since 1961, while the population of the world has only doubled (Sengupta). The pressure this places on the environment is therefore immense. And the solutions, as has been explained, are either too narrow, and ineffective to be worthwhile (as in the case of Intensive Production) or too far-reaching, and impossible to be implemented (as in ICLS). This has led many, including billionaires like Jeff Bezos, to a surprising solution: eliminate the animals all together. What Bezos, along with upstart companies such as Big Food, an Israeli company, have proposed, is "cellular meat"

(Sengupta). This "meat" is already being produced in labs in places like North Carolina, and involves using cow, or chicken cells to grow the "ideal" meat, without all the accouterments, such as hooves, tails, and ears…and without the worst of the climate impacts. Methane, land-degradation, and manure, are all nearly eliminated in cellular meat, making it the apparent "perfect" solution. But the question arises: what is meat if it is made in a lab? In a world where humans are already subjugated to many mysteries about what exactly we are putting into our bodies, lab grown meat would seem to cause some concern. And it has. Already, cellular meat has been banned in Singapore and Florida. Ron DeSantis, the Governor of Florida, rationalized this decision, saying he was "fighting back against the global elite's plan to force the world to eat meat grown in a petri dish or bugs to achieve their authoritarian goals" (Sengupta).

So, the future of the meat industry is far from crystalline. Too many people, eating too much meat, have led the world to a state with deteriorating environmental conditions, and no fix-all solutions. And despite their shortcomings, Intensive Production and ICLS are the best solution for the near future, and the government would do well to incentivize farmers to utilize such techniques. At this stage, even imperfect solutions are better than the environmentally disastrous practices used in industrial livestock production today.

Likely, however, the future will look similar to the present…at least for a while. Humans have time and again demonstrated that we are slow to make necessary changes, and it seems likely that the meat industry, and the cattle industry in particular, will be no different.

Works Cited

Franzluebbers, A. J. "Integrated Crop-Livestock Systems in the Southeastern USA." *Agronomy Journal*, vol. 99, no. 2, Mar. 2007, pp. 361–372, https://doi.org/10.2134/agronj2006.0076.

Jacobs, Frank. "The U.S. Is Cow Country, and Other Lessons from This Land Use Map." *Big Think*, 9 Aug. 2018, bigthink.com/strange-maps/the-us-is-cow-country-and-other-lessons-from-this-land-use map/.

"Livestock Methane and Nitrogen Emissions - Agriculture." *Agriculture.vic.gov.au*, 2022, agriculture.vic.gov.au/climate-and-weather/understanding-carbon-and-emissions/livestock-methane-and-nitrogen-emissions.

McAllister, Tim A., et al. "Chapter 5 - Nutrition, Feeding and Management of Beef Cattle in Intensive and Extensive Production Systems." *ScienceDirect*, Academic Press, 1 Jan. 2020, www.sciencedirect.com/science/article/abs/pii/B9780128170526000057.

Quinton, Amy. "Cows and Climate Change." *UC Davis*, UC Davis, 27 June 2019, www.ucdavis.edu/food/news/making-cattle-more-sustainable.

Sengupta, Somini. "Our Appetite for Meat Is Hurting the Environment. Enter Lab-Grown Meat." *Nytimes.com*, The New York Times, 21 Sept. 2024, www.nytimes.com/2024/09/21/climate/lab-grown-meat-future.html.

"The Environmental Impacts of Intensive and Extensive Systems." *Www.leap.ox.ac.uk*, www.leap.ox.ac.uk/environmental-impacts-intensive-and-extensive-systems. Vas Portugal, A. *Intensive Beef Production*. 2000.

"Yes, Cattle Are the Top Source of Methane Emissions in the US." *Verifythis.com*, 2021, www.verifythis.com/article/news/verify/environment-verify/cattle-cows-the-top-source-of-methane-emissions-in-united-states/536-8d5bf326-6955-4a9c-8ea5-761d73ba464c.

3.2 Sustainable Animal Husbandry: A Comparative Analysis of Conventional and Traditional Methods for Cattle and Chicken Rearing in the Upper Midwest

Arin Moua

1. Introduction

A vital part of agricultural systems, animal husbandry has a direct impact on environmental sustainability, economic stability, and food security. Knowing the sustainability of different animal husbandry techniques is crucial in the Upper Midwest, where agriculture is a major industry. This essay investigates the following sub-question: How do the most environmentally friendly approaches to animal husbandry for raising chickens and cattle stack up against more conventional methods? The increased knowledge of the negative effects cattle production has on the environment, such as greenhouse gas emissions, land erosion, and water pollution, makes this subject crucial. It is crucial to assess both traditional and alternative farming methods as society moves toward more sustainable food systems. Common Harvest CSA and Whetstone Farm, two alternative agriculture farms in northwest Wisconsin, are the subject of this study. This article seeks to uncover sustainable practices and their effects on animal welfare, environmental health, and economic viability by examining how they operate.

2. Research Methods

On September 28, visits to the chosen farms in northwest Wisconsin were part of qualitative fieldwork aimed at answering the research question. Direct observations of farming operations were part of the research, as were semi-structured interviews with the farmers. With an emphasis on feeding procedures, waste management, animal welfare, and environmental effect, these conversations sought to learn more about their methods of animal husbandry. The purpose of the interviews was to gather information about their decision-making procedures, as well as the perceived advantages and difficulties of sustainable farming.

The information gathered from interviews and observations was subjected to a thematic analysis. Comparing feeding techniques, land use policies, waste management plans, and general animal welfare considerations were among the major themes. A more sophisticated knowledge of how sustainable techniques appear in actual environments and the possibility of wider regional application were made possible by this qualitative approach.

3. Findings, Analysis, and Discussion

3.1 Conventional Practices

Intensive farming methods that emphasize efficiency and high yields are commonly used in conventional cattle and chicken husbandry. This frequently entails using battery cages for poultry and feedlots for cattle. Despite their short-term economic benefits, these activities have serious ethical and environmental costs. For example, because feedlots produce concentrated waste, they contribute to greenhouse gas emissions, water pollution, and land degradation (Steinfeld et al., 2006). These systems' environmental costs—such as biodiversity loss and soil nutrient depletion—highlight how unsustainable these methods are. In addition, intensive farming frequently results in a greater need for antibiotics to treat medical concerns in crowded settings, which can exacerbate antibiotic resistance. These problems can be lessened by switching to more ecologically friendly and humane techniques, like integrated farming methods and pasture-raised systems. The sector can improve long-term viability and make a good impact on local communities and ecosystems by putting sustainability and animal welfare first. Ultimately, adopting more sustainable techniques helps agricultural systems become more resilient to resource scarcity and climate change, in addition to helping animals.

Grain-based diets are the main feeding strategy used in conventional systems, which can result in overgrazing and soil erosion. In addition to decreasing biodiversity, the use of monoculture crops for animal feed gradually depletes soil nutrients. Moreover, because the production and transportation of grain feed contribute to greenhouse gas emissions, the environmental effects go beyond the farms (Tilman et al., 2011). Because it takes precious crops away from direct human consumption, this reliance on grain-based diets also raises questions about food security. Making the switch to more sustainable and varied feeding methods, such adding legumes or forage crops, might boost biodiversity, improve soil health, and lessen dependency on fossil fuels for feed transportation. Agroecological concepts can also be used to build more resilient farming systems, which will help the local ecosystems and livestock production. Rethinking feeding methods can help the agriculture industry transition to a more sustainable future where production and environmental health are given equal weight.

Waste management is another important concern. Large amounts of waste are produced by concentrated animal feeding operations (CAFOs), and nutrient runoff from these facilities can contaminate water supplies. Aquatic ecosystems can be negatively impacted by toxic algal blooms and dead zones caused by excess nitrogen and phosphorus from animal waste contaminating nearby streams (Rotz, 2020). Reducing these negative effects on the ecosystem requires efficient waste management techniques. In addition to lowering nutrient discharge, techniques like anaerobic digestion and composting can turn trash into useful products like organic fertilizers and biofuels. Encouraging pasture-based systems and improved feed efficiency can aid in reducing waste production at its source. The cattle industry can improve sustainability, safeguard water quality, and support healthier ecosystems by tackling waste management issues, which will ultimately improve agricultural productivity and the environment.

3.2 Sustainable Practices in Alternative Farms

The alternative farms we saw, on the other hand, employ a number of sustainable techniques that make up for the drawbacks of traditional approaches. Common Harvest CSA, for example, feeds its livestock mostly grass. This approach lowers the carbon footprint related to grain production

while simultaneously enhancing soil health. Cattle that graze on a variety of pastures improve water retention, increase soil organic matter, and absorb carbon, all of which benefit the ecosystem. Farmers may improve soil health and nutrient cycling while also fostering biodiversity by implementing techniques like rotational grazing and combining livestock production with crop production (Teague et al., 2016). In addition to helping the environment, this strategy increases farming systems' resistance to climate change. Furthermore, as local economies frequently depend on direct marketing and community involvement, adopting these sustainable practices can result in stronger local economies. Adopting these practices provides an opportunity for the agriculture industry to make a significant contribution to climate solutions while maintaining ecosystem health and animal welfare.

The integrated farming method used at Whetstone Farm involves rotating hens among pastures. Because livestock dung improves the soil and lessens the need for synthetic fertilizers, this method takes advantage of natural pest management and nutrient cycling. Because shifting animals keeps germs from accumulating in one area, the rotation system also reduces the risk of illness.

Additionally, by letting animals behave naturally, both farms put an emphasis on animal care. In addition to improving the animals' productivity and well-being, this emphasis on humane care satisfies consumer demand for food that comes from ethical sources. Donald M. Broom emphasizes the growing significance of animal welfare in contemporary agriculture in "Animal Welfare: An Aspect of Care, Sustainability, and Food Quality Required by the Public," highlighting the fact that public expectations are moving toward better welfare standards. According to Broom, promoting animal welfare enhances food safety and quality while also promoting animal well-being, which in turn promotes food systems' sustainability. Farms can increase their overall output and satisfy consumers' ethical concerns by implementing policies that put animal care first. Furthermore, a greater market demand for goods from farms that follow these values may result from increased understanding of the advantages of humane treatment. Therefore, including animal welfare into farming methods prepares farms for long-term profitability in a changing agricultural environment while also benefiting animals and aligning with consumer values.

3.3 Comparison of Costs and Benefits

Both short-term and long-term expenses must be taken into account when evaluating the economic effects of conventional versus sustainable activities. Because of economies of scale, conventional methods could appear more cost-effective at first. Lower pricing are made possible by the capacity to produce vast amounts of animal feed while maintaining high production rates. These savings, however, may be offset by the long-term expenses of livestock medical treatment, environmental cleanup, and possible fines from the government.

Sustainable practices frequently result in lower greenhouse gas emissions and better soil health, despite occasionally requiring more work. Regenerative grazing, for example, improves biodiversity and pasture quality, making farms more climate change resilient. Livestock production can drastically reduce its carbon footprint by putting animal welfare first and optimizing feed efficiency. Along with boosting local economies and educating consumers about the effects on the environment, these practices also support regional food systems. "Livestock Production Systems" emphasizes that various approaches to livestock management support sustainability, highlighting how the incorporation of animal welfare practices enhances both productivity and health (Derner et al., 2017). By implementing these innovative strategies, farmers can meet consumer demands for ethically sourced products while creating a positive feedback loop that benefits both ecosystems and the economy. This holistic approach ultimately addresses critical issues of environmental sustainability and food security. Whiting (2011) also points out that sustainable techniques require an understanding of the cultural context of animal care, highlighting the necessity of both environmentally sound and culturally sensitive approaches. Farmers may satisfy customer demands for products produced ethically and establish a positive feedback loop that benefits the economy and ecosystems by putting these creative solutions into practice.

Furthermore, there is a growing consumer desire for food that comes from ethical sources, which gives sustainable farms a chance to gain market share. Compared to traditional methods, direct-to-consumer sales via farmers' markets and Community Supported Agriculture (CSA) initiatives allow these farms to get paid more for their goods. In the long term, this trend toward ethical consumption might give sustainable farms a competitive advantage and improve their financial sustainability (Berki-Kiss & Menrad, 2020). According to their research, consumers' intentions to buy products sourced ethically are influenced by a number of important factors, including their knowledge of Fairtrade policies and the advantages of supporting ethical products. Sustainable farms can set themselves apart by highlighting their values and practices, as consumers place a greater emphasis on environmental responsibility and transparency when making purchases. In addition to helping local economies, this expanding trend promotes a more conscientious consumer base and cultivates a culture that prioritizes sustainability over convenience. This market shift may encourage conventional farms to embrace more sustainable practices as more consumers look to match their purchases with their ethical convictions, which would have a positive knock-on effect for the entire agriculture industry.

4. Conclusions

According to the analysis, using sustainable animal husbandry techniques to raise cattle and chickens can greatly lessen the environmental effects of using conventional methods. While traditional approaches might provide immediate financial gains, sustainable practices have long-term positive effects on animal welfare and environmental health. The results highlight how sustainable farming methods can enhance biodiversity, lower greenhouse gas emissions, and improve soil health.

It is advised that livestock production move toward integrated and pasture-based systems in order to improve sustainability. This shift promotes a healthier ecosystem in addition to satisfying consumer demand for food that is produced ethically. The scalability of these sustainable practices across various farming systems and geographical areas should be further investigated in future studies, taking into account the particular opportunities and challenges associated with each location.

Works Cited

Berki-Kiss, D., & Menrad, K. (2022). Ethical consumption: Influencing factors of consumer´s intention to purchase Fairtrade roses. In Cleaner and Circular Bioeconomy (Vol. 2, p. 100008). Elsevier BV. https://doi.org/10.1016/j.clcb.2022.100008

Broom, D. M. (2010). Animal Welfare: An Aspect of Care, Sustainability, and Food Quality

Required by the Public. In Journal of Veterinary Medical Education (Vol. 37, Issue 1, pp. 83–88). University of Toronto Press Inc. (UTPress). https://doi.org/10.3138/jvme.37.1.83

Derner, J. D., Hunt, L., Filho, K. E., Ritten, J., Capper, J., & Han, G. (2017). Livestock Production Systems. *Rangeland Systems*, 347–372. https://doi.org/10.1007/978-3-319-46709-2_10

Whiting T. (2011). Understanding Animal Welfare: The Science in its Cultural Context. *The Canadian Veterinary Journal*, *52*(6), 662.

Rotz, A. (2020). Environmental Sustainability of Livestock Production. In Meat and Muscle Biology (Vol. 4, Issue 2). Iowa State University. https://doi.org/10.22175/mmb.11103

Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M. and de Haan, C. (2006) Livestock's Long Shadow: Environmental Issues and Options. Food and Agriculture Organization of the United Nations (FAO), Rome.

Teague, W. R., Apfelbaum, S., Lal, R., Kreuter, U. P., Rowntree, J., Davies, C. A., Conser, R., Rasmussen, M., Hatfield, J., Wang, T., Wang, F., & Byck, P. (2016). The role of ruminants in reducing agriculture's carbon footprint in North America. In Journal of Soil and Water Conservation (Vol. 71, Issue 2, pp. 156–164). Soil and Water Conservation Society. https://doi.org/10.2489/jswc.71.2.156

Tilman, D., Balzer, C., Hill, J., & Befort, B. L. (2011). Global food demand and the sustainable intensification of agriculture. In Proceedings of the National Academy of Sciences (Vol. 108, Issue 50, pp. 20260–20264). Proceedings of the National Academy of Sciences. https://doi.org/10.1073/pnas.1116437108

Taylor 1

3.3 Animal Husbandry Sustainability: How Does Agricultural Specialization Harm Water Quality?

Claudia Taylor

Since 1935, there has been a sharp decrease in the number of farms in the United States and a steady increase in the size of each farm (The Number, 2023). There has been increased specialization and industrialization of crop farms and animal husbandry operations due the increasing scale of economies (MacDonald et al., 2009). This uncoupling of animals and crops increases productivity and lowers prices, but also creates externalities that harm the environment, human health, and small-scale economies.

Water pollution is a particularly harmful externality resulting from both sides of this specialization. In mixed-use agriculture, livestock produce manure that can be used to fertilize adjacent crop fields. However, farmers that specialize in animal husbandry or crop farming are left with excess fertilizer or a lack thereof. Animal husbandry operations, especially Concentrated Animal Feeding Operations (CAFOs), dispose of this excess manure in lagoons that pose risks of contamination. Crop farmers increasingly replace manure with inorganic fertilizer that can runoff into water sources. Clean water is vital for drinking, irrigation, and recreation and must not be threatened.

In this investigation, I set out to compare the contribution of water pollution of specialized animal husbandry and crop farming operations with mixed-use operations. I will begin by outlining how contaminants from farms enter surface and groundwater sources. I will describe the environmental, social, and health costs of CAFOs and explain the environmental, economic, and most importantly social benefits of mixed-use agriculture. Lastly, I will detail some current community-based solutions to address water pollution and suggest further policy for empowering smallholders to protect themselves from polluters.

Methods

This investigation began at Common Harvest Farm, a 40-acre vegetable Community Supported Agriculture (CSA) in Osceola, Wisconsin dedicated to sustainable agriculture practices. Common Harvest's farmers, Dan Guenther and Margaret Pennings, led the fall 2024 section of Food, Agriculture and the Environment at Macalester College around the farm and put students in contact with other farmers and sources of knowledge to answer their respective research questions. At Guenther's recommendation, I spoke with Lisa Doerr, a retired farmer and environmental advocate in the St. Croix River Valley about the impacts of CAFOs on water quality. In addition, the agriculture course visited Whetstone Farm, an organic vegetable CSA and small free-range sheep farm in Amery, Wisconsin. I spoke with Emily Hanson, one of the farmers at Whetstone, about her experience with water pollution and the farm's management of animal waste. The majority of the research for this investigation took form as a literature review of past studies of the relationships of CAFOs with environmental, social, and economic harms to surrounding communities through water pollution.

Background: Water Contamination

Manure from CAFOs can contaminate surface water sources through manure lagoon overflows and malfunctions and wind-eroded contaminated soil (Hribar, 2010; Burkholder et al., 2007). Manure lagoons are typically open-air and can overflow into lakes and streams during heavy rain events (Agricultural Waste, 2022). Contaminants from manure lagoons can leach into surrounding soils that may contaminate surface water when soil particles move to water sources through wind erosion (Hribar, 2010). These pollutants can remain in soil long after a farming operation closes (Doerr, 2024). Groundwater sources are also threatened by manure; contaminants are spread through soil infiltration after lagoon malfunctions (Hribar, 2010). Threats to groundwater are particularly serious as pathogens persist longer underground, groundwater is more difficult to monitor, ground water can leach into surface water, and groundwater sustains more than half of the United States population (Hribar 2010).

Findings

Environmental Impacts

Surface and groundwater pollution from CAFOs and industrial crop farms have devastating effects on local and regional aquatic ecosystems. High ammonia concentrations from manure contamination kill fish directly by causing cell death in their central nervous systems

(Randall et al., 2002). In addition, veterinary medicines in manure can leach into water sources, exposing aquatic organisms to toxic levels of pharmaceuticals and antibiotic-resistant bacteria (Boxall et al., 2003). One of the greatest consequences of pollution from agriculture is eutrophication, or the runoff of excess nitrogen and phosphorus that stimulates algal bloom growth, removing oxygen from the water after their decomposition and killing oxygen-dependent organisms (Randall et al., 2002). Long-term exposure to excess nutrients can stimulate a transition in the aquatic ecosystem to sustaining predominantly noxious plankton species (Randall et al., 2002). Individual manure leaks may travel kilometers downstream, but the combined effects of many instances of manure leaks and fertilizer runoff affect entire watersheds (Burkholder et al., 1997). Inorganic fertilizer and manure runoff from the Mississippi watershed drain into the Gulf of Mexico where they create a dead zone about the size of New Jersey (The Dead; Gulf of Mexico).

Health Impacts

The appearance of manure from CAFOs in local water sources often poses a serious health hazard for community members through the transmission of pathogens and antibiotics. More than 150 pathogens present in manure can be spread through drinking water (Hribar, 2010). Symptoms of pathogen exposure range from inconvenient to deadly, especially for vulnerable populations like children, the elderly, and immunocompromised people (Hribar, 2010). In addition, the use of antibiotics for non-medical reasons in CAFOs spurs the development of antibiotic-resistant bacteria that can pose serious risks to human health if contracted through drinking water (Hribar, 2010). In Kewaunee County in Wisconsin, a child played in a contaminated stream with a scratch on his knee and contracted Methicillin-resistant Staphylococcus aureus (MRSA), an antibiotic resistant bacteria. The infection was so serious that doctors removed his knee cap (The CAFO, 2024).

Eutrophication and nitrate pollution have serious consequences to human health as well as environmental health. Acute exposure to nitrates in drinking water can lead to methemoglobinemia, or the loss of ability to deliver oxygen throughout the body (Townsend et al., 2003). This is particularly risky for infants who drink more water compared to body weight than adults and convert methemoglobin to hemoglobin quicker than adults (Johnson, 2019). This “blue-baby syndrome” can be fatal if not addressed quickly, which can be difficult in hospital-scarce rural areas (Knobeloch et al., 2000). Nitrate pollution can impact reproductive health and can increase one's risk for certain cancers (Knobeloch et al., 2000). Harmful algal blooms (HABs) from eutrophication produce toxins that contaminate shellfish, threatening humans that consume them (Burkholder, 1998). Other toxins can affect humans directly, like in the *Pfiesteria piscicida* outbreak in the Chesapeake Bay in 1996 (Grattan et al., 1998; Magnien, 2001). *Pfiesteria* can cause burning skin and cognitive issues in humans that merely come into contact with contaminated water for up to two weeks after exposure (Grattan et al., 1998).

Economic Impacts

The threat of water pollution from CAFOs poses economic harms through the reduction of property values and contamination of recreational areas. Eutrophication alone can cause up to $2.8 billion in property value damage (Dodds et al., 2009). CAFOs pose other financial risks to homeowners; a study of Wisconsinites found that each additional CAFO causes more than $200,000 of non-market water quality damages (Raff et al., 2022). Residents of Devils Lake, North Dakota faced threats to their recreation-reliant livelihoods when a plan to build a CAFO near the shoreline of the lake was proposed. Devils Lake connects to four other lakes and a river, so a contamination event could impact the entire surrounding watershed (CAFO Farm, n.d.). Fishing in the area generates about $89 million per year and fuels the local economy. One campground owner, Rick Schwab, highlighted that any pollution in the lake not only impacts the lake itself, but also the success of the businesses in town that support recreation at the lake (CAFO Farm, n.d.).

Analysis and Discussion: Small Mixed-Use Agriculture as a Community-Building Solution

Mixed animal and crop farming offers an alternative approach to waste management and fertilization. Mixed-use farmers take advantage of the ecological relationships of plants and animals to maintain a cyclical balance on the farm and prevent pollution. Emily Hanson from Whetstone, the free-range sheep farm, explained that they leave a majority of sheep manure in the pasture to fertilize grasses (Hanson, 2024). They compost manure from some "sacrifice areas" and "wasted hay" from sheep trampling and urination (Hanson, 2024). Combined with vegetable waste and waste from neighbors, the farmers at Whetstone rely on no inorganic fertilizer and contribute no excess manure to their surrounding water sources (Hanson, 2024). The cultivation of animals and crops also saves the Whetstone farmers money by reducing their input costs and eliminating their waste disposal costs. There are added social benefits of mixed-use agriculture as well; Hanson and her partner Klaus Zimmerman build relationships with neighbors through their collection of organic material for compost (Hanson, 2024). This community-building is made increasingly possible with smaller farms as families live closer to one another. Connections such as these become essential when larger entities threaten the health and well being of farmers and other residents.

Small communities are tasked with enforcing environmental regulation and monitoring polluters due to the limited resources of the Department of Natural Resources. In Wisconsin, there are 336 CAFOs and only 15 staff members at the DNR responsible for their inspection (Protect Your, n.d.). The Wisconsin State Journal found that many CAFOs are inspected "once or twice every five years" (Seely, 2010a). This leaves communities responsible for inspecting their own water sources. Whetstone Farm is located within 10 miles of a dairy CAFO and tests their wells every couple of years (Clean Water, 2024; Hanson 2024). One well tested positive for nitrate pollution from a past owner's intensive crop field operation and requires filtration (Hanson, 2024). The farmers at Whetstone, like other farmers in Wisconsin and across the country, must have the knowledge and financial resources to test their own water, or risk serious health consequences.

The siting of new CAFOs also disproportionately affects small rural communities. In the Pelican Township where the permits for a CAFO near Devils Lake were proposed, the township board rejected the original proposal, but were sued by the North Dakota Farm Bureau. Pelican's township board of three people represents the 23-person township; in Pelican they "were selling tickets to raffle for cash to pay our lawyers" (Gillam, 2023). Farm bureaus aim to weaken local zoning regulations to promote agricultural development, and can typically out-bid residents in the form of legal fees to win lawsuits and acquire permits (Gillam, 2023). In addition, powerful lobbying groups write and influence policy that make it easier for potential CAFOs to get permits (Seely, 2010b).

One solution that many farmers and community members have turned to in Wisconsin is the formation of township operations ordinances, or local policies that regulate CAFOs. These ordinances set controls on air pollution and require CAFOs to create plans for the proper disposal or spreading of manure, disposal of carcasses, resource use, fire emergencies, and closing operations (Protect Your, n.d.). Most notably, the ordinances require CAFOs to pay for the township to hire individuals to enforce the other plans set by the ordinance (Protect Your, n.d.). Lisa Doerr is an advocate for ordinances in Wisconsin townships. Doerr never planned on becoming an environmental and farming advocate, but was forced to do so, stating that Iowan farmers could "put up a hog factory at the end of [her] driveway with no regulation at all" (Doerr, 2024). These coalitions of farmers and residents with the shared interest of protecting themselves from environmental harm exemplify a new solution of grassroots resistance to powerful entities like large landowners, farm bureaus, and lobbyists.

Conclusion

The uncoupling of animal husbandry and crop farming has exacerbated two major sources of water pollution, threatening rural communities' health, environments, and financial well being. To reduce water pollution without offloading costs onto other communities, we need both a democratization of agricultural decision-making in rural communities and a larger shift in the agricultural system. We should begin by empowering rural communities to organize against government, lobbyist, and corporate attempts to pollute their communities. Individuals like Doerr are teaching townships how to fight for themselves in the form of ordinances, and we need to spread this local self-governance across the country. Rural communities that act in the best interest of their health and financial well being will also protect the local and regional environment by preventing water pollution. In addition, we need to encourage the reunion of animal husbandry and crop farming to reduce both manure and inorganic fertilizer pollution. At the federal level, we should strengthen the Clean Water Act (CWA) to include facilities that are known to contribute to non-point source pollution.

However, to address the ultimate cause of water pollution and other negative environmental, economic, and health effects from agricultural specialization, it is necessary to confront our food and economic system as a whole. Under Capitalism, there will always be an incentive for farmers and large farming corporations to industrialize and specialize, further weakening human-environment relationships and limiting sustainability. The democratization of decision-making around the siting and regulation of CAFOs would be a good first step towards building the power of communities to inform agricultural lawmaking as a whole.

Works Cited

Agricultural Waste Lagoons (Accidents Waiting to Happen). (2022). Environment America. https://environmentamerica.org/wp-content/uploads/2022/08/AccidentsFactsheet-Manur e Lagoons-1.pdf

Boxall, A. B. A., Kolpin, D. W., Halling-Sørensen, B., & Tolls, J. (2003). Peer reviewed: Are veterinary medicines causing environmental risks? *Environmental Science & Technology*, *37*(15), 286A-294A. https://doi.org/10.1021/es032519b

Burkholder, J., Libra, B., Weyer, P., Heathcote, S., Kolpin, D., Thorne, P. S., & Wichman, M. (2007). Impacts of waste from concentrated animal feeding operations on water quality. *Environmental Health Perspectives*, *115*(2), 308–312. https://doi.org/10.1289/ehp.8839

Burkholder, J. M. (1998). Implications of harmful microalgae and heterotrophic dinoflagellates in management of sustainable marine fisheries. *Ecological Applications*, *8*(sp1), S37–S62. https://doi.org/10.1890/1051-0761(1998)8[S37:IOHMAH]2.0.CO;2

Burkholder, J. M., Mallin, M. A., Glasgow, H. B., Larsen, L. M., McIver, M. R., Shank, G. C., Deamer‐Melia, N., Briley, D. S., Springer, J., Touchette, B. W., & Hannon, E. K. (1997). Impacts to a coastal river and estuary from rupture of a large swine waste holding lagoon. *Journal of Environmental Quality*, *26*(6), 1451–1466. https://doi.org/10.2134/jeq1997.00472425002600060003x

CAFO Farm in Devils Lake, North Dakota. (n.d.). Homegrown Stories. Retrieved October 15, 2024, from https://www.homegrownstories.org/devils-lake-cafo

Clean Water Action Council of Northeast Wisconsin. (2024). *Wisconsin CAFOs and EPA Impaired Water* [Map]. Earthstar Geographics. https://www.arcgis.com/apps/View/index.html?appid=5b5fb32a0db4453bb58de98f2c49 a f9a

Dodds, W. K., Bouska, W. W., Eitzmann, J. L., Pilger, T. J., Pitts, K. L., Riley, A. J., Schloesser, J. T., & Thornbrugh, D. J. (2009). Eutrophication of u. S. Freshwaters: Analysis of potential economic damages. *Environmental Science & Technology*, *43*(1), 12–19. https://doi.org/10.1021/es801217q

Doerr, L. (2024). [Interview by C. Taylor].

Gillam, C. (2023, November 1). *"What we're up against"—North Dakota towns fight Farm Bureau to try to keep water clean*. The New Lede. https://www.thenewlede.org/2023/11/2796/

Grattan, L. M., Oldach, D., Perl, T. M., Lowitt, M. H., Matuszak, D. L., Dickson, C., Parrott, C., Shoemaker, R. C., Kauffman, C. L., Wasserman, M. P., Hebel, J. R., Charache, P., & Morris, J. G. (1998). Learning and memory difficulties after environmental exposure to waterways containing toxin-producing Pfiesteria or Pfiesteria-like dinoflagellates. *The Lancet*, *352*(9127), 532–539. https://doi.org/10.1016/S0140-6736(98)02132-1

Gulf of Mexico 'dead zone' larger than average, scientists find | National Oceanic and Atmospheric Administration. (2024, August 1). https://www.noaa.gov/news-release/gulf-of-mexico-dead-zone-larger-than-average-scien t ists-find

Hanson, E. (2024). [Interview by C. Taylor].

Hribar, C. (2010). *Understanding concentrated animal feeding operations and their impact on communities*. https://stacks.cdc.gov/view/cdc/59792

Johnson, S. F. (2019). Methemoglobinemia: Infants at risk. *Current Problems in Pediatric and Adolescent Health Care*, *49*(3). https://doi.org/10.1016/j.cppeds.2019.03.002 Knobeloch, L., Salna, B., Hogan, A., Postle, J., & Anderson, H. (2000). Blue babies and nitrate-contaminated well water. *Environmental Health Perspectives*, *108*(7), 675–678. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1638204/

MacDonald, J. M., & McBride, W. D. (2009). The transformation of u. S. Livestock agriculture scale, efficiency, and risks. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1354028

Magnien, R. E. (2001). The dynamics of science, perception, and policy during the outbreak of pfiesteria in the chesapeake bay. *BioScience*, *51*(10), 843. https://doi.org/10.1641/0006-3568(2001)051[0843:TDOSPA]2.0.CO;2

Protect Your Town. (n.d.). Protect Your Town. Retrieved October 15, 2024, from https://protectyourtown.org/factsheet

Raff, Z., & Meyer, A. (2022). Cafos and surface water quality: Evidence from wisconsin. *American Journal of Agricultural Economics*, *104*(1), 161–189. https://doi.org/10.1111/ajae.12222

Randall, D. J., & Tsui, T. K. N. (2002). Ammonia toxicity in fish. *Marine Pollution Bulletin*, *45*(1–12), 17–23. https://doi.org/10.1016/s0025-326x(02)00227-8

Seely, R. (2010a, February 28). *Tracking a rising tide of waste*. Wisconsin State Journal. https://madison.com/special-section/factory_farms/managing_manure/tracking-a-rising-t i de-of-waste/article_df56a7f6-2255-11df-90a7-001cc4c03286.html

Seely, R. (2010b, March 1). *Dairy lobbyists shape policy*. Wisconsin State Journal. https://madison.com/special-section/factory_farms/dairy_power/dairy-lobbyists-shape-p o licy/article_40a90440-2256-11df-9a80-001cc4c03286.html

The CAFO Next Door. (2024). Re-Amp Network. https://www.reamp.org/wp-content/uploads/2024/07/The-CAFO-Next-Door.pdf *The dead zone: How the Midwest kills marine life in the Gulf of Mexico*. (2022, June 15). Friends of the Mississippi River. https://fmr.org/dead-zone-how-midwest-kills-marine-life-gulf-mexico

The number of U.S. farms continues slow decline. (2023). USDA. http://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=5826 8 Town, P. Y. (n.d.). *Protect your town*. Protect Your Town. Retrieved October 16, 2024, from https://protectyourtown.org/factsheet

Townsend, A. R., Howarth, R. W., Bazzaz, F. A., Booth, M. S., Cleveland, C. C., Collinge, S. K., Dobson, A. P., Epstein, P. R., Holland, E. A., Keeney, D. R., Mallin, M. A., Rogers, C. A., Wayne, P., & Wolfe, A. H. (2003). Human health effects of a changing global nitrogen cycle. *Frontiers in Ecology and the Environment*, *1*(5), 240–246. https://doi.org/10.1890/1540-9295(2003)001[0240:HHEOAC]2.0.CO;2

3.4 Automated Milking Systems: A yay or nay for the dairy industry?

Anonymous

Introduction

The dairy industry and most animal husbandry industries in general have sparked controversy in the sustainability community. Much of their operations are a result of our industrial economy and participate in that economy in several ways. Dairy farms are a part of this industrial agriculture economy. This is problematic because industrial agriculture is too focused on production and profit rather than the goal of providing good, healthy, whole food for society. The dairy industry has a role to play in the conversation of degrowth versus large scale industrial agriculture. According to Progressive Publishing Dairy, the average herd size in 2023 was 357, which was about 20 cows more than 2022 (Progressive Dairy, 2023). One system within the dairy industry that has been growing in popularity in recent years is the introduction of automated milking systems (AMS). Is the increase in machinery associated with the growth of dairy farms? The obvious answer is yes, but the goal of this paper is to see how automated milking systems affect dairy farms and whether they are a hindrance or aid in making dairy farming more sustainable.

Methods

The research for this paper was done in several stages. It began with a visit to two farms (Common Harvest CSA Farm and Whetstone Farm), then online research into automated milking systems and degrowth, and then interviews with dairy farmers. The visit to the farms was done through a class. We went to learn about the operations of the farms and about sustainable agriculture. Farmer Dan of Common Harvest had mentioned on the tour of the surrounding area that he had seen an increase of new technology use in dairy farms specifically in recent years. He was talking about larger scale farms with new technology because they are the ones who can afford them. After the farm visit, I wanted to know more about the use of new technology in dairy farming. The online research was focused on dairy farming as a whole as well as automated milking systems and then the theory of degrowth. The research of degrowth is important because I wanted to know whether AMS can be used in an agricultural society that emphasizes degrowth. With the research, I was able to formulate questions to ask dairy farmers. I got in contact with four dairy farmers, three over the phone and one over email. I asked them general questions such as the daily operations of their farms as well as yearly output and amount of cows. I then asked whether they used any machinery in their operations. If they did, I asked how it helped productivity and how it worked. I also asked about general politics surrounding dairy farming now to get a whole picture of the dairy farming culture and industry.

Findings and Analysis

Farm Visit

In the research, I identified two potential issues within the dairy industry: degrowth and labor issues, and the use of automated systems as a result of both issues. However, the use of automated systems is not perpetuating the issues. This began with the visits to Common Harvest and Whetstone. When Farmer Dan was talking about the increase of automated machinery, he was highlighting it in view of the larger farms. One robotic milker costs about $200,000. Robotic milkers are expensive, but not an unattainable asset. In his own operations, Farmer Dan tries to avoid machinery as it is expensive to buy as well as upkeep. On a smaller farm, machinery may not help efficiency the same way it would on a larger farm. Farmer Dan and Emily Whetstone both touched on the fact that their operations only work because they are small. They are ecologically focused, so every part of their farm works together, allowing for the natural processes to work for them, rather than against them. The added layer of machinery would work against this and just add more complications than making it easier for them. So, a question that arose is whether a large-scale or small-scale farm is better for the food industry overall and how does the use of machinery fit into that?

Degrowth

Before diving into dairy farms specifically, I wanted to look at the theory of degrowth more closely and then see if it applied to dairy farms. According to Paul Robbins in his book called *Political ecology: a critical introduction*, degrowth is the recognition of the limitations of the Earth and society needs an economy that will surpass those limits. Hence, in such an economy, growth is not the solution. Capitalism right now drives growth: we value profit over everything else. In this theory, there is a large skepticism of technology. The goal of this book is to see what is compatible with political ecology, including the use of new technology (Robbins, 2020). Technology in the theory of degrowth perpetuates growth and does not take into account the limits of the Earth. It is utilized to allow for more production rather than less. However, Robbins discusses another theory, ecomodernism, which allows for technology (Robbins, 2020). Ecomodernism asserts that progress can reduce the human footprint rather than increase it and technology is needed for this reduction within progress (Robbins, 2020). Regardless of which method is going to be the most successful, Robbins argues for political ecology, which is looking at how political power within societies works with the relationships of the environment. Agriculture is a prime example in which political ecology can operate with the balance of human power and natural systems. It is still unclear, however, whether technology has a place in sustainable farming or not, as according to Robbins it could go either way.

Regardless of degrowth and ecomodernism, limits need to be made clear and followed. Limits mitigate climate change (Kallis, 2021). Giogros Kallis argues that unchecked growth will destroy the planet and only adhering to the Earth's natural limits can this be curbed. The existence of limits suggests that there are already enough resources on the planet if utilized well and sustainably (Kallis, 2021). Kallis also argues that technology is not inherently bad, but the lack of limits is. If they can exist in conjunction with each other, then there does not need to be an issue (Kallis, 2021). Julien-François Gerber argues that in degrowth, society can still live well. Degrowth does not have to equate a decrease in quality of life, just a change. It just means we need to learn how to use our natural resources well, which means using some more and others less (Gerber, 2021). Gerber is also not completely anti-technology, just that it also needs to be used well, like locally produced electricity or solar power. (Gerber, 2021). It is all about balance.

So, all these authors in the discussion of degrowth are in general not completely against technology in agriculture. But is it a problem in dairy farming? According to M. A. G. von Keyserlingk et al., the dairy industry has gotten more intense as well as more efficient. They particularly highlight that milking processing centers represent a large portion of dairy farms' energy usage as each step requires a significant amount of energy. Adding technology can increase this energy usage (Keyserlingk, 2013). The labor issue is also highlighted. Labor is scarce so large farms employ a large number of immigrant workers, but now they are being replaced by machinery (Keyserlingk, 2013). So, technology may help to increase efficiency, but at high energy costs.

Automated Milking Systems (AMS)

Automated milking systems encompass a large variety of different machines. The began to be invented in the 1950s but did begin to be used until the 1970s when the labor cost began to spike (Sharipov, 2021). They steadily grew more popular until by 2017, there were over 35,000 automatic milking systems worldwide (Sharipov, 2021). Several different systems have been developed, allowing farmers to choose which system will work best for them. Some systems include the single box, the multi box, two parallel milking boxes, and multi box with several milking boxes located on one row (Sharipov, 2021).

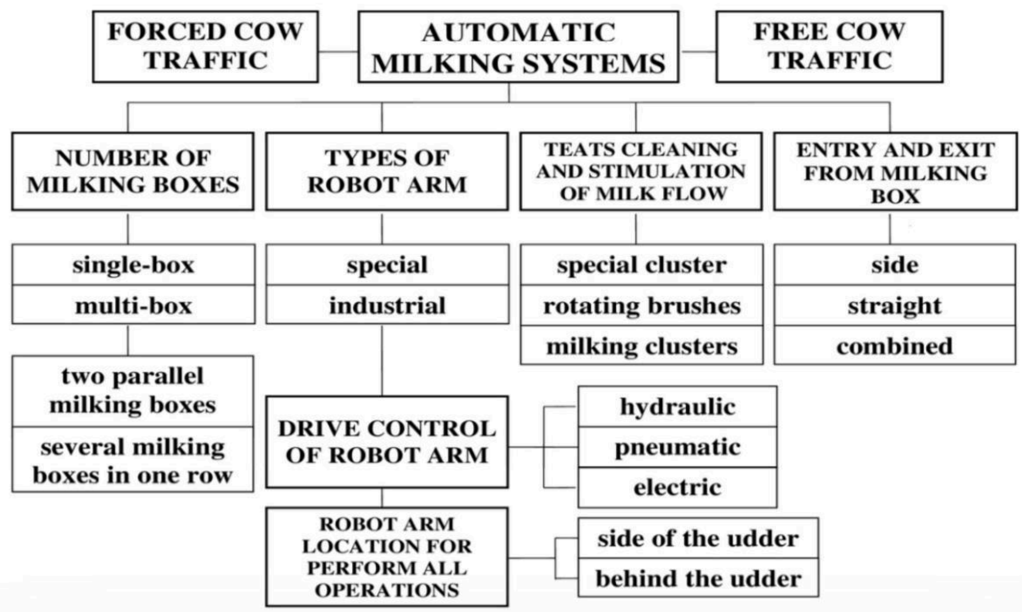

Figure 1. Classification of automatic milking systems.

Proposed Classification of AMS (Sharipov, 2021)

Now there can be several risk factors associated with AMS (Tremblay, 2016). Tremblay et al. specifically looked at the factors of traffic type (free vs forced) and number of robots per pen. Both factors impact milk production and quality, and Tremblay et al. seemed to identify forced traffic and increased milking per day increased quality and quantity (Tremblay, 2016). But this seems to be in line with the productionist view of things. Another study by A.M. Wagner-Storch and R.W. Palmer looked at the difference between an AMS parlor or conventional milking parlor. They found that AMS increased milk yield because it increased milking frequency (Wagner-Storch, 2003). This again shows that AMS is correlated with higher production.

Interviews

I was able to interview 4 dairy farmers: three I connected with through Farmer Dan and one through a family friend. They all had a variety of herd sizes, from the lowest herd size being 50 cows and the largest being 600 cows. According to one farmer, his herd size of 250 cows used to be average but in the last 10 years has shifted to being small scale (Warmkagathje, 2024). By this standard, most of the farmers I interviewed are considered small scale except the 600 one, which may now by average or on the cusp of large scale.

Despite the variety of sizes, I was able to identify several themes across the board in these interviews: growth of dairy farms, labor issues, and lack of desire within the dairy industry to do dairy industry. David Wurst, the first farmer I interviewed, runs his 50 cow farm with his 21-year-old daughter (Wurst, 2024). He was very adamant about the labor problem. According to him, 85% milk is produced in the United States but most of the work is done by immigrant workers (Wurst, 2024). He says that the dairy industry used to be valued but now it is driven purely by the consumer (Wurst, 2024). Bill Hassel runs his operation of 550-600 cow operation with his wife and two sons. In larger operations like this, he says labor saving solutions like robotic milking or other machinery can be very helpful (Hassel, 2024). Dairy farming is labor intensive, like most agriculture and it can be difficult to find laborers outside the family.

All the farmers spoke on AMS. None had anything bad to say about it. Troy DeRosier of Crystal Ball Farms said that all his automated systems, both within the milking process and for cleaning and getting feed to the cows, are a huge labor saver and keep the cows clean (DeRosier, 2024). He has 200 cows. Even those who did not use AMS said that the problem with growth was not AMS, though of course AMS is associated with growth. Hassel says that "[a]utomation is beneficial in all size operations", both economically and practically. The issues they do have with the dairy industry are not associated with AMS systems.

Pictures from Ed Warmkagathje's Farm (Warmkagathje, 2024)

Discussion

This paper highlights a lot of issues within the dairy industry. It discusses a potentially controversial topic with many different opinions across the board about the role of new technology within the dairy industry. Even with the farmers I talked to, there was not an agreement on the use of new technology. There was not agreement on whether AMS is in accordance with ecological practices in farming. Farmer Dan would probably say no while the other farmers I talked to would say yes. If the scope of the project had allowed, I would have found more farmers, especially those with more AMS or even larger farms and speak to them about their sustainable or unsustainable practices. I was not able to tour any dairy farms. If there was more time, I would have done a deeper dive into the different kinds of AMS and their levels of productivity and more research on the general routines of dairy farms to contrast them. The scale of this project was small, but still there is an interesting and necessary conversation about the use of technology in sustainable agriculture.

Conclusion

So, is AMS good or bad? Well, the answer is not so black and white as maybe one would like. It is correlated with an increase in size of dairy farms. As they get larger, dairy farms need to increase efficiency and as many of the farmers highlighted as well as several articles, there is a real labor issue in the dairy industry right now. But as the farmers said, small scale farms can utilize AMS as well to help with their own labor issues. With the lack of willing workers and farmers, dairy farms either resort to AMS or immigrant workers. AMS itself is not inherently bad. In fact many of the studies showed that it can improve herd health as well as increase in productivity and quality. They may present an energy usage problem, but that is a problem in bigger farms rather than smaller farms. There are also energy saving methods such as solar or wind. The real issue is the increase in farm sizes and the fact that they are displacing smaller scale farms. The average size of farms is going up, which is in line with the productionist ideals brought up in the degrowth theory. So, in conclusion, AMS systems are not inherently bad, and the real issues facing the dairy industry right now are growth and labor. Instead, the focus should be towards supporting smaller farms that are still family run and are working towards relationships with consumers.

Sources

(Bill Hassell, Hassell Farm, personal and email interview, October 2024)

(David Wurst, personal interview, October 2024)

(Ed Warmkagathje, Sunshine Acres Farm, personal interview, October 2024)

(Troy DeRosier, Crystal Ball Farms, email interview, October 2024)

Gerber, J.-F. (2020). Degrowth and critical agrarian studies. *The Journal of Peasant Studies*, *47*(2), 235–264. https://doi.org/10.1080/03066150.2019.1695601

Kallis, G. (2021). Limits, ecomodernism and degrowth. *Political Geography*, *87*, 102367-. https://doi.org/10.1016/j.polgeo.2021.102367

Ritchie. (n.d.-c). *The benefits of adding a Ritchie to your operation extend far beyond saving you time, money, and water*. https://www.progressivepublish.com/downloads/2024/general/2023-pd-stats-lowres.pdf

Robbins, P. (2012). *Political ecology : a critical introduction* (2nd ed., pp. 236-244). J. Wiley & Sons.

Sharipov, D. R., Yakimov, O. A., Gainullina, M. K., Kashaeva, A. R., & Kamaldinov, I. N. (2021). Development of automatic milking systems and their classification. *IOP Conference Series: Earth and Environmental Science*, *659*(1), 12080-. https://doi.org/10.1088/1755-1315/659/1/012080

Tremblay, M., Hess, J. P., Christenson, B. M., McIntyre, K. K., Smink, B., van der Kamp, A. J., de Jong, L. G., & Döpfer, D. (2016). Factors associated with increased milk production for automatic milking systems. *Journal of Dairy Science*, *99*(5), 3824–3837. https://doi.org/10.3168/jds.2015-10152

von Keyserlingk, M. A. G., Martin, N. P., Kebreab, E., Knowlton, K. F., Grant, R. J., Stephenson, M., Sniffen, C. J., Harner, J. P., Wright, A. D., & Smith, S. I. (2013). Invited review: Sustainability of the US dairy industry. *Journal of Dairy Science*, *96*(9), 5405–5425. https://doi.org/10.3168/jds.2012-6354

Wagner-Storch, A. M., & Palmer, R. W. (2003). Feeding Behavior, Milking Behavior, and Milk Yields of Cows Milked in a Parlor Versus an Automatic Milking System. *Journal of Dairy Science*, *86*(4), 1494–1502. https://doi.org/10.3168/jds.S0022-0302(03)73735-7

Chapter 4

Marketing Alternative Agriculture

By: Sidney Berjamin, Anonymous, Isaac Gilchrist

4.1 Marketing Alternative Agriculture

Sidney Berjamin

Question: What part do Community Supported Agriculture (CSA) initiatives play in creating ties within the community and guaranteeing alternative farmers financial stability?

Introduction

Community Supported Agriculture (CSA) initiatives are an essential model in today's agricultural landscape, offering an alternative approach that crosses the gap between farmers and local communities. CSAs allow clients to pre-purchase shares of a farm's production, ensuring consistent access to fresh, locally sourced vegetables throughout the growing season. This strategy gives small-scale and alternative farmers upfront capital and a specific market for their products, but it also offers unique opportunities for community involvement, and assistance.

The question, "What part do Community Supported Agriculture (CSA) initiatives play in creating ties within the community and guaranteeing alternative farmers financial stability?" supports study into the diverse ways that CSAs support local food systems. This paper will look at if CSA programs really promote sustainability, build and enhance community bonds, and or increase small-scale farmers' financial stability. Using personal stories and in-depth research from CSA practitioners and researchers, this paper will highlight the various advantages that CSAs provide to farmers and customers and its flaws.

METHODS

In order to respond to the essay question, "What role do Community Supported Agriculture (CSA) initiatives play in fostering community relationships and ensuring alternative farmers' financial stability?" I used an organized method to select suitable sources. The procedure sought finding publications that provided expert analysis of the economic and social effects of CSA programs in addition to first-hand accounts from farmers active in CSA. In addition to addressing the community-building and financial stability aspects of CSA models, the selected publications offer extensive viewpoints.

2

Source 1: *Community Supported Agriculture Farmers' Perceptions of Management Benefits and Drawbacks*

This article was picked because it includes first-hand stories from CSA farmers who talk about the advantages and difficulties of running a CSA. The source is especially relevant because it emphasizes how CSAs help farmers maintain financial stability by providing them with upfront payments at the start of the season, which facilitates resource allocation and budgeting. It also looks at how CSAs build relationships between farmers and customers to strengthen community links. The first-hand account in this article enables a solid knowledge of how farmers view the social benefits and financial stability offered by CSA models.

Source 2: Community Supported Agriculture by Daniel Prial

To investigate how Community Supported Agriculture (CSA) programs strengthen ties within the community and give alternative farmers financial security, I carried out a qualitative analysis for my study. Key themes on how CSAs foster local engagement and financial stability were found when I studied a body of existing research, which included studies and articles from agricultural organizations like the National Center for Appropriate Technology (NCAT). I sought to comprehend the effects of different CSA models on regional food systems by looking at urban and cost-offset programs, among others. A drawback of this approach, as mentioned in the NCAT article, is the lack of first-hand farmer reports, which restricts the depth of understanding of their firsthand experiences. This implies that more study is required to include these viewpoints in surveys or interviews.

Source 3: Food justice in community supported agriculture – differentiating charitable and emancipatory social support actions

I selected this article to examine how CSAs foster community relationships and contribute to the financial security of alternative farmers because it provides a critical and comprehensive analysis of the movement. Rather than concentrating just on the advantages of CSAs, the paper explores their drawbacks as well, offering an objective evaluation. Utilizing the Strategic Action Fields (SAFs) theory, it effectively breaks down the complex relationships among farmers, consumers, and community members in the CSA model. It discusses how CSAs affect community ties in addition to the financial assistance they provide farmers. It discusses both the charity aspect of CSA, where farmers assist members with lower incomes, and the objective to increase participation and level equal opportunities for all.

The article's topic is further explored by the inclusion of perspectives from those who are directly involved in managing CSAs, such as coordinators and organizers. It provides a more comprehensive understanding of CSA operations beyond the consumer-farmer interaction by incorporating different perspectives, which makes it a reliable resource for investigating how CSAs improve community bonds and support farmers' financial stability.

ANALYSIS

Community Supported Agriculture (CSA) programs create cooperative relationships between producers and consumers through pre-paid subscription models that guarantee consistent revenue and encourage local participation in the food production process. This strengthens community ties and gives alternative farmers financial stability. Samoggia et al.'s study, "Community supported Agriculture farmers’ Perceptions of Management Benefits and Drawbacks," examines how CSA programs encourage a sense of community while simultaneously giving small-scale farmers in the US and Hungary financial stability. CSA models involve consumers directly in the food production process, strengthening community bonds. Members pay in advance for harvest shares, allowing farmers to pay for operations ahead of time. This approach "reallocates power to CSA farmers, consumers, and local community," as stated by Samoggia et al., promoting a network based on cooperation and trust. CSAs meet the community's need for willingness and reliability by letting customers know where their food comes from and getting involved in the agricultural process. This improves community ties and raises the value of the CSA system.

Through upfront payments, CSAs provide farmers with a steady income, protecting them from the unstable nature of conventional market pressures. The article notes that although non-monetary benefits are essential to the CSA model, the "long-term perspective and upscale" of CSA operations depend on the financial stability provided by "monetary benefits" from pre-paid subscriptions. Due to the steady income streams this approach offers farmers, improved financial planning and investments in sustainable practices are made possible. CSA appeals to people who want both social engagement and economic sustainability in local food systems because of its dual emphasis on community connection and financial stability, which makes it a desirable alternative to traditional agriculture. Important information about the advantages and disadvantages of CSA programs as regarded by farmers in the US and Hungary may be found in Table 5 above. It demonstrates that CSA farmers strongly believe that environmental advantages (mean score of 4.49), product quality and variety (4.45), and health and nutritional characteristics (4.13), all of which improve community relations, are important. With a minimum score of 3 and a standard variation of 0.55, the economic benefits also receive high marks, demonstrating a continuous awareness of the significance of financial stability in CSA farming. The table also shows how American and Hungarian farmers have different perspectives, with Hungarian farmers placing a higher priority on product attributes and community support (p-values of 0.045 and 0.077, respectively). In line with the main idea of the essay question, this data shows that CSA programs not only promote a feeling of community but also help alternative farmers remain economically viable by guaranteeing a steady market for their goods.

Initiatives for Community Supported Agriculture (CSA) provide as a link between farmers and consumers, fostering close ties within the community and providing small-scale and alternative farmers with financial security. NCAT (National Center for Appropriate Technology) publishes a report on Community Supported Agriculture (CSA), which describes CSAs as direct consumer-farmer relationships in which people buy shares of a farm's produce in advance and receive regular deliveries of fresh commodities in exchange. Farmers and community members can share in the risks and benefits of local agriculture thanks to this approach, which highlights the economic and social aspects of food production.

By placing food production in a local context, CSA programs strengthen community bonds and promote transparency and trust between farmers and consumers. Members of CSAs establish a direct line of communication with the farm that provides their food, frequently through farm visits, newsletters, or neighborhood gatherings. This degree of involvement not only raises consumer awareness but also develops pride in supporting local agriculture and a sense of shared responsibility. "CSAs provide farmers with upfront availability of capital, which is a benefit shared by both urban and rural CSAs," the NCAT paper adds. In addition to guaranteeing that farmers receive the money they require, this upfront payment scheme gives participants an interest in the farm's success.

As demonstrated by urban CSA efforts that partner with educational programs, nonprofits, and other community organizations, the advantages of CSAs go beyond the direct farmer-member relationships. For example, the dense population in urban areas offers a consistent pool of prospective members as well as a chance to involve a variety of groups in sustainable agricultural methods. By including local organizations in food production and education, "Urban CSA operators frequently link their programs with educational institutions, youth programs, and nonprofits," according to NCAT. This not only increases the CSA's influence but also strengthens community participation. In doing so, CSAs contribute significantly to the advancement of agricultural awareness and food sovereignty among urban residents, who may not otherwise have as much access to these experiences.

Small-scale farmers' financial resilience is also greatly enhanced by CSA plans. CSAs provide a more steady and predictable source of revenue than traditional farming, where profits are mostly dependent on market prices and seasonal demand. "Multi-farm CSAs bring together multiple farmers to collaborate on providing products... in such a way that no one farmer has to bear all the responsibility," the NCAT article says, stressing this point. For small farmers who do not have the means to individually satisfy all of their clients' needs, this multi-farm strategy is very beneficial. By combining resources, producers may provide a variety of goods and capitalize on one another's advantages, increasing the CSA's appeal and lowering the financial risk for individual members.

Additionally, as the article discusses, CSA-specific technology enables farmers to effectively manage customer relationships and adjust to consumer preferences. Long-term financial stability depends on greater retention rates, which are supported by this as well as increased customer pleasure. With the use of tools like CSAware and Harvie, farmers can interact directly with

members and offer customisable shares, enabling them to react swiftly to changes in customer demand. This flexibility is essential because, according to NCAT, "Farmers will need to incorporate more opportunities for consumer choice—such as structuring their CSAs around a market-style pick-up." Farmers may maintain members year after year by using such adaptable models, guaranteeing a consistent flow of income that sustains the long-term health of their businesses.

To improve the sustainability and community impact of Community Supported Agriculture (CSA) initiatives, I advise policymakers to put support programs in place. For low-income families, financial aid or subsidies can greatly boost involvement, strengthening community bonds and enhancing public health results. Furthermore, creating educational initiatives that link farmers and customers would simplify the CSA model and emphasize the advantages of regional food systems. Raising awareness of CSA offers through increased marketing initiatives and community outreach can benefit both farmers and consumers. Lastly, giving farmers an opportunity to express their views can foster cooperation and deepen understanding, which will ultimately improve the local food chain.

While CSAs benefit farmers by giving them a steady income and encouraging community involvement, study has also revealed that these programs can unintentionally perpetuate social injustices and have difficulty incorporating low-income households completely into their models. This partial exclusion draws attention to the difficulties CSAs encounter in fostering relationships within the community that are really inclusive and ensuring everyone's financial security. Although CSAs have the potential to help smallholder farmers, the report notes that they frequently lack the systems necessary to guarantee that low-income households are engaged, empowered participants rather than passive beneficiaries of charity. Because of this, CSA programs don't always succeed in creating the strong community ties they want to.

One of the main problems is that social support initiatives in CSAs may make beneficiaries feel more dependent rather than empowered. As Parot notes, "These donations may cause the recipients to become dependent and perpetuate altruism and indignity on the same hand" CSAs run the risk of weakening the very ties to the community they are trying to build by portraying low-income households as merely beneficiaries of aid rather than as equal partners. In addition to having an impact on the recipients, this kind of dependency produces an unbalanced dynamic that may cause tension in the relationship between farmers and CSA members.

Furthermore, the idea that CSAs may offer alternative farmers in a variety of regions dependable financial stability is called into question by the absence of financial accessibility for low-income households. As the long-term commitment of membership surpasses their planning horizon, the article points out that "the membership fee is a frequently mentioned reason why persons with a
low income are excluded from CSA" (Parot, 2023). This cost barrier highlights the CSA programs' limited inclusivity and shows that, although they may help farmers stabilize their income, they mostly benefit members who can afford the commitment.

7

CONCLUSION

In conclusion, it became evident to me how crucial Community Supported Agriculture (CSA) programs are for fostering community relationships and providing alternative farmers with a steady stream of income as a result of my investigation into these programs. It really encouraged me to see how CSAs build genuine relationships between farmers and their consumers in addition to providing financial stability through pre-purchased shares. I became aware of the close bonds that form within these programs and the commitment of participants to promoting local farming after reading the testimonies of CSA practitioners. At the same time, I became aware of the difficulties CSAs encounter, particularly with regard to inclusivity and the potential for low-income participants to feel dependent. This caused me to reflect more thoroughly on the complexity of CSAs and their role in the community.

Works Cited

Parot, J., Wahlen, S., Schryro, J. *et al.* Food justice in community supported agriculture – differentiating charitable and emancipatory social support actions. *Agric Hum Values* **41**, 685–699 (2024). https://doi.org/10.1007/s10460-023-10511-w

Samoggia, Antonella. “Community Supported Agriculture Farmers' Perceptions of Management Benefits and Drawbacks.” *MDPI*, 13 June 2019, https://www.mdpi.com/2071-1050/11/12/3262. Accessed 17 October 2024.

Prial, Daniel. “Community Supported Agriculture – ATTRA – Sustainable Agriculture.” *ATTRA – Sustainable Agriculture*, https://attra.ncat.org/publication/community-supported-agriculture/. Accessed 17 October 2024.

Silverberg, Marissa. “The Ins and Outs of Community Supported Agriculture (CSA).” *OpenGov*, 19 February 2020, https://stories.opengov.com/jeffersoncountyco/published/qvMWVPWcC. Accessed 17 October 2024.

4.2 Untitled

Anonymous

Introduction:

To start this essay, I first must define alternative agriculture. Alternative agriculture is a category of agriculture that refers to unique farming methods that emphasize and strive for sustainability and natural approaches to growing livestock and crops. This blanket approach can be used amongst many different types of farms but is typically used in smaller scales and aims to improve our environment and stray away from the conventional production methods which include widespread tilling, water usage, and significant use of pesticides, herbicides, and fertilizers. This concept of organic farming and use of CSAs (community supported agriculture) can be seen in action through the production and selling methods used that our class saw at both Whetstone Farm and at Common Harvest Farm that we visited in Wisconsin. This methodology has massive upside and potential and has become increasingly popular due to its philosophy of producing more local, healthier, and nutritious food whilst also focusing on being sustainable which often is a concept that is not highly valued among many American farms that seek to produce and profit as much as possible from their farmland. That being said, a major problem with alternative agriculture exists: it often isn't very available to the public or accessible due to its high costs. This begs the question, how can we incentivize this type of agriculture but also make it cost efficient and make it appealing to the entire market of consumers? My group for this project specifically focused on marketing and attempted to answer the overarching questions of what are the pros and cons of different strategies for alternative farmers, and are there new alternative agriculture marketing strategies that could increase access or expose new audiences to alternative agriculture? More specifically, I wanted to focus on how we can effectively market alternative agriculture and healthy and sustainable foods to low income people and try my best to answer this question. Obviously this issue is complex and difficult to answer, especially because of the fact that in our world right now it is ingrained in our society that alternative agriculture is not the norm and that even when it is available, it isn't equitable and accessible to people of all different economic ranges. We know that it is clear that this style of agriculture caters to high-end customers who have the capacity and the willingness to spend extra money on more nutritious alternatives to mainstream agricultural food sources. With this issue in mind, we must figure out a method or multiple methods to help move away the focus from marketing to wealthier customers to a more general and broader audience so that everyone has an equal opportunity to experience the benefits of healthy and locally grown produce.

Research methods:

To gather the information necessary to answer this question about marketing and accessibility of alternative agriculture that is an ongoing issue, I combined brief interviews I did with farms with my own research using various different sites to learn about previous projects and studies that have investigated what methods work and what don't. Most of my information did come from outside resources, but I did do my best to contact individual farms to hear their opinions as well. I first off reached out to both Whetstone Farm and Common Harvest Farm which are both small family farms located in western Wisconsin. I asked both farms if they could answer this question: "How can we effectively market alternative agriculture and healthy and sustainable foods to low income people?". I also made sure to clarify that I was interested to hear how to make alternative agriculture more accessible and affordable, but also how to make it a more appealing option even if it is accessible. Whetstone Farm reached out to me fairly late in the process and unfortunately we could not find a time to get an interview in, but Farmer Dan from Common Harvest gave me some good feedback on how he thinks marketing could be improved and he also pointed me towards a lot of trials and sources that gave additional insight into what methods might be most effective and beneficial to the public. With these sources he provided me and a wide variety of sources I found through researching online, I was able to come up with a better idea of how to tackle this seemingly insurmountable issue of the lack of availability but most importantly accessibility and appeal of alternative agriculture to lower income communities.

Findings, Analysis, and Discussion:

In the end, marketing alternative agriculture to low-income populations presents some challenges, but many strategies have proven effective or have shown signs of potential success in the future. Farmer Dan provided me with a bunch of ideas on how this can work and one of them in which he was closely related was very interesting to me. He explained that Common Harvest farm works closely with Pillsbury United Community which operates three of the largest food shelves in Minneapolis. He mentioned that a few years ago they built a grocery store for low income residents in North Minneapolis (a particularly impoverished area), and he noted that they are working on dignifying the food distribution process by giving people more choice rather than simply handouts of largely government commodities. At this grocery store patrons get vouchers for so many pounds per member of a household and produce doesn't count against that weight limit to encourage making better health choices. This is an interesting start, and I also find myself leaning towards the idea of food shelves in major urban centers which are usually reasonably accessible being a good source or place to sell organic and alternative agriculture.

Furthermore, Farmer Dan emphasizes that psychologically people in lower income communities as well as people just in general prefer to do something themselves than to get a handout. To play with this idea of people preferring choice, he recommended expanding community gardening and making land available for disadvantaged communities to grow their own food. He also recommended cooking classes, meal prep and education which would be helpful in giving these people the tools and knowledge to support a lifestyle in which they cook and make themselves more nutritious meals.

Another program that Farmer Dan mentioned that I learned about was the LFPA. The LFPA refers to the Local Food Purchase Assistance Cooperative Agreement Program which "uses non-competitive cooperative agreements to provide up to $900 million of American Rescue Plan (ARP) and Commodity Credit Corporation (CCC) LFPA Plus funding for state, tribal and territorial governments to purchase foods produced within the state or within 400 miles of the delivery destination to help support local, regional and underserved producers." The program applies to all 50 states and was established in 2021 during the rough times of COVID. It was meant to help protect the farmers who were struggling but also make this type of food accessible to many different groups of people. In their description they state specifically that "the food will serve feeding programs, including food banks, schools and organizations that reach underserved communities." This initiative has largely been successful from what I have seen, helping out both struggling farmers and underprivileged communities.

The other thing Farmer Dan mentioned was to face the source of our problem which is the system of making fast food and beverages with little nutrition cheap and easily accessible and available. These are very structurally ingrained into our society, but it is possible to change them through changes in policy that can occur if a big social movement is sparked. One specific example of a policy change that was effective was the soda tax in New York City. New York City attempted 6 models of soda taxes to try and cut back on soda consumption in the city and the results they found were very encouraging. Soda consumption decreased by 35% among adults and 27% among public high schools. This initiative ended up saving thousands of people from acquiring health complications related to sugar consumption like diabetes, and also saved the city millions of dollars in health care costs. While initiatives like this do show promise and emphasize that changing political policy does actually have a big impact, it doesn't show how we can create a system where alternative agriculture and healthy and nutritious foods are the norm for people.

Another successful approach that has been put into action in a few American cities has been the use of farmers' markets and community-supported agriculture (CSA) programs in low-income neighborhoods. These programs have helped increase access to fresh and sustainable food through partnering with other food assistance programs, like the Supplemental Nutrition Assistance Program (SNAP). For example, cities like Philadelphia and Detroit have farmers' markets that have started to accept SNAP benefits and unsurprisingly, these cities have seen increased participation from low-income families. This model offers an affordable way to purchase alternative agriculture products and also on top of that it educates consumers about the health benefits of sustainable food, making people more likely to circle back and keep consuming these products.

On the flip side, one thing we have learned in trying to solve this issue is that traditional advertising methods like digital marketing or TV ads, have often failed to appeal to low-income audiences when promoting alternative agriculture. These marketing methods tend to target affluent consumers who are already interested in and knowledgeable about the organic and sustainable food movement. One study found that conventional advertising for alternative agriculture products was largely inaccessible to lower-income groups due to both cost barriers but also due to a "lack of perceived relevance." Furthermore, many low-income individuals prioritize cost and convenience over sustainability to try and get by, making it difficult for products from alternative farms to compete with cheaper conventional options even if they wanted to.

Looking ahead towards the future, other innovative solutions like mobile markets and subsidized CSA memberships could play a major role in marketing alternative agriculture more effectively to low-income communities. Mobile markets are systems where farmers bring their fresh produce directly to underserved areas, reducing the transportation barriers that often prevent low-income individuals from accessing alternative agriculture products. Additionally, local governments or organizations could play a role in subsidizing CSA memberships for low-income families, making it more affordable for them to receive fresh and healthy food on a regular basis. This model has extreme potential too because it has already been successfully utilized in parts of California, where community health organizations partnered with local farms to offer discounted CSA memberships to low-income residents. These strategies address the key aspect of the issue which is making alternative agriculture more accessible, and also fit the needs and values of low-income consumers, who we know to be more likely to embrace sustainable food if it is convenient, affordable, and can realistically support them in their daily lives.

Conclusion:

In summary, what we know is that this issue of how to make alternative agriculture that is nutritious, accessible and appealing to lower income communities is a difficult problem to solve, but progress can and already has been made. We know that conventional digital marketing isn't very effective, but we also know that through implementation of local and community-driven solutions, the alternative agriculture movement does have potential to expand its reach to include low-income populations. More specifically, farmers' markets that accept

SNAP benefits, mobile markets, cooking education, and subsidized CSA memberships provide valuable examples of systems that have been put into place that have already worked that could be adopted by other communities to help benefit lower-income communities on an even larger scale. These strategies acknowledge the socio-economic challenges faced by these communities while also attempting to find ways to help provide them sustainable and nutritious food to help limit health associated problems and provide a balanced and healthy life for everybody, not just those with wealth, privilege, and knowledge.

Works Cited:

Local Food Purchase Assistance Cooperative Agreement Program | Agricultural Marketing Service. (n.d.). https://www.ams.usda.gov/selling-food-to-usda/lfpacap#:~:text=The%20Local%20Food%20Purchase%2 0Assistance,purchase%20foods%20produced%20within%20the

Minnesota Local Food Purchase Assistance Program | Minnesota Department of Agriculture. (n.d.). https://www.mda.state.mn.us/business-dev-loans-grants/minnesota-local-food-purchase-assistance-progra m

Gortmaker, S., Long, M., Ward, Z., Giles, C., Barrett, J., Resch, S., Greatsinger, A., Garrone, M., Tao, H., Flax, C., Cradock, A., The CHOICES Project Team at the Harvard T.H. Chan School of Public Health, New York City Department of Health and Mental Hygiene, & The JPB Foundation. (2021). *New York City: Sugary & diet drink taxes*. https://choicesproject.org/wp-content/uploads/2021/11/CHOICES_NYC_SugaryDrinkTax_Repor t_FINAL_2021.pdf

Kansagra, S. M., Kennelly, M. O., Nonas, C. A., Curtis, C. J., Van Wye, G., Goodman, A., & Farley, T. A. (2015). Reducing sugary drink consumption: New York City's approach.

American Journal of Public Health, *105*(4), e61–e64. https://doi.org/10.2105/ajph.2014.302497

Hagues, R., Stotz, S., Childers, A., Phua, J., Hibbs, J., Murray, D., & Lee, J. S. (2018). Social marketing nutrition education for low-income population. *Social Work in Public Health*, *33*(5), 317–328. https://doi.org/10.1080/19371918.2018.1469065

Montague, H. (2017). Food Marketing and Low-Income Children: A study of exposure to food marketing and the impact on perceptions and behaviors of Low-Income families. Arch : Northwestern University Institutional Repository. https://doi.org/10.21985/N28T1N

Nordhagen, S., Demmler, K., & Dutch Ministry of Foreign Affairs. (2022). *BUSINESS MODELS FOR REACHING LOWER-INCOME CONSUMERS WITH NUTRITIOUS FOODS* (Roberta Bove, Oliver Camp, Ashish Deo, & Saul Morris, Eds.). https://www.gainhealth.org/sites/default/files/publications/documents/Business-models-for-reachi ng-lower-income-consumers-with-nutritious-foods.pdf

USDA ERS - Access to affordable, nutritious food is limited in "Food Deserts." (n.d.). https://www.ers.usda.gov/amber-waves/2010/march/access-to-affordable-nutritious-food-is-limite d-in-food-deserts/

4.3 Alternative Agriculture and Online Marketing

Isaac Gilchrist

Introduction

The agricultural methods used to bring our food have become increasingly energy-intensive and unsustainable. In a wealthy nation such as the United States, we have access to a huge variety of cheap products hidden behind an obscure food system that hides the way modern agriculture is failing us in the long term. Since the green revolution, our industrialized food systems have become increasingly reliant on pollutants like synthetic fertilizers and fossil fuel-intensive farming methods, pesticides that have slowly lost effect as insects become resistant, and intense tillage and overuse of fields that deplete resources for future crops (United Nations Environment Programme, n.d.). As a result, for every one calorie of food produced in the United States, ten calories of fossil fuels are consumed (Pollan, 2007). With a still-growing population, the agricultural practices we currently rely on will be unable to sustain humanity long-term without detrimental effects on our planet.

To respond to this crisis, we must turn to more sustainable agricultural practices. Alternative agriculture refers to agricultural practices that do not use conventional large-scale farming methods and focus on sustainability as well as the principles of Agroecology (Ribard et al., 2018). These practices can be seen in the US in small-scale organic farms and CSA (Community Supported Agriculture) farms. The core principles of alternative agriculture include long-term land stewardship, a closer relationship between consumers and the food they eat, and producing food with a low environmental impact. The crops these farms produce are driven by what can be grown best under given circumstances rather than producing what the market incentivizes. The practice of alternative agriculture can produce higher yields with less environmental impact and much more sustainability on less land than modern industrial farming.

Despite this, these farms only supply a tiny fraction of the food we consume, as our current methods of purchasing food are dominated by large corporations.

The way we purchase goods has been completely transformed by the internet, and food products are no exception. The food we consume, where we choose to get it from, and how we get it are all shaped by online marketing. Amid this silently growing crisis, alternative agriculture offers more sustainable means of producing the food we need. In a digital world, online services seem like a potentially useful tool for alternative agriculture farms to sell shares and build their community presence. There is, however, a tension between the shared risk community based network of alternative agriculture and the capitalistic consumer-based nature of online marketing and shopping. The internet in many ways perpetuates the "pick exactly what you want when you want it" view of food that Big Farming companies promote. On the other hand, there is potential for building awareness of alternative agriculture online and growing the movement of sustainable farming. Through the experiences of two different CSA Farmers we can develop an idea of why or why not alternative agriculture farmers use online tools and identify how an online presence could grow alternative agriculture.

Methods

To understand how and why Alternative Ag. farmers use online tools and retail methods, I will focus on the perspectives of two different Alternative Ag. farmers in eastern Wisconsin. For the beginning of my research, I visited two farms on a class trip where we toured and learned about each farm's practices and operations. First we visited Common Harvest Farms, which grows a variety of produce, and then Whetstone Farms, which grows produce and farms sheep. Both farms distribute their harvests using a CSA method, where shareholders support the farm in return for weekly deliveries of fresh produce. At the visit I discussed with both farmers about their main marketing and outreach strategies, and whether or not they maintained an online presence. After the visits, I talked on the phone with farmer Dan Guenthner from Common Harvest Farms about his and other farmers' choices to use online tools, and how these tools can be effective. We also discussed the overall direction of CSA farms and alternative agriculture in the United States.

Findings

The first farm we visited, Common Harvest Farms, uses the internet minimally for yearly operations and to attract shareholders. Part of this is a function of when they started. Thirty years ago, personal computers and internet access were not widespread, so other means were needed to build a community of investors. Common Harvest Farms found that the people most likely to return year after year and keep investing were people who had connections with others in the CSA. Having someone else to talk to about using different vegetables or someone to pick up a box for you fostered the sense of community that kept people returning to the CSA. To find people with pre-existing relationships, Common Harvest Farms would advertise to pre-existing groups, like a Twin Cities young mothers group or a specific workplace. When they worked with people from pre-existing groups such as these, people would return 60% of the time (Dan, 2024).

Alternatively, Common Harvest Farms also found that marketing online to random consumers the way many businesses currently do was unsuccessful for the CSA business model. With standard online marketing, only around 15% of CSA shareholders would return the following year. With this low retention rate, online marketing of a CSA wasn't justifiable for the time it would take compared to the low returns. Traditional online marketing didn't have the same community-oriented feel as physical marketing.

The fact that CSA farms tend to work better with physical marketing links to its decline in an increasingly digital world. CSA membership in the United States peaked around 15 years ago and has been declining since (Guenthner, 2024). A big reason for the decrease in CSA membership is larger corporate vegetable farms adopting online marketing strategies that attract the same group of customers interested in fresh produce. Subscription box services have become extremely popular in which customers select exactly what fruits and vegetables they want each month, and then get them delivered like any other online package. From a consumer perspective, it seems like a win; I get a monthly box of produce just like a CSA box, but I pick exactly what I want (including fruits and vegetables grown in all different climates). However, this produce does not come from alternative agriculture sources focused on sustainability; it comes from the same nebulous food system that stocks our grocery stores and destroys our planet. One huge factor of CSA farming that online box services eliminate is the idea of shared risk.

Shared risk is vital to CSA communities and crucial to creating a sustainable and equitable food system. Shared risk in this context means that if there are bad conditions preventing certain crops from growing or leading to bad harvests, consumers accept they won't receive as many items or will have less variety for a certain time. Conventional agriculture puts the risk solely on the farmers, driving them to use the modern agricultural practices (such as inorganic fertilizers/pesticides and overuse of fields) that increase short term production but lack long term sustainability. In any equitable and sustainable food system, there must be some shared risk from the consumer perspective and the understanding that changing yearly weather or pest patterns will affect the availability of certain foods. In taking the CSA model of subscription produce boxes, the prevalence of online marketing has also pushed traditional agriculture into the CSA Niche. So far, it seems the digitization of our world has hurt the growth of CSA model alternative agriculture. Despite this, there is potential for other online tools to reverse the decline of CSA and grow alternative agriculture.

The Power of Social Media

Online advertising is a naturally consumerist practice focusing on commodification that is unappealing to many alternative agriculture farmers, who support a food system less driven by profit. On top of that, paying for online advertisements is a substantial capital investment. The growing prevalence of social media, however, has presented a new route for growing alternative agriculture's image with no capital investment. Social media has the potential to be the perfect place to increase the movement of alternative agriculture and reach audiences without a cost barrier.

For many people, especially younger generations, social media is their primary source of information. Over half of US adults report they sometimes or always get their news from social media (Aubin, 2024). Social media has also become the main base for current social movements and has proven incredibly effective. In many ways, the switch to alternative agriculture is a social movement as much as a change in consumer behavior. The systematic change that needs to occur (on both the consumer and producer side of agriculture) will only gain traction if more awareness spreads about the importance of alternative agriculture and how people can participate. There are plenty of people who want to make a positive impact on the environment and support the sustainability of our planet, they simply need to be informed.

In addition to spreading the alternative agriculture movement, social media can be used to build the earlier-mentioned communities that are vital to a successful CSA. Whetstone Farm is leveraging social media to promote their business. They have gathered a following of over 2000 people on their Instagram page (shown at right), creating a large net of influence for a small farm that only services a couple hundred CSA members. Through this page, they advertise events they host on their farm that bring together community members and build awareness about sustainable agriculture. This is a perfect example of how the internet can bring awareness and bring together people who want to make a positive impact on our food systems.

Why Awareness Matters

To end my call with Farmer Dan, we discussed what the expansion of alternative agriculture might look like in the United States. Online tools have the potential to spread awareness and build up larger communities of people who want food from sustainable and equitable sources. For this growth of alternative agriculture to occur, farmers need to be in a position to change and meet this new demand for sustainable food systems. Currently, around 60-70 percent of farms in the United States are large corporate entities (Guenthner, 2024). Another 10 percent of farms directly market their products, making up the category Micheal Pollan calls Big Organic. The remaining percent are family-owned farms, known as The Ag. of the Middle (Guenthner, 2024). This was the dominant class of farmers before neoliberal specialization ideals took over US agriculture. Now, they are a slowly shrinking class of farms too small to compete with larger direct marketing competitors and not in a financial position to sign corporate contracts. These farmers are in a position where transfering to alternative agriculture and small-scale diverse farming is possible. The transition won't be without challenges, but by using online tools to build awareness of the change needed (and a market of people who desire sustainable food), it's possible. The farmers making the change can use online tools like social media to grow a supporting community, recruit shareholders, and even use methods like crowdfunding to help them transition. If awareness and demand are created, small family farms can occupy this niche without competing with large corporate farms.

Conclusion

Just as the internet has changed almost all other aspects of our lives, it has changed alternative agriculture. This change has brought opportunities for big agriculture to move into the space of CSA’s, while also bringing opportunity for growing awareness of the alternative agriculture movement. Alternative agriculture farming is centered around community, and this ultimately is what shapes Alternative Agriculture farmers’ choices to use or not use online tools. In the case of long-time farms like Common Harvest, community structures were built around word-of-mouth communication that proved to be more effective than marketing online. In the case of Whetstone Farms, the internet and social media create tools for building community and marketing their CSA membership. The internet as a whole has the potential to be the breeding ground for a more widespread social movement around alternative agriculture. Fixing our food system will require extensive changes in how we think about agriculture. These changes have to start with educating our society on the flaws in our current system and the potential of alternative agriculture. Despite this potential, it’s important to consider that the internet can’t replace the local, physical communities we have. These are vital for a shift to more local, small-scale agriculture. Online tools instead can work to bring people from the digital world into these physical communities, so we can all have a closer relationship with what we eat and how we get it.

References

Pollan, M. (2007). *The Omnivore's Dilemma: A Natural History of Four Meals*. Turtleback Books.

Ribard, Magdelaine, & Sarthou. (2018). *Alternative agriculture : Dictionary of Agroecology*. Retrieved October 5, 2024, from https://dicoagroecologie.fr/en/dictionnaire/alternative-agriculture/

United Nations Environment Programme. (n.d.). *9 ways food systems are failing humanity*. UNEP. https://www.unep.org/news-and-stories/story/9-ways-food-systems-are-failing-hu manity

Aubin. (2024, September 19). Social media and news fact sheet. *Pew Research Center*. https://www.pewresearch.org/journalism/fact-sheet/social-media-and-news-fact-s heet/

Guenthner, D. 2024, October 6). *Phone interview*.

Chapter 5

Aiding and Abetting Revolution

By: Julia Castellano, Anonymous, Scout Holding Eagle-Bushaw, JJ Surigao

5.1 Agricultural Revolution through Government Policy

Julia Castellano

Introduction

Ensuring stable food prices has been the source of agricultural subsidies in the United States since the Dust Bowl and Great Depression, which saw falling food prices as a result of overproduction and left farmers unable to recover. The Agricultural Adjustment Act of 1933 marked the first policy offering subsidies to farmers in an effort to regulate food prices. It has since evolved through farm bills, which determine policies today (Dobbs, 2016). Now, there are many different types of farmer support, including two major categories: coupled subsidies are dependent on the level of output of a specific crop, and decoupled subsidies are independent of production (FAO, UNDP, & UNEP, 2021). Overtime, as policies changed, industrial agriculture became the dominant form and small farms disadvantaged. In the Midwestern United States, this looks like acres of corn and soybean farms and industrial livestock production with very few vegetable and animal husbandry farms. It is important to examine this shift and find methods to reverse the process, for commercial farms encourage unsustainable relationships with the land, inhibit nutrition, and support global monopolies. This essay considers these different types of support to answer the question: how do government policies favor industrial agriculture, and how could they be changed to support a shift toward alternative agriculture?

Methods

This essay addresses the agricultural inequities caused by government subsidies. First, I contextualize the distribution of support programs on a national scale. I work through the findings of a report published by the USDA's Economic Research Service to determine the distribution of farmer support at a national level. Then, I use academic research, an interview and experiences with local farmers in Wisconsin, and class lectures to determine the policies which favor industrial agriculture in the Midwestern United States. Finally, I utilize the previous sources, in addition to a report by the United Nations, to outline three potential solutions to support farmers more equitably and offer policy recommendations based on the findings.

Findings, analysis, and discussion

Context: unequal distribution

The USDA Economic Research Service has published many reports about agricultural production and the use of government subsidies. The first I examine is titled "The Evolving Distribution of Payments from Commodity, Conservation, and Federal Crop Insurance Programs." In the report, the authors quantify differences in the distribution of subsidies from 1991-2015. Farms are classified into small, medium, and large categories based on gross cash farm income (GCFI). Large farms have a GCFI of $1,000,000 or greater, small farms of $349,999 or less, and medium farms in between (Hoppe & McFadden, 2017). The report on the distribution of subsidies examined a variety of support types, including crop insurance and commodity programs. The tables below summarize these findings for large and small farms. Crops supported by coupled programs consist of major commodity crops: corn, cotton, rice,

soybeans, wheat, barley, canola, peanuts, sorghum, and sunflower (Hoppe, MacDonald, & Newton, 2018 and Hoppe & McFadden, 2017).

Farm size	Percent of total farms, 2015	Percent of production, 2015

Large	3.2%	51.1%
Medium	6.3%	24.2%
Small	91.1%	24.7%

Table 1. Summary of farm distribution by size (Hoppe, MacDonald, & Newton, 2018)

Farm size	Percent of total coupled program payments received, 1991	Percent of total coupled program payments received, 2015	Production of crops supported by coupled programs, 1991	Production of crops supported by coupled programs, 2015	Percent of total crop insurance payments received, 1997	Percent of total crop insurance payments received, 2015
Large	11%	34%	11%	40%	12%	39%
Small	61%	30%	58%	22%	48%	22%

Table 2. Summary of subsidy and production distribution by farm size (Hoppe & McFadden, 2017)

These statistics are indicative of the impact of agricultural subsidies on production and the unequal distribution of support across farm sizes. Table 2 explains the direct relationship between subsidies and production. The share of coupled subsidy payments strongly aligns with production of commodity crops; proportions decreased for small farms from 1991-2015 and increased for large farms. Small farms also saw a decrease in the proportion of crop insurance payments they received while large farms experienced an increase. This data suggests that large farms are taking up a greater portion of agricultural subsidies at the expense of small farms. If the distribution were equal, the 2015 values in Table 2 should match the percent of total farms in Table 1—both columns represent a raw number of payments—but this is not the case. Although large farmers consistently receive more subsidies, they make up a small fraction of total farms.

Agricultural subsidies are clearly unevenly distributed, and the difference is growing.

Policies

Supply management is one of the biggest challenges of agriculture in a market-based economy because demand is fixed to the limits of the population; people can only eat so much food. According to an article in the Journal of Rural Studies, supply management was originally a major focus of agricultural subsidies; from the Great Depression to the 1960s, policies included acreage restrictions and market quotas. However, advancing industrial technologies such as chemical inputs and GMO seeds left corporate producers hungry for more capital—the technologies themselves are a result of US policy favoring industrial agriculture, for their development and spread was fueled by the government's concerns about communism through the Green Revolution. Eventually, the 1996 Farm Bill got rid of any last supply regulations (Graddy-Lovelace & Diamond, 2017). This shift benefitted industrial farmers over small farmers because commercial farms are better equipped to scale-up production. Therefore, the removal of supply management practices in combination with new technologies allowed industrial production to further take off.

Dan Guenthner, co-owner and operator of Common Harvest Farm in Osceola, Wisconsin, picks up where the supply management perspective leaves off in 1996. He explains that subsidies have been viewed as primarily negative by farmers, who would rather receive a fair market price than navigate convoluted subsidy programs—according to Dan, willingness and ability to "play

the game" of agricultural support is one of the main reasons why large farms receive more subsidies than small farms. Therefore, the 1996 Farm Bill intended to reduce subsidies by replacing old support programs with crop insurance, which covers the same commodity crops as previous subsidies. This is not a typical insurance program, but another coupled policy which requires strategy to reap its benefits. Crop insurance sets an average yield across all acres on a farm and offers direct payments per acre of below average production each year. To maximize payments, farmers increase production of marginal land because it is more likely to have low yields, thus incurring more crop insurance payments (Dan Guenthner, personal communication, October 12, 2024). As discussed previously, industrial farmers receive the largest share of crop insurance; this is the result of a willingness and ability to participate in the game of policies based on certain industrial commodity crops. Small farmers have limited access to such crops—and therefore crop insurance policies—because they require expensive technologies and inputs, particularly when combined with the poor conditions of marginal lands.

While subsidies directly benefit large farms, they also indirectly disadvantage small farmers through increasing land prices (Edwards, 2023). This is a major issue in the Midwest; during our field trip to small farms in Wisconsin, Emily Hanson, co-owner of Whetstone Farm, shared that land is inaccessible to new farmers because of a lack of availability and high prices. She purchased a significant amount of land from a farmer who went out of business, which she described as a once in a lifetime opportunity. It was also a risky investment, as the purchase put her into debt (Emily Hanson, personal communication, September 28, 2024). Agricultural subsidies are one cause of high land prices, for landowners capitalize on the prospect of future support. If a farmer is expected to receive subsidies on their production, landowners can preemptively exploit this predicted income. However, high land prices are not equally navigable for industrial and small farmers. Because small farms participate in fewer subsidy programs, they do not receive the same amount of expected support which rationalizes increasing costs of land. Young, beginning farmers—who are more likely to raise small farms—are also more vulnerable to high land prices because they may have fewer resources than experienced farmers (Edwards, 2023).

Solutions and recommendations

At the end of a report on agricultural policy by the Food and Agriculture Organization of the United Nations, the authors outline a six-step guide to reform by "repurposing strategies" to reduce harm as the system is shifted, particularly for vulnerable groups. Small Farmers—particularly those in developing countries—are most in need of support throughout policy amendments because economic changes leave them more at risk. Since reform cannot be generalized globally, the guide is vague, though it does offer suggestions based on a country's income level. For high-income countries like the US, the FAO recommends removing subsidies which distort the economy, such as import and export subsidies and coupled support. Instead, these countries should implement decoupled subsidies which invest in agroecological practices, small farms, and restoration of land (FAO, UNDP, & UNEP, 2021). Dan Guenthner offers a similar idea; he suggests a balance between farmers' desires to pay a fair market price and the inequalities between industrial and small-scale farms. For him, subsidies which incentivize alternative crops and sustainable practices for the soil and environment would offer a way out of the current situation (Dan Guenthner, personal communication, October 12, 2024). I agree that decoupled support should replace coupled policies to uplift small farmers and sustainable agriculture. This would also require the removal of crop insurance policies, as well as the implementation of intermediate policies to ensure a smooth transition. Decoupled supports may contain conditions regarding a farm's scale or practices. It is important that crops are not a condition within these subsidies, for this could replicate problems caused by coupled subsidies for industrial crops.

While subsidies offer possibilities for agricultural reform within a market economy, there remains an inherent conflict between supply management and competition, which rules capitalist economies and encourages farmers to produce the most for the cheapest. Decentralized initiatives, including cooperatives and marketing boards, orders, and agreements, offer solutions outside of the market. These groups utilize production quotas to prevent surplus and ensure a fair price. Cooperatives and marketing agreements rely on voluntary participation and mutual trust while marketing boards and orders are government-run. (Graddy-Lovelace & Diamond, 2017). Because the cooperative must take the hit of overproduction, they may be more or less encompassing; some buy the entirety of a farmer's crop, and others purchase within reasonable supply and demand constraints. Farmers may also share losses to mitigate their impact on a single farm. Similarly, marketing agreements are led by farmers and allow them to coordinate production quotas together. Marketing boards and orders are usually government-run and require farmers within a geographic area or industry to participate. All of these systems of price controls achieve the goals of agricultural subsidies through decentralized supply management practices. These systems emerged as a response to agribusiness monopolies in the 1920s, but they have become more obsolete as corporations have strengthened their hold on agriculture (Graddy-Lovelace & Diamond, 2017). Regarding policy reform, I recommend that marketing boards and orders are reimplemented for commodity crops to address surplus issues and institute price controls. I also support cooperatives and marketing agreements as methods of supply management, though their voluntary nature makes them less useful for government policy.

Common Harvest Farm offers insight into another solution outside of the market: Community Supported Agriculture (CSAs). This is a system in which farmers and farm members operate together, in relationship with each other; it is a method of working around current agricultural structures and their inequalities. On Dan and Margaret's farm, members pay a fixed price to receive a box of vegetables every week. The farmers may ask for member input on production decisions, and members may financially support new initiatives on the farm, such as farming technologies or inputs (Dan Guenthner, personal communication, September 28, 2024). In this way, Dan says that farm members have helped subsidize his farm (Dan Guenthner, personal communication, October 12, 2024). Through this perspective, Common Harvest Farm turns to its community as an alternative source of government assistance. While the CSA structure works well for Common Harvest Farm and its members in the Midwest, its commitment to a relationship with the farmer may be inaccessible to some and difficult to replicate in a government policy. It functions best as a temporary alternative while the food system does not align with a farmer's values.

Conclusion

Agricultural policy has always intended to address instability of food prices caused by surplus. As policies changed over time, they came to favor industrial agriculture at the expense of small farmers. Through this research, I synthesized the conclusions of many reports, articles, and local experiences to contextualize possibilities for shifting agricultural subsidies in the Midwestern United States within a national and international context. I have identified a few key factors causing this inequality: the removal of supply management practices within a market-based economy, coupled subsidies which favor inaccessible industrial crops, and increasing land prices. After analyzing solutions and alternatives proposed by a variety of sources, I have recommended the following steps to reform agricultural policy: replace coupled subsidies with decoupled supports oriented toward small farms and sustainable practices and reimplement decentralized initiatives to regulate supply. These policy changes would facilitate a smooth transition away from the dominance of commercial farms toward alternative agriculture and a healthier, more just food system within the Midwestern United States.

References

Dobbs, C. (2016, January 29). *Agricultural Adjustment Act*. New Georgia Encyclopedia, Georgia Humanities, University of Georgia Press. https://www.georgiaencyclopedia.org/articles/business-economy/agricultural-adjustment act/.

Edwards, C. (2023, August 31). *Cutting Federal Farm Subsidies*. Cato.org, www.cato.org/briefing-paper/cutting-federal-farm-subsidies.

FAO, UNDP, & UNEP. (2021). *A Multi-Billion-Dollar Opportunity: Repurposing Agricultural Support to Transform Food Systems*. Food and Agriculture Organization of the United Nations, https://openknowledge.fao.org/server/api/core/bitstreams/05983446-7ad7-4ea5-9257-fda 5e186467f/content.

Graddy-Lovelace, G., & Diamond, A. (2017). From Supply Management to Agricultural Subsidies—and Back Again? The U.S. Farm Bill & Agrarian (In)Viability. *Journal of Rural Studies*, *50*, 70–83. https://doi.org/10.1016/j.jrurstud.2016.12.007.

Hoppe, R.A, MacDonald, J.M., & Newton, D. (2018, March). *Three Decades of Consolidation in US Agriculture*. Economic Research Service, United States Department of Agriculture. https://www.ers.usda.gov/webdocs/publications/88057/eib-189.pdf.

Hoppe, R.A, & McFadden, J. (2017, November). *The Evolving Distribution of Payments from Commodity, Conservation, and Federal Crop Insurance Programs*. Economic Research Service, United States Department of Agriculture. https://www.ers.usda.gov/webdocs/publications/85834/eib-184.pdf?v=2337.9.

5.2 Dirt in the Database: Potential Futures of Digital Technologies in Alternative Agriculture

Lily Eggers

Introduction

Technology has been a key component of agriculture since its inception thousands of years ago. Not all agricultural technology is created equal in benefits or in impacts, however. Scientific breakthroughs in synthetic fertilizers, pesticides, and genetically engineered crops all helped empower industrial production methods to dominate global food systems over the past decade (Sullivan, 2023). Now, a new generation of technologies are emerging which emphasize digital infrastructure, automation, and data collection. Yield monitors, GPS and GIS usage, remote sensing platforms, variable rate application (VRA) products, and even robotic milkers are all being commercially deployed at an increasing rate in industrial food systems (Kremsa, 2021). These technologies are all pitched to farmers (and the public) as money, labor, or time-savers, allowing for customization and higher efficiency. Implicitly or explicitly, many are presented as solutions to problems that geographers like Lindsay Naylor contend are symptomatic of "larger structural conditions, pointing to a food system where profit is valued over people" (2017). Yet the proposed "fixes" typically operate within, and are supported by, status quo heavyweight agribusinesses, manufacturers, and interest groups.

This prompts difficult questions for contemporary farmers who are engaged in alternative agriculture. Emerging digital agricultural technologies (digital "agtech") clearly have enormous potential, but is that potential harnessable within the philosophies and methodologies of agroecology and sustainability? What benefits can alternative farmers even get from using high-cost gear that was designed for extensive industrial monocropping? In this paper, I will contribute to my broader group's theme of 'aiding and abetting revolution' by exploring this question: *Is there a role for digital and precision agricultural technologies in the growth and spread of alternative agriculture?*

Methods

For the purposes of this paper, I conducted a literature review of recent and emerging scholarship surrounding digital agricultural technologies, including precision agricultural methods, and their current and potential future uses in agroecological approaches. To that end, I used Google Scholar to gather a compendium of journal articles and books published from 2017 to 2023. In my searches, I incorporated the following key words relating to agriculture: digital agriculture, digitalisation, precision agriculture, alternative agriculture, big data, remote sensing, organic agriculture, digital technologies, and political economy. Some of these texts were literature reviews in their own right, while others were the product of intense fieldwork and participant interviews. To supplement analyses of the findings of the literature review, I will also draw on conversations with Dan Guenthner, co-owner of Common Harvest Farm, as well as on my own experience working as an intern for a precision agriculture technology service provider. Core themes I will address include: the fundamental and epistemological challenges of combining digital ag-tech with agroecological approaches; the current 'symptoms' and areas of contention in these processes; and visions presented of the path forward.

Findings, Analysis, and Discussion

A word on words

As Sullivan (2023) notes, "the definitions of both agroecology and ag-tech are themselves unsettled, with different interpretations leading to distinct outcomes," a theme that also holds true for terms like digital agriculture, precision agriculture, and alternative agriculture. This study will use Kremsa's (2021) definition of alternative agriculture as agricultural "production systems that do not use conventional [industrial] methods [and] aim at following the concept of agroecology." Agroecology originated as a deeply place-based science that supports "diversified farming systems utilizing practices that foster complex species interactions to enhance biodiversity and support beneficial ecosystem services such as nutrient cycling and weed, disease, and pest management" (Sullivan, 2023). In recent years, justice-oriented agitations for shifts towards agroecological systems have meant that it can now be described as a science, a practice, *and* a social movement (Isaac *et al.*, 2018). Digital agriculture describes the increased usage of digital technologies in the agricultural sector, most frequently referring to drones, robots, sensing systems, and data analytics used to 'optimize' industrial monocropping schemes by minimizing labor requirements and maximizing raw output (Ditzler and Driessen, 2022).

Fundamental challenges

The most abstract and difficult-to-reconcile differences between digital agricultural and agroecological practices are at fundamental epistemological levels; that is, they concern assumptions and modes of knowledge baked into both approaches. While most scholars seem to agree that digital agricultural technologies have largely been engineered for conventional industrial agriculture, they disagree about whether these tools can truly be repurposed. For example, Ditzler and Driessen (2022) argue that "there appears to be no fundamental reason why automated tools could not be designed to progress agroecological aims," and increase farmer agency. Some literature in development economics contends that the conventional/alternative binary is constructed, and that farm operations actually exist on a continuum which could enable practices that combine both sides (Sullivan, 2023). Why can't systems like drones be repurposed, as Pappalardo and Andrade (2022) put it, "for good"?

Labor and political economy scholar Summer Sullivan complicates that narrative, writing about the findings of her interviews with engineers, social scientists, and agroecologists who were collaborating at a University of Santa Cruz interdisciplinary program centered around the topic. Sullivan (2023), while noting the social scientist literature like Rotz *et al.* (2019) that find agroecology and ag-tech to not be "*necessarily* mutually exclusive", does raise important concerns about reconciling the base assumptions of both. Sullivan found that the engineers interviewed tended to present a neutral, apolitical stance on their role and impact as developers of agricultural technology and were generally optimistic about technology's capacity to 'solve problems.' Citing Cech, she describes the "technical/social dualism of engineers," a documented mindset that separates technological and social proficiencies, devaluing the later to second-rate status. The agroecologists who were interviewed, on the other hand, focused on the complexity of food systems, and many doubted whether digital agricultural technologies could even provide its claimed 'solutions'. Issues such as food access, food distribution, and wealth inequality are wicked problems without a (purely) technological fix. The agroecologists tended to hold "transformative visions" for future food systems that focused on political and social justice. Sullivan notes how these clashing epistemologies do not meet on an even playing field, however, even in a public institution, because the university administration itself prioritizes 'real-world problem-solving' efforts that dovetail into partnerships with existing agribusiness.

Symptoms and sites of conflict

Another body of literature seeks to identify and critique the emerging sites of contestation over what implementing digital agriculture technologies in agroecological systems should look like. Rotz *et al.* (2019) use a political economy lens to investigate the myriad links between technologies, actors, and systems, and thereby identify which groups of actors are being (dis)empowered by technological changes. First, they discuss issues of data ownership and control. The proliferation of proprietary systems that are mutually incompatible (which have no restricts farmers' agency on the ground. More than ever, farmers are also having to "trade in data ownership for platform access," particularly for cloud-based systems that take in field data without clear recognition of who gets to store or use that data — particularly salient in an age where AI model training requires massive datasets. Ogunyiola (2021) uses Marxist theory, casting these data ownership shifts as part of an "accumulation by dispossession" process that alienates farmers from the products of their own labor and renders them remote (sometimes literally remote) from their traditional on-the-ground roles as farmers. When I asked Dan Guenthner at Common Harvest Farm about digital agricultural technologies, the chief concern he raised was along these lines; to paraphase, he asked: "Where are the *people*? Where is the role of humans in all this?"

Rotz *et al.* also question how technological development is currently conducted. The 'top-down' model at present focus more on end profit for the developers than actual farmer needs; unsurprisingly, such systems are often too expensive, inaccessible, and unnecessary for farmers in alternative agriculture in the Global North, let alone the Global South. Consider, for example, how an agroecologist might be frustrated by standard data-driven models; how is the farmer supposed to input embodied historical knowledge of the landscape, or understandings of ecosystems' complex components, into rigid one-size-fits-all formats? I will elaborate on my own experiences with this theme in the conclusion.

Imagining another path

What is to be done? Not only are there serious challenges with data ownership, data security, and tech development when digital ag-tech is combined with agroecology, but there are also divergent philosophies between the two that some would consider irreconcilable! Some writers and academics have attempted to chart ways forward besides the wholesale rejection of digital technology. Rotz *et al*. (2019) point to data justice principles that can be modelled through "open, co-operative, publicly funded and locally appropriate technology and data systems" as the "first steps" towards supporting farmers' sustainable use of technologies. They point to case studies like the Three Rivers Farmers Alliance, whose app allows for consumers and restaurants to direct-order from local farmers, or to open-source technology groups like Farm Hack and FarmOS who are building community through data sharing and combatting data siloing. Scholars also promote smaller-scale instutitonal efforts to rethink how we invest in and study food. For Rotz *et al.* this takes the form of advocating for "locally appropriate, citizen-led policy environments." For the French research team in Bellon-Maurel *et al.* (2022), this prompts attempts at entirely new ways of conducting research, collaborating using Responsible Research and Innovation (RRI) principles in the hopes of breaking out of researchers' disciplinary "path dependency" and directing work towards technology that truly empowers farmers.

Yet almost all literature I found ultimately had to address that broader structural shifts may need to occur before digital agricultural technologies can truly be ethically embraced by agroecology. Part of these shifts is a reimagining of what is germane to the discussion: Carolan (2019) argues that, due to the power that our anticipatory imagined worlds of the future can have on shaping their eventual form, "debates about robotics and digital agriculture need to be bundled with conversations about intellectual property law, education policies, government spending and the value of public goods, immigration policies, farmer and farm-worker wellbeing, social justice, and the like." In true agroecologist fashion, it is all connected, and no one element can be disconnected from the remainder.

Conclusion

A few summers ago, I interned for a St. Paul-based company that focused on precision agriculture technology solutions. They make their own drones, create their own sensor cameras, and provide a suite of workflows and apps that give farmers information on the health of their fields. Great, I thought at the time, this is GIS in action, allowing farmers to use irrigation and herbicide more sparingly and sustainably! It took some time before I truly understood who was benefitting from this work, however; despite the talk of multi-scale technologies and the 'Small Family Farms' program, over half of our order volume was devoted to Bayer-Monsanto alone. As a GIS Analyst intern I processed imagery of thousands of monocrop fields whose farmers I would never meet, and I even helped create wholly computer-generated facsimile crop fields that trained our weed-detecting models. Checking the company website today reveals they have gone all-in on the weed detection strategy, promoting a new service that sends drone-captured AI-assessed weed data to herbicide-spraying tractors.

I recount this experience not to single out that company, but rather to demonstrate how digital agricultural technologies are currently set up with specific data structures and use cases. As far as I know, the weed detection model cannot even fathom the existence of polyculture, of not eliminating all but one crop. Similar processes are playing out across the technological landscape right now. After reviewing contemporary literature, I conclude that these techniques may only be ethically and practically viable within alternative agriculture if we can rethink the entire nature of data capture itself. We need frameworks that are open-source and hard to constrain; interfaces that allow for locally-specific, contextual, qualitative, and traditional knowledge; and shifts in broader political and economic structures that determine who gets funding and access. While digital agricultural technologies could be a log on the bonfire of revolution, for now it seems doubtful they could ever be a self-sustaining spark.

References

Bellon-Maurel, V., Lutton, E., Bisquert, P., Brossard, L., Chambaron-Ginhac, S., Labarthe, P., Lagacherie, P., Martignac, F., Molenat, J., Parisey, N., Picault, S., Piot-Lepetit, I., & Veissier, I. (2022). Digital Revolution for the agroecological transition of food systems: A responsible research and innovation perspective. *Agricultural Systems*, *203*, 103524. https://doi.org/10.1016/j.agsy.2022.103524

Carolan, M. (2019). Automated Agrifood Futures: Robotics, Labor and the distributive politics of Digital Agriculture. *The Journal of Peasant Studies*, *47*(1), 184–207. https://doi.org/10.1080/03066150.2019.1584189

Cobby, R. W. (2020). Searching for sustainability in the Digital Agriculture Debate: An alternative approach for a systemic transition. *Teknokultura. Revista de Cultura Digital y Movimientos Sociales*, *17*(2), 224–238. https://doi.org/10.5209/tekn.69475

Ditzler, L., & Driessen, C. (2022). Automating agroecology: How to design a farming robot without a monocultural mindset? *Journal of Agricultural and Environmental Ethics*, *35*(1). https://doi.org/10.1007/s10806-021-09876-x

Guenthner, D. (2024, September 28). Conversation with Dan Guenthner. Personal.

Isaac, M. E., Isakson, S. R., Dale, B., Levkoe, C. Z., Hargreaves, S. K., Méndez, V. E., Wittman, H., Hammelman, C., Langill, J. C., Martin, A. R., Nelson, E., Ekers, M., Borden, K. A., Gagliardi, S., Buchanan, S., Archibald, S., & Gálvez Ciani, A. (2018). Agroecology in Canada: Towards an integration of agroecological practice, movement, and science. *Sustainability*, *10*(9), 3299. https://doi.org/10.3390/su10093299

Kremsa, V. (2021). Sustainable management of agricultural resources (Agricultural Crops and animals). *Sustainable Resource Management*, 99–145. https://doi.org/10.1016/b978-0-12-824342-8.00010-9

Naylor, L. (2017). A place for GMOs in food sovereignty? *Geographical Review*, *107*(4), 572–577. https://doi.org/10.1111/gere.12258

Ogunyiola, A. (2021). *Interrogating the socio-ethical dilemmas of Precision Agriculture Technologies* (dissertation). *Interrogating the socio-ethical dilemmas of precision agriculture technologies*.

Pappalardo, S. E., & Andrade, D. (2022). Drones for good: UAS applications in agroecology and organic farming. In *Drones and Geographical Information Technologies in Agroecology and Organic Farming* (pp. 122-148). CRC Press.

Rotz, S., Duncan, E., Small, M., Botschner, J., Dara, R., Mosby, I., Reed, M., & Fraser, E. D. G. (2019). The Politics of Digital Agricultural Technologies: A preliminary review. *Sociologia Ruralis*, *59*(2), 203–229. https://doi.org/10.1111/soru.12233

Sullivan, S. (2023). Ag-tech, Agroecology, and the politics of alternative farming futures: The challenges of bringing together diverse agricultural epistemologies. *Agriculture and*

Human Values, *40*(3), 913–928. https://doi.org/10.1007/s10460-023-10454-2

5.3 Untitled

Scout Holding Eagle-Bushaw

Introduction

Agriculture is as important now as it has ever been, which is to say incredibly important. However, agriculture looks different than perhaps it ever has. New technological advancements and agricultural alternatives are continually arising, but their adoption looks incredibly different place to place. Within the overarching category of "Aiding and Abetting Revolution", my group is attempting to answer different aspects of the question: *What needs to happen in our society for alternative agriculture to thrive and be normalized?* Specifically, I'm aiming to answer the question of *What farmer or community attitudes lead to uptake of alternative agricultural techniques?* In answering this question, we are focusing primarily on the Upper Midwest. I argue that whether farmers and their communities see and believe in a problem will impact the uptake of alternative agricultural techniques.

Farmer's voices and stances are critical to understanding whether alternative agriculture is viable in the Upper Midwest. Farmer's opinions on alternative agricultural practices shape whether they even see these practices as something to try to implement. However, farmers don't exist in a vacuum. Community attitudes also shape the viability of alternative agriculture. Community pressure in any direction can impact their beliefs.

For the purposes of this paper, 'alternative agriculture' and 'sustainable agriculture' are synonymous. 'Sustainable agriculture' is defined by the Alternative Farming Services Information Center, run by the United States Department of Agriculture, as "integrating plant and animal production practices that target several specific long-term objectives. These objectives include increasing economic viability of farm operations, satisfying human food and fiber needs, maximizing the use of renewable resources, and enhancing the natural resource base and environmental quality of the production site…all designed to improve the quality of life for farm families and their communities" (United States Department of Agriculture, 2022).

Methodology

To answer my research question of *How do farmer attitudes and community attitudes impact the uptake of alternative agriculture techniques in the Upper Midwest?* I utilized a variety of data sources. These sources took two main forms, namely first, a scholarly literature review, and second, interviews gathered for research and informational purposes. The literature focused on the Midwest broadly, whereas the profiles are mostly of Minnesotan farmers.

Findings & Analysis: Literature Review

For the literature review aspect of the project, three articles were found and analyzed. Keywords like "alternative agriculture" or "sustainable agriculture" were coupled with terms like "farmer", "perspectives", "beliefs", and "upper Midwest" on Google Scholar. The article "Understanding Corn Belt Farmer Perspectives on Climate Change" (Arbuckle Jr. et al., 2014) investigates exactly that. The authors analyzed results from a survey of 4,778 larger-scale corn farmers across 11 Corn Belt states (Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, Ohio, South Dakota, and Wisconsin). They sought to both find difference and similarity in their answers. Their first research question was "to what degree do farmers differ on key measures of beliefs about climate change, experience with extreme weather, perceived risks to agriculture, efficacy, and level of support for public and private adaptive and mitigative action" and the second question was “are there potential areas of common ground among farmers?” (Arbuckle Jr. et al., 2014, 505). From this information, they categorized farmers into six categories primarily based on their beliefs around climate and belief in their own ability to deal with climate change. The majority of farmers (63%) fall into the three categories that believe in climate change to some degree *and* support adaptation and mitigation measures. The other 37% are dubious about climate change, believe in their ability to deal with climate variability, and are less interested in mitigation measures. The main goal of this research was to aid in scientific communication to farmers. The most actionable finding was that communication to farmers should decenter the human cause of climate change and instead focus on “adaptation to weather variability” (Arbuckle Jr. et al., 2014, 515). From this study, we can infer that willingness to adopt alternative agriculture practices may vary based on beliefs in climate change. Is there anything to adapt to? Do farmer practices point to the changes farmers may see in their soil? These beliefs are shaped by beliefs in climate change, especially human-caused climate change. Beyond this, the study also points to beliefs in farmers' own efficacy in dealing with climate change as being important. Farmers who have experienced climate events or have concerns about climate change more broadly may feel more concerned about their ability to deal with climate change. This subset of farmers (approximately 39%) seem to be the most persuadable to implement alternative agriculture practices (Arbuckle Jr. et al., 2014, 514). Farmers who haven’t personally seen a problem are less likely to actually believe there is a problem. Farmers who have are looking for solutions.

The article “Upper Midwest Farmer Perceptions: Too Much Uncertainty About Impacts of Climate Change to Justify Changing Current Agricultural Practices” (Morton et al., 2017) works to understand the underlying causes behind farmer uncertainty in the value of changing agricultural practices on the basis of climate change. The study highlighted four potential places where uncertainty or certainty might come from, namely "beliefs about climate change, experiences with drought, concern about heat stress on crops, and agricultural information networks" (Morton et al., 2017, 215). The authors utilized the same survey data set as Arbuckle et. al. (2014), coupled with 178 in-depth interviews (Morton et al., 2017, 218-219). From this data, they found that 89.5% of farmers "perceived there was too much uncertainty about the impacts of climate to justify changing their agricultural practices and strategies" (Morton et al., 2017, 215). Belief in climate change was positively associated with lower uncertainty about climate impacts. From this, we can infer that these farmers could justify changing their agricultural practices. This matches up with the findings by Arbuckle et. al (2014).

Interestingly, sources of information also matter. When answering my original research question about community attitudes impacting alternative agricultural practice uptake, this is important. In looking for information, farmers turn to their social networks. Those social networks take two main forms: "PublicAg" and "Agribusiness." PublicAg refers to university extension departments, government agencies, and similar institutions. Agribusiness includes farm chemical and seed dealers. These two institutions impact farmers in opposite ways. Farmers who trust PublicAg are less uncertain about climate impacts and vice versa (Arbuckle Jr. et al., 2013, 222). Each of these are part of the community, with extension agents and seed dealers both possibly being neighbors, and certainly are part of the farming community in a region. In an era of overwhelming information, these two institutions act as trusted information and research brokers. However, their approaches to climate change and underlying motivations behind their input are very different.

In regards to direct experience with climate events, most types of experience were not especially strongly associated with a change in uncertainty regarding climate impacts. Heat stress was the main exception. Could the contrast between extreme wet and dry almost "cancel each other out" by creating confusion and obscuring the climatic patterns directly experienced by farmers?

The final article of the brief literature review is "Climate Change Beliefs, Risk Perceptions, and Adaptation Behavior Among Midwestern U.S. Crop Farmers" (Mase et al., 2017). Like the two earlier articles, the authors analyze the survey sent out to farmers in 11 Corn Belt states. They were interested in the specific techniques implemented, and how utilization of adaptive techniques related to belief in climate change, concern with variable climate, and observation of changing climate across the Corn Belt and on their own farms. The study found that the majority of surveyed farmers were managing climate impact by implementing in-field conservation practices (Mase et al., 2017, 15). However, very few were diversifying crops. Broadly, they found that viewing impacts of climate change and belief in climate change were associated. Both of those were also associated with adaptive techniques. The authors additionally noted that while on-farm perceived risks were most significant in changing behavior, social norms and influence from other farmers did play a part (Mase et al., 2017, 15)

Which techniques were implemented bears further investigation. This evidence ties in with the previous work that found actually seeing climate impacts was important for farmers in their decision making.

Findings & Analysis: Profiles and Interviews

Two sources were consulted to get fifteen individual farm profiles. These are not complete interviews, but this part of the paper still seeks to find common threads across profiles and tie them together.

The Minnesota Institute of Sustainable Agriculture interviewed ten farmers during the 2012-2015 period to hear about their experiences transitioning to organic farming. All farmers were Minnesota-based, but otherwise differed greatly in type of farm and size. There were three purely field-crop-based farms, five livestock farms that grew some amount of crops, one livestock farm that was purely pasture-based, and one farm that grew some vegetables and herbs but mainly processed.

Understanding community opinion on going organic is useful for this analysis. Throughout the profiles, community opinion can be gauged a couple of ways. One way is just whether the farmers directly mention the community opinion. A second way is whether the farmers learned about going organic through other people speaking about it positively.

Two interviews specifically named the reactions of their neighbors as "difficult to deal with at times" (DiGiacomo & King, n.d., 12). However, farmers have taken the chance to educate their neighbors and turn around public opinion. On the other hand, several farmers started in part because of recommendations of others. Usually the recommendation is because of it being perceived to be financially beneficial. One farmer recalled when "our buyer said to us, 'You should be growing organic—it pays more" (DiGiacomo & King, n.d., 10). This positive depiction of organic farming incentivized him to look further into the option. Other farmers mention support of other organic farmers as being a help in going organic. Community reactions could be beneficial but also difficult. Overall, however, it seems the negative reactions are mostly surprised or confused at this new choice.

Interestingly enough, environmental impact is rarely a factor brought up by the farmers. Some farmers mentioned environment-adjacent factors, such as "lik[ing] the idea of healthier animals" (DiGiacomo & King, n.d., 25) or because ""I felt sick every time I sprayed [chemicals]"" (DiGiacomo & King, n.d., 30). While some farmers enjoyed the individual environmental benefits, concern for overall climate doesn't seem to be a concern. Instead, financial reasons are the main driver of going organic. This is an interesting contrast to the studies in the literature review, who tended to implement more alternative agricultural practices in response to climate variation.

The next five profiles come from the article "Agricultural Sustainability: Five Midwestern Row Crop Farmers Share Their Views" (2017). There, the author interviewed five corn farmers in Central Michigan and Southwestern Indiana. Each had previous connections to sustainability.

Each of the farmers were more concerned about sustainability compared to the organic farmers. This is certainly a product of how the farmers interviewed were sourced. Each had to balance their interest in sustainability with their bottom line–it's a difficult balance that doesn't always work out. Still, an interest in the environment, sometimes deriving from what they've seen on their own farms, is a contributing factor to their choices to use alternative agriculture technique. Economic benefits is also a factor.

The farmers do mention community views as a factor, though not one that impacted their personal choices. One farmer discussed how when he began farming, he rented land from his uncle who was a big proponent of heavy tilling. It was difficult for his uncle and others in their farming community to understand his choice not to till, but over time they are beginning to appreciate the benefits and "other farmers now come to him with questions" (Laws, 2017, 57A).

Conclusion

Alternative agriculture is a hard sell for many farmers. Through three studies and two sets of interviews with individual farmers, the question of *What farmer or community attitudes lead to uptake of alternative agricultural techniques?* may be explored. I argue that farmers directly seeing and believing in a problem increases the uptake of alternative agricultural techniques. Farmers may be swayed by economic benefits that come from alternative agriculture, but generally farmers do not feel compelled to fix a problem they don't see. In addition, community support for alternative agriculture comes from actors who see a problem. PublicAg believes in climate change and sees the overarching impacts of climate change, and thus encourages farmers to adopt alternative agricultural practices. Similarly, other farmers who have adopted sustainable practices see the benefits of them and are a positive force for others adopting sustainable practices. Finally, farmers who have experienced climate events or see issues that can be solved through sustainable practices on their own farm are more likely to see the need for those practices. As one farmer says, "I just want to do it right, here. Those problems will go away if we manage what's right here. And we don't have to spend lots and lots and lots of money to do all that—we just need to do it individually" (Laws, 2017, 58A).

References

Arbuckle Jr., J. G., Hobbs, J., Loy, A., Morton, L. W., Prokopy, L. S., & Tyndall, J. (2014, Nov/Dec). Understanding Corn Belt farmer perspectives on climate change to inform engagement strategies for adaptation and mitigation. *Journal of Soil and Water Conservation*, *69*(6), 505-516. https://doi.org/10.2489/jswc.69.6.505

DiGiacomo, G., & King, R. P. (n.d.). *Making the Transition to Organic: Ten Farm Profiles*. Minnesota Institute for Sustainable Agriculture. https://misa.umn.edu/publications/making-transition-organic

Laws, L. (2017, May/June). Agricultural sustainability: Five midwestern row crop farmers share their views. *Journal of Soil and Water Conservation*, *72*(3), 53A-58A. https://doi.org/10.2489/jswc.72.3.53A

Mase, A. S., Gramig, B. M., & Prokopy, L. S. (2017). Climate change beliefs, risk perceptions, and adaptation behavior among Midwestern U.S. crop farmers. *Climate Risk Management*, *15*, 8-17. https://doi.org/10.1016/j.crm.2016.11.004

Morton, L. W., Roesch-McNally, G., & Wilke, A. K. (2017, May/June). Upper Midwest farmer perceptions: Too much uncertainty about impacts of climate change to justify changing current agricultural practices. *Journal of Soil and Water Conservation*, *72*(3), 215-225. https://doi.org/10.2489/jswc.72.3.215

United States Department of Agriculture. (2022, March). *What is Sustainable Agriculture?* Alternative Farming Systems Information Center. Retrieved October, 2024, from https://content.govdelivery.com/accounts/USDAARS/bulletins/3000a54

5.4 Rooted in Community: Scaling Alternative Agriculture for Viability and Market Growth

JJ Surigao

Introduction

How can alternative agricultural practices in the Upper Midwest be scaled to achieve economic viability for Community Supported Agriculture (CSA) farmers while increasing market share and promoting sustainability?

CSA memberships peaked around years 2005 – 2006, but the prices of land went beyond the threshold, intensive labor-demand increased, and consumer behavior rapidly shifts. However, there is a clear growing demand for sustainable farming solutions rooted in the idea that the human population can feed the world whilst protecting the planet. This paper explores how CSA farms can remain viable despite competition, market challenges, and climate pressures, thus attempts to identify that success for CSA farms lies not just in increasing farm size but through community partnerships, logistical efficiencies, and sustainable practices.

Research Methods

To explore how alternative agriculture practices in the Upper Midwest can be scaled for economic viability, market share growth, and sustainability, I employed both field-based research and literature review methods. I visited Common Harvest Farm, operated by the Guenther family in Farmington, Wisconsin on the 28th of September 2024. On the same day, I also visited Whetstone Farm, to understand the structure of their CSA.

These visits and informal interviews provided valuable qualitative data on the logistical, financial, and cultural dynamics of CSA farms, highlighting the challenges of organic farming ranging from high land costs, pest management, and market competition whilst upholding the importance of community involvement in maintaining farm vitality.

In addition to my field visits, I conducted a literature review to provide a broader theoretical framework for understanding the scaling of CSA farms. I reviewed "The Role of Consumer Citizens and Connectedness to Nature in the Sustainable Transition to Agroecological Food Systems" by Sepide Mehrabi, Juan Carlos Perez-Mesa, and Cynthia Giagnocavo. Another relevant article, "The Role of Advocacy Research in the Right to Repair Campaign" by Anne Marie Green and Nathan Proctor, sheds light on the right-to-repair movement—an effort to enable farmers to repair their own equipment. These observations paired with academic literature situate my findings within broader discussions on food systems and community economics. Additionally, I reviewed University of Minnesota's collection of data on Southwest Minnesota farmland prices for general ideas on costs.

Findings, Analysis, and Discussion

Economic Viability of CSA Farms

Community Supported Agriculture, as explained by Dan and Margaret Guenther, is a farming model where consumers purchase shares of a farm's output in advance, typically for a season. Using Common Harvest as an example, Guenthers' Farm in Farmington, Wisconsin, provided invaluable, first-hand information about the inner workings of a CSA farm, how they obtain their customer base, and how they price their shares. Common Harvest specializes in distributing hundreds of pounds of organic produce – offering around forty different vegetables and herbs – to members of their community who otherwise lack access to fresh, organic food through their Sharing the Harvest program. The Guenthers prioritize coordination to ensure smooth distribution, managing sixteen drop-off points for CSA members.

Farmers gain upfront capital and financial security, while members share in both the rewards and risks of the harvest. In return, members or subscribers receive regular deliveries of produce or other farm products throughout the season. The CSA model provides essential economic support by spreading financial risk across the community. Initiatives like multi-year shares, volunteer programs, and work-share opportunities, where members exchange labor for discounted shares. Shareholders are investing in the growth of their food, knowing that harvests may be impacted by factors such as pests, weather events, or seasonal limitations. This shared risk helps losses be mitigated that would otherwise fall entirely on themselves. To allow farmers to purchase seeds, materials, and labor early in the season, upfront payments are necessary for operations to run smoothly. Dan emphasized that CSA membership is about more than just financial transactions and logistics; it builds community bonds between growers and consumers. Dan noted that his experience as a farmer for the community "has been a very humbling, to have someone call and say 'hey, you've done well and now we want to contribute." Many members seek to form relationships with the land and become more conscious of where their food comes from which is one of the reasons Dan supports the growth of CSAs in the agricultural sector.

However, high land prices in the Upper Midwest present a significant challenge for CSA farmers, especially those starting out with high debt burdens such as "recent college graduates" interested in the field of agriculture. For example, according to data from the University of Minnesota Extension, farmland prices in southwest Minnesota have averaged $6,745 per-acre in 2022. These prices make it difficult for new farmers to acquire land and maintain economic viability without significant upfront capital. As Guenther emphasized, farming is difficult because "of the land, the expense of land, and capitalizing the business" and, in essence, the "return in investment doesn't make a lot of sense," so why do farmers become farmers? According to Guenther, prospective farmers recognize the occupation for the lifestyle, one can "be [their] own boss" and being able to have "intimacy of working with animals" is convincing enough. At the end of the day, farmers get "a sense of accomplishment" as in "[farmers] just rolled up [their] sleeves and did [their] job." Essentially, farmers don't get into farming for the profits, but rather for the lifestyle and the benefits of community they gain as well as the potential connections they could foster throughout neighboring sectors of a farmer's farm. Young, prospective farmers are a great way to scale CSA farming for its potential benefits to the community. Given the high-land costs, policy measures such as land access grants, conservation easements, and low-interest loans for new farmers are essential. Without such measures, it will remain difficult for small farmers, including CSA operations, to expand.

Arrangement, Adaptation, and Agency

Early in the development of their farm as a CSA, Dan and Margaret employed public speaking to draw in interest in CSA philosophy. They discussed practices including using organic seeds when available, avoiding the usage of pesticides, leveraging green fertilizers, and staying within the limits of the farms. Both farms implement sustainable agricultural practices to reduce environmental impact. For example, Whetstone Farm focuses on rotational grazing for their grass fed livestock, which helps regenerate soil health and prevents overgrazing. The farm also emphasizes low-tillage practices in vegetable production to maintain soil structure and reduce erosion. At Common Harvest Farm, the Guenthers rely on a "wood-based heating system" of which they forage firewood to heat their greenhouse, further minimizing reliance on fossil fuels.

They discussed with their audience the importance of building a relationship with the land and each other and that the audience should consider CSA as a partnership to the earth. Though the

Guenthers relied on informal, word-of-mouth networking, it attracts customers.

Another meritorious key related to sustainable farming is the collaboration among CSA farmers. Both farms participate in networks where they share equipment, knowledge, and strategies to combat pests – such as the Colorado Potato Beetle – manage weeds organically. This collaborative approach of sharing knowledge mirrors Green and Proctor's (2023) research, specifically on the right-to-repair movement. The article addresses the importance of self-reliance and shared expertise in reducing costs for small farmers as stories like "Jared Wilson [who] was forced to take his fertilizer spreader to a John Deere dealer to repair a blown mechanical valve, which is a repair he believes he could have done himself with the proper tools" illustrate advocacy for right-to-repair. By maintaining autonomy and agency over their equipment through computerization partnerships, CSA farms can avoid expensive repairs and stay financially viable.

Gaining Market Share and Competing with Conventional Models

It is important to recognize that farming is inherently difficult in the sense that the farming economy is heavily integrated in the dependency on the consumer. A problem noted by Dan is that global prices are "out of farmers hands," which cause farmers grievances to keep prices low, limiting the profitability of small farms that cannot match these prices. Dan explained that

specifically the cheap food policy involves the "government overtly pursuing policies [keeping] prices low." Additionally, CSA farmers must navigate competition from meal delivery services and changing consumer preferences. Services like Blue Apron and DoorDash have grown in popularity, as consumers increasingly favor convenience foods over fresh produce. Dan noted that shifting consumer habits, such as a "decline in home cooking and vegetable consumption," present further challenges to retaining CSA members and gaining market share.

To address this, Whetstone employs several strategies to attract customers, including multiple drop off sites in Minneapolis, St. Paul, and nearby towns, making it convenient for urban residents to take part. Their CSA pricing ranges between $575 and $700 for an 18- 22-week season. Common Harvest, similarly, operates on a shareholder model, with shares priced between $500 and $600 per season. To improve accessibility, both farms offer flexible payment plans when requested, ensuring a broader range of member participation. Over the years, both farms have also relied on long-term investments from members, including donations to help fund infrastructure projects, such as the installation of Common Harvest's solar panels and construction of their barns through community labor. According to Dan, we must focus on "anything that we can do to help people invest in health and wellbeing; [our society] is missing the culture around food, eating healthy, cooking, and sharing with others." If we show the public, through educational campaigns, the health, environmental, and community benefits of CSAs, farmers have a chance to compete with those latter challenges. CSAs rely on "farm members [who've] funded and contributed to the growth of the farm" and that is proved by the "volunteers for over 30 years." These investments reflect a CSA model that prioritizes community-driven economics over short-term profitability, where the community is "investing in creating a vibrant health farm that has all the benefits," ensuring financial stability through long-term relationships. "People sign on for more than just the food that they get in the boxes." This not only makes the CSA more affordable but also strengthens the sense of community involvement.

Conclusions

CSA farms depend on community investment, collaborative farming, and adaptive sustainability practices to remain viable. Common Harvest and Whetstone Farms exemplify how multi-year shares, volunteer programs, and flexible payment plans can reinforce community bonds while providing financial stability. However, scaling these farms to compete with industrial agriculture demands more than just production increases; it requires policy support, logistical innovation, consumer education, and cultural shifts toward local and sustainable consumption.

The barriers to scaling CSA farms in the Upper Midwest are significant. High land prices, market competition, and shifts in consumer behavior present challenges that cannot be overcome by farmers alone. Therefore, policy interventions – such as subsidies, conservation programs, and right-to-repair initiative – are essential to create viable conditions for new and small-scale farmers.

However, Scaling CSA farms is not just a technical challenge but a social movement – it represents a paradigm shift toward a more community-centered food system. This shift requires grassroots movements that promote stronger relationships between farmers and consumers, collaborative farmer networks to share resources and knowledge, and consumer education to encourage participation in local food systems. The success of this model will depend on consumers' willingness to embrace slower, more intentional consumption. As Guenther urged me at the end of my interview, and consequentially to general consumers: "Slow down, get to know what it took for food to get to [you], add meaning to the food – a powerful thing."

The future of CSA farms lies in their ability to balance sustainability with market demands, forge deeper community ties, and advocate for policy reforms that lower financial barriers. Common Harvest is a great example of a successful, debt-free farm who became successful not by itself, but by its reliance on the community and the support communities around it sacrifice. Scaling CSA farming in the Upper Midwest requires both systemic policy changes and cultural transformation. If these alternative agricultural farms can secure the necessary support, as Common Harvest has successfully secured and strives for more, they could serve as a model for a sustainable, community-based agricultural future – one where profit is not the sole priority and relationships with the land, food, and community are at the forefront.

References

Common Harvest Farm. Website. Retrieved Oct 05, 2024, from http://commonharvestfarm.com/

Green, A. M., & Proctor, N. (2021, January 1). *The role of advocacy research in the right to repair campaign*. Figshare. https://researchrepository.ul.ie/articles/conference_contribution/The_role_of_advocacy_research_in_the_right_to_repair_campaign/19867108?file=35283919

Guenther, D. (2024, October 06). Personal Communication with Dan Guenther [Telephone interview].

Guenthner, D., & Pennings, M. (2024, September 28). Tour of Common Harvest Farm and Surrounding Farms [Personal interview].

Mehrabi, S., Perez-Mesa, J. C., & Giagnocavo, C. (2022). The role of Consumer-Citizens and Connectedness to Nature in the sustainable transition to agroecological food Systems: the mediation of Innovative business Models and a Multi-Level perspective. *Agriculture*, *12*(2), 203. https://doi.org/10.3390/agriculture12020203

Farmland sale prices. (n.d.). UMN Extension. https://extension.umn.edu/farmland-rent-and economics/farmland-sale-prices