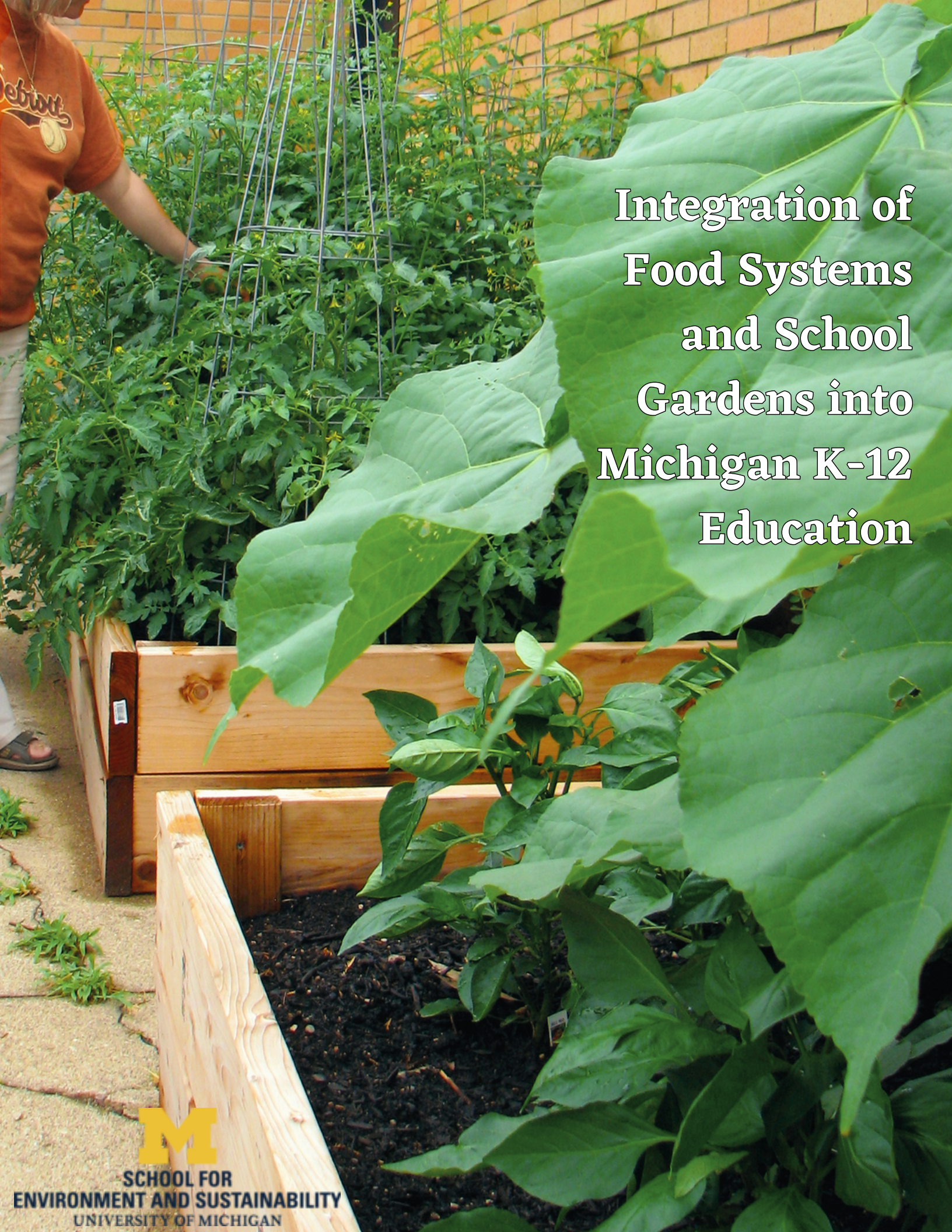

Integration of Food Systems and School Gardens into Michigan K-12 Education

SCHOOL FOR ENVIRONMENT AND SUSTAINABILITY
UNIVERSITY OF MICHIGAN

Integration of Food Systems and School Gardens into Michigan K-12 Education

A Masters Project submitted in partial fulfillment of the requirements for the degrees of Master of Science / Master of Landscape Architecture at the University of Michigan, April 2023

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Abstract

This project focused on building an understanding of how educators across grade levels utilize school gardens, connect them to content and explore unrealized opportunities to expand these connections to food systems. Educators engage with place-based education (PBE) and utilize school gardens as a way of building community connections and exploring environmental topics. Unfortunately, the topics of exploration are often limited to nutrition, health, or the basics of plant growth and exclude the opportunity to discuss the broader food system. A series of interviews and focus groups investigated how community partners and PBE facilitators desire to strengthen the connection between school garden activities and food systems topics. These interviews and focus groups provided the basis for the creation of informational resources we call Framework Documents that can be used by educators to deepen their understanding of the importance of Michigan's food system. In particular, they focus on topics like agriculture, local food production, justice, equity, and climate change. This data also informed the creation of a Garden Design Guide to aid schools in building accessible learning environments to explore food systems through PBE. The Garden Design Guide offers strategies for school garden design depending on the needs of the community, varying levels of learning experiences, and coverage of food systems and PBE topics. Through the Framework Documents and Garden Design Guide, teachers can expand the breadth of food systems topics they feel confident exploring in their classrooms. Then, they can increase their students' civic engagement, ability to grapple with complex systems thinking, and be informed consumers in our changing environment.

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I. Background

The Importance and Challenges of Understanding Food Systems

Food systems are a complex web of global processes working to produce, transport, prepare food for consumption, and dispose of food waste (*Sustainable Food Systems*, 2018). Food systems have a significant impact on our climate, economy, and health. Understanding how food systems relate to climate, economy, and health in addition to social influences and unexpected upsets is key to building resilient communities with empowered citizens (Ericksen, 2008). Working to increase the productivity of our food systems through advances in technology like fertilizers and automation, should lead to the reduction of hunger globally, but our food systems are fragile, and their instability leads to social, economic, and environmental complications (*A Global Food Crisis,* 2023*)*. As our environments continue to fluctuate, an understanding of our food systems will be key to adapting to these upsets. However, there is currently a societal lack of understanding of our food systems (Holt, 2016).

In part, food systems are difficult to understand because of their scale. There are varying definitions of food systems. They encompass food availability (production, distribution, and exchange), food access (affordability, allocation, and preference), and food utilization (nutritional and societal values and safety) (Gregory et. al, 2005). When food systems are stressed at any of these three levels, food security can be threatened along with societal disruption. Stressors include climate change, which can impact growing seasons; cropland availability; and food safety. Additional stressors include social-environmental changes like conflict or most recently the COVID-19 pandemic (Tirado et. al, 2010). Conceptualizing current systems and possible stressors can seem overwhelming to the average citizen.Thus, K-12 education can act as a starting point to parse through these systems-level interactions and better prepare students for addressing other complex systems interactions. To educate students on the relevance of food systems, we must provide educators with the support they need to understand these complex systems in an accessible manner.

Using Place-Based Education to Understand Food Systems

One framework for discussing food systems in the classroom is through place-based education or PBE. PBE is the process of using one's local community and environment as the starting framework for teaching academic K-12 subjects (Powers, 2004). It is a form of immersive teaching rooted in local natural phenomena that seeks to break down the gap between content learned in and outside of the classroom. PBE lessons are constructed around community assets and local resources of the students' surroundings (Jennings et al, 2005). Engaging students with relevant content rooted in experience prepares them to relate concepts to more abstract phenomena and can be an important learning tool to

improve students' relationships and understanding of their surroundings (Smith, 2002). This emphasis on hands-on, real-world learning experiences allows students to better connect and understand academic content because they are exploring concepts related to their daily lives. The isolation of the school day from home life is broken down through these connection-building tactics providing many social benefits for students while fostering curious minds (Sobel, 2004). One method for integrating PBE into the classroom is through school gardens. Using a school garden and the principles of place-based learning, we propose that students can more easily break down and understand the complexities of food systems.

Having K-12 students better understand food systems can help shape their futures. As climate change and other stressors continue to threaten our current food systems, upcoming generations must be familiar with basics like soil health, habitat, and ways of producing food to help shape what our new food systems can look like. Furthermore, by knowing the details of the components of food systems, we anticipate that they can better understand the ways they are being fed, how they can better serve those who are not benefiting from food systems, and can be empowered to make informed decisions for themselves and their families. However, to give students these opportunities, educators need to integrate food systems education with their already demanding standards. Therefore, this project focuses on addressing teacher's needs in a PBE context so they can best educate future generations on food systems.

Our Clients

Great Lakes Stewardship Initiative (GLSI)

The Great Lakes Stewardship Initiative is a statewide place-based education initiative. The Great Lakes Stewardship Initiative (GLSI) was developed in 2007 by the Great Lakes Fishery Trust and created with a 10-year plan and a commitment to environmental education leading to stewardship of the Great Lakes. GLSI was created to "develop knowledgeable and active stewards of the Great Lakes and their ecosystems through place-based studies and explorations in local communities" (*Learning for the greater good, n.d.*). They became an independent nonprofit organization in 2018, but the goal remains the same: building strategies for place-based education through sustained professional development and school-community partnerships. Working through six regional hubs in Michigan, GLSI offers resources and small grants to teachers working to increase place-based education at their schools. Each hub acts as a local network in Michigan where teachers of nearby counties can share ideas and undergo professional development. Our research focuses on the GLSI hub Discovering PLACE which covers the counties of Genesee, St. Clair, and Lapeer in Southeastern Michigan.

Michigan State University Extension (MSU-E)

University extensions are often used to provide resources to learners who are not full-time students. Michigan State University Extension (MSU-E) acts as a liaison between the academy and the community. Their mission is to "help people improve their lives through an educational process that applies knowledge to critical issues, needs, and opportunities," (*About*, n.d.). Some ways MSU-E engages in local

food systems include providing resources and programs to develop local food policy councils, creating food hubs and farmers markets, and providing a plethora of resources related to growing food.

Statement of Purpose

Food systems are key to our social and economic well-being but are not well understood by the average citizen. In part, this is because they are not taught extensively in our K-12 schools. Because most food-related curriculum that has been tied to school gardens focuses on science, social studies, and nutrition or health, there exists an opportunity to expand food systems education over multiple grade levels and content areas. Teachers need access to resources that will help them learn about food systems and assist them to connect their curriculum to food systems education. Therefore, the goal of this research was to create informational resources we call Framework Documents. These documents support the missions of GLSI and MSUE to provide educators and community partners with information to be used in a PBE setting while also fostering stewardship with the environment. To that end, we created Framework Documents for use in a classroom or community setting and in conjunction with a school garden for hands-on learning opportunities if such resources are available. The Framework Documents cover a variety of food systems components including their relationship to the local economy, climate change, and justice issues in a manner that teachers can integrate into their curriculum. Additionally for educators interested in improving or starting a school garden, a Garden Design Guide for school gardens was also created that could work at all levels of education and funding. Through these works, we hope to expand the understanding of food systems through PBE in Michigan K-12 school settings.

II. Understanding the Challenges of Integrating Food Systems Education and School Gardens

In order to create Framework Documents and a Garden Design Guide that address the needs, wants, barriers, and opportunities of educators discussing food systems and using school gardens, educator's voices need to be heard and understood. Therefore, this study utilized qualitative methods of data collection. Over two months in the fall of 2022, two focus groups were held with six Michigan teachers, and eleven individual interviews were held with Michigan professionals working in fields related to food systems education.

Focus Groups and Interviews

Each member of the research team developed ten interview questions they believed would address gaps in the literature and provide context to help in the development of our Framework Documents and the Garden Design Guide. The list of questions was condensed and grouped by themes. The themes included questions surrounding food systems subject matter (successes, challenges, practices for longevity in schools), school gardens (design elements, usage for educational purposes, creation or usage limitations), what current educational resources for food systems and school gardens are available, and content presentation.

A pilot focus group was held in a food systems graduate class at the University of Michigan. Graduate students were asked to reflect on their K-12 education and experience with or exposure to school gardens and food systems content to help the team revise and finalize their focus group questions. The graduate students took part in a Google Jamboard activity where they answered questions about their educational experiences with food systems. This pilot established the structure and flow of the focus group and influenced the types of conversations wanted during the focus group activity. The activity was slightly modified for the teacher focus groups to be shorter and have visuals based on student feedback.

Focus group email invitations were sent to nine teachers who had a prior connection with the Discovering PLACE hub of the Great Lakes Stewardship Initiative (GLSI). These individuals were chosen because they expressed interest in using place-based education to discuss food systems in the classroom or had experience with or interest in a school garden. The Discovering PLACE hub includes teachers working in Lapeer, Genesee, and St. Clair counties in southeastern Michigan. Other invitations were also sent by a second GLSI hub in northeastern Michigan, but it was unknown how many additional invitations were sent.

The email invitation contained a brief description of the project and a flyer inviting teachers to partake in a focus group. The flyer reiterated the purpose of the project, why their input was requested, and the researcher's pictures and contact information (see Appendix A for the flyer and the questions asked in the

Google Form). They were additionally given a link to a Google Form where they could share some information about themselves, including the school where they were teaching, and the courses and age group(s) they taught. The teachers were offered compensation in the form of a $20 Amazon e-gift card. The dates and times were chosen to work with teachers' schedules and around school holidays.

Based on teacher availability, two focus groups were developed, one for five teachers and another for four teachers. Once the dates were finalized, emails confirming attendance, consent to participate in the study, and calendar invites with the Zoom link were sent to the participants (see Appendix A for the focus group consent Google Form).

For the interviews, a list of professionals who work in fields related to food systems education or who had experience working with school gardens for place-based education for K-12 grade levels through Michigan was developed by our partners at the Michigan State University Extension and Great Lakes Stewardship Initiative. Thirteen professionals were sent an email invitation asking them to participate in a 1-hour virtual interview about the potential of adding food systems content and school gardens in K-12 education. A one-page overview of the project was provided for further clarification of project goals and research questions to be addressed by the project (see Appendix B for the one-page overview). A Calendly link was included for the individuals to schedule an interview time via Zoom with team members.

Prior to each focus group or interview, a consent form was emailed to the interviewees to agree to partake and give consent for the team to record. (See Appendix B for the consent Google Form). Two members of the research team were present during each focus group and interview. One researcher acted as the moderator and the other as the note-taker. In the first focus group, 4 out of 5 teachers joined the call (80%), and in the second group, 2 out of 4 teachers joined the call (50%). Eleven interviews were held with a response rate of 85%.

Each focus group and interview lasted approximately 1.5 hours and 1 hour, respectively, and was facilitated, transcribed, and recorded using Zoom software. Following the focus groups, each teacher was emailed a $20 electronic gift card to Amazon.com as a thank-you for their participation.

Data Analysis

Coding

The transcripts created with Zoom software were checked for accuracy using the audio files. Qualitative data analysis of the interviews and focus groups were coded according to the methods outlined in Miles et al. (2014). The codes were developed using an inductive-deductive approach. The codes barriers, successes, and garden designs were deduced from the literature and focus group/interview question development. However, other codes emerged from the data adding extra components to the analysis which were applied to the creation of the Framework Documents. Each transcript was coded by two team members, and each pair compared notes to ensure inter-coder reliability. Once all transcripts were coded, the codes were organized to determine emerging themes from the data.

III. Food Systems Education

Introduction

Including Food Systems Topics in K-12 Education

Currently, K-12 public school curricula do not focus on food systems topics. According to the Michigan Department of Education Academic Standards, food is taught in relation to science topics like chemistry and biology as a means for discussing energy or health about nutrition and labeling literacy (n.d.). Unfortunately, there is no deeper connection building required between food and the environment, economy, or social skills. If educators are passionate about drawing these connections or deepening their students' thinking capacity through conceptualizing food systems, they have to work to integrate topics within the state standards.

Food systems topics are an underutilized area of education. K-12 education is a foundational time in building students' understanding of complex systems. Food is an ideal lead into conversations about topics related to all K-12 subjects. Since every student has to eat, food is an effective learning leverage point. Unfortunately, food systems in the state standards are only included in the curriculum when referencing science and nutrition (n.d.). Even in science and nutrition, food systems are not fully explored or presented to students in a manner that would allow long-term benefits.

Approaching Food Systems Learning in Greater Depth

Generally, food systems education is not taught throughout K-12 subjects, but even when it is a component of the curriculum, it is not explored to the full extent of its possibilities. For example, in science classrooms, where food systems are already commonly included in the curriculum, educators could focus on the connection of food and climate change as a means of discussing larger complex systems they may have a more difficult time conceptualizing.

Similarly, food systems are a component of nutrition courses but are not approached with enough nuance or depth. Topics in nutrition courses are taught in a literal manner, telling students what to eat and what not to eat. Food systems have the capacity to influence longer-term success in students' health and healthful eating. Current research suggests a link between youth interest in alternative food production practices and dietary quality (Prescott, 2019). And yet alternative food production is not integrated into curricula. Students could learn about more interesting elements of food systems that they can connect to more tangibly while also seeing the added benefits of improving dietary quality, which educators are already striving for in nutrition courses. Yet, it can be difficult for educators to understand where to begin integrating food systems into the curriculum, but the under-exploration of food systems does a disservice to students.

Listening to Educators

Conversation Themes

Eight codes were identified when conducting the interviews and focus groups. The codes were: barriers and challenges, benefits and justification, design, learning tools, presentation of information, topics to teach, successes and opportunities, and sustainability and longevity. In this section, we highlight the themes from three codes: benefits and justification, successes and opportunities, and barriers and challenges. The information from these three codes is most applicable for enhancing the integration of food systems education in the classroom. Data collection provided a breadth of information – from specific recommendations at an individual level to general advice.

The three codes most applicable for exploring the integration of food systems education into the classroom, benefits and justification, successes and opportunities, and barriers and challenges, are further broken down into distinct themes based on the frequency interviewees raised relevant topics. The benefits and justifications of food systems education that educators highlighted were agency, climate change, and social skills. Educators indicated the current successes and opportunities in food systems education as relatability and community connections. And educators noted that barriers and challenges are particularly complicated because they take place at the educator, institutional, and state levels. Additionally, educators reiterated that these three levels of barriers all grapple in different ways with the breadth of information needed to teach food systems topics in education and the time and effort that is required for its implementation.

Benefits and Justification

Educators spoke about the benefits of food systems education and what they see as the long-term gains in this area of work throughout the interview and focus group processes. When asked “What are some of the benefits you would like to see come from furthering education on food systems topics?” three frequent themes emerged: agency, climate change, and social skills.

Educators spoke about agency in food systems as a means of granting students the benefit of individual choices by having ownership over their food choices to make more informed decisions. The ability to make confident decisions in food choices like what food to eat, where to source your food from, and the impacts of your sourcing gives students a feeling of independence. Preparing students for their changing environments by connecting food systems learning to climate change was highlighted by educators as a benefit and justification for food systems learning. Food systems education allows students to practice resiliency through recognition of climate patterns in context and an understanding of how food chains may be disrupted as the environment shifts. Additionally, educators emphasized food systems education's connection to social skills. Food systems education increases students' civic engagement because it allows them to better understand the systems they are living in and grants them the skills to decide how they want to engage in their systems. Food systems education provides students with knowledge of nutrition beyond conventional “what is a calorie” or “how to interpret a food label” by exposing them to a variety of foods and a deeper understanding of local and seasonal produce. Lastly, food systems education can act

as a means of connection building. Food is a universal connector, so food systems education deepens student's understanding of what role they play in the food system and how they are connected to those within and beyond their communities. Tables 1a - 1c below highlight agency, climate change, and social skills with a quote detailing how educators specifically spoke about these three themes.

Agency	**Quote**
Individual Choice	"So I think that the real key to food systems education is equipping people with the information and the skills to engage with the food system wherever and however they want to, but also making sure that they're making an informed choice about how they do so based on the impact on their health, impacts on their community, [and] impacts on the environment."
Ownership	"...[food systems education] give[s] people more ownership of their food choices…"
Informed Decisions	"...what we actually want is for people to make an informed decision and actually know where their food is coming from, how it gets there, and know what their options are. So that's what I would like to see is that people can make informed decisions, that people feel empowered to know what they have access to, and how their decisions affect the people around them."
	"...we don't think about how it gets there, you know, we don't get a say well, maybe I don't want to eat this particular product because it came from a place where people were not getting paid appropriately...maybe I don't want to use this particular food product because it…comes from an agricultural practice where it's getting to a monoculture and it's affecting a forest climate

Agency	**Quote**
	because the forest is being completely cut down.”
Independence	“How independent can we get [students]?”

Table 1a: Agency Justification for Food Systems Education

Climate Change	**Quote**
Resilience	“I think the food system has a big impact on climate, right? And we're gonna see that more and more. And I think understanding our food systems is part of building resilience for climate change.”
Climate Patterns in Context	“...changing weather patterns, changing climate patterns, changing movements of people, post-oil economies…even back to the growing process…where food comes from, the effort it takes to get somewhere…I think have a cultural impact on climate change, a slow one. It's not like the fast one of stopping using fossil fuels. But you're building a generation of people who understand that.”

Table 1b: Climate Change Justification for Food Systems Education

Social Skills	**Quote**
Civic Engagement	“Having people know the systems that they are living in, again, allows them to participate in those systems as active members of it, and not just

Social Skills	Quote
	passive receivers.”
Nutrition	“There’s been environmental changes that aren't quite policy yet in those schools, but they're headed toward it, that are benefiting people, opening them up to access to more nutritious food. So I think that there's a health benefit.”
Building Connections	“I mean, I feel like food is…people say this a lot and I guess maybe it can be a little bit trite, but…everybody has to eat, right? And I think… talking about food systems or food as something [that] connects us.”

Table 1c: Social Skills Justification for Food Systems Education

Successes and Opportunities

Educators mentioned successes in food systems education throughout interviews and focus groups. Specifically, interviewees were asked to recall any successes they’d experienced while working within their current structures or systems. Two frequent themes within successes and opportunities highlighted by respondents were relatability and community connections. Educators saw connecting relevant material to tangible items or experiences, like food students are familiar with, labels they see regularly, or careers they are interested in as an effective engagement strategy. Providing students with community connections through partnerships with community members in the food system, local elders, or food producers themselves led to greater success in student interest. Tables 2a and 2b below present these two themes alongside quotes from interviews and focus groups showing how respondents specifically spoke about these themes.

Relatability	Quote
Food	“I always related it to the foods my kids loved. So I would be like ‘All right, your Hot Cheetos and

Relatability	**Quote**
	Takis – What's in those? How do we go from something in a farmer's field to this bag of spicy deliciousness that you go crazy for? And what are the ingredients, and what can we grow ourselves? And what are the health benefits or not of this food?””
Labeling	“...the same thing with the food labels. Does [a label] really need to be on there when it's on ground beef?...talking about those labels because they see them. Or what does it mean to be natural? What does it mean to be organic? Because again, it's on a product that they use every day.”
Careers	“...when you're teaching the consumable, the consumer part of it, then you try to link…their career goals. I guess that makes it relatable to them.”

Table 2a: Relatability Successes in Food Systems Education

Community Connections	**Quote**
Community Partners	“So those kinds of community practices where you're putting community partners [and] community agricultural partners together with teachers, and then matching that with some support resources and letting people just talk and share – that's pretty powerful. Connections are important...and I feel like that's an untapped opportunity.”

Community Connections	**Quote**
Elders	"...they had some connections to some elders who lived in the community, and they brought them into the classroom and had them talk about their memories of that community and the green space, and its safety and what mattered to them there. And I was a little worried that that would fall flat, but the young people loved it. Loved it."
Producers	"...connecting students with their local farmers like we're gonna go out to Kenobi's Apple farm, or we're gonna go visit the neighbor's sugar bush, or we're gonna go out and talk to the commercial fishermen as they bring in fish. So there's the going out and participating in the very local food systems with the producers themselves…"

Table 2b: Community Connections Successes in Food Systems Education

Barriers

Barriers at the individual educator, institutional or school, and state standards or systems levels were outlined during the data collection process. In reference to barriers and challenges, interviewees were asked: "What structures or systems prevent educators from more effectively engaging with food systems content?" and "What barriers do you see for engaging educators with [specific expert's] subject matter?"

Educator, institutional, and state level barriers all have unique and overlapping barriers. Generally, all three levels grapple with the broadness of information to teach on the topic of food systems education and the time or effort it takes to integrate information into the classroom. Our respondents expressed difficulty in engaging with the complexity of food systems and noted that at any level of education food systems topics can feel like an overwhelming area to teach in a digestible and coherent manner to students. There is a general lack of confidence in how we define our food systems and a feeling of intimidation in trying to approach its integration into schools.

Examples of educator barriers highlighted by respondents included the overworking of teachers, the breadth of information related to food systems, the necessity of cross-communication in teaching food systems, and a general lack of confidence in teachers' ability to teach food systems content. Respondents referenced institutional barriers by highlighting the difficulty of buy-in from administrations that food

systems are a worthy cause, the training required to competently teach food systems topics, and the time that it takes to integrate these topics across school subjects while fulfilling the state standards. At the state level, respondents provided example barriers including state standards and curriculum. Tables 3a - 3c below illustrate the three frequent barriers of educator, institutional, and state alongside quote examples of how respondents spoke towards these themes specifically.

Educator

Barrier	**Quote**
Overworked	"I just think teachers are too taxed right now. By responsibilities, because under staff, because not paid enough, because not socially valued…and they feel that."
Breadth	"So I think one thing is when we talk food systems…it's so broad…because we all eat, because…the food that we eat is produced in so many diverse ways and gets to us in so many different ways. And then we have to decide what to eat and then dispose of what's left, so it's a big system."
Cross-Communication	"We did complete cross-curriculum for a year with the seventh grade, and they hated it. The teachers hated it because they have to be together…"
Lack of Confidence	"...it is a really intricate process and system, and if you don't know that it can be intimidating."

Table 3a: Educator Barriers in Food Systems Education

Institutional

Barrier	**Quote**
“Buy-in”	“...if it's not something that they are evaluated on or it's not something that's specifically in their curriculum that their school is following or if it's not something that their administration at the school level has buy-in into, it's not important because teachers are pulled in a million different directions [and] are trying to do so many different things…”
Training	“When I was in the more supervisory role…[we] started focusing on doing more training for teachers, professional development for teachers, and that was not super successful. I think mostly because we did not put enough thought into the scheduling of it and making sure that it really fit with teachers’ schedules and that they had an incentive to come to those trainings.”
Time	“I think the biggest challenge is time. You have so many standards that you have to hit that I could go in eight million directions with this topic.”

Table 3b: Institutional Barriers in Food Systems Education

State

Barrier	**Quote**
Standards	“And so I think it's just not built into existing standards. And when you have teachers who are working on meeting all those standards, while also implementing curriculum, and then just the work that goes into teaching, I think it's just not a big priority with all of the other areas where they're being measured and need to measure their student's growth and progress.”

Barrier	Quote
Curriculum	“How do you make something that's so big small because you have to continue on with the rest of the curriculum?”

Table 3c: State Barriers in Food Systems Education

Discussion

Opportunities in Food Systems Education

To effectively promote the integration of food systems education into classrooms, it is important to understand how educators currently justify food systems education. Educators saw food systems education as supporting student agency by empowering students to know the extent and impacts of food choices, allowing them to weigh their options and choose one that aligns with their needs and beliefs. Food systems education grants students a sense of autonomy with the ability to weigh food choices beyond enjoyment or nutritional makeup by exploring how their food may impact their community or environment. Students cannot make confident decisions about who or what they want to support with their food choices unless they understand the options. Therefore, equipping our students with the knowledge of topics like regenerative farming, local food economies, or equitable pay in the food system allows students to gain a better sense of the impacts and broadness of our food system so they can better advocate for the type of food system they want to support.

Educators noted the ability of food systems education to address climate change. Using food, a universal connector, as a lead into climate change discussions may be an effective means for beginning a cultural shift in attitudes towards climate change – even if it is a slow one. Food systems education will continue to become a more pressing need as our environment continues to change because our food landscape is also changing. Climate change will likely affect local food security by disrupting food availability, decreasing access to food, and making the utilization of food more difficult. Food systems education is one method to prepare students with an awareness of the future changes they may see in their food systems and the skills they may need to grapple with these changes. Additionally, respondents saw food systems education as a way for students to see themselves as part of a greater whole which could begin to instill in students a sense of stewardship for the environment. Food systems education can involve understanding climate patterns, movements of people, or where our food comes from. All of these topics deepen students’ ability to see global and regional flows as being larger than themselves or their communities. Fostering this sense of wholeness, that we are part of a system larger than ourselves, can deepen students' capacity for environmental stewardship.

Lastly, respondents believe that food systems education can act as a tool for furthering social skills. Food is universal, everybody has to eat, so the topic lends itself to exploring regional and cultural connections. Respondents saw food systems education as one method for promoting civic engagement. Understanding food systems awakens students' participation in the systems they are living in. Education surrounding your local food system is a form of place-based learning. Gaining knowledge or experience of your place through food systems education can lead to a shift in attitudes towards fostering an attachment to your place, which can lead to a more civically involved behavior change. This behavior change can then deepen community and social capital which ultimately leads to healthier social communities. Interviewees justify the implementation of food systems education into the curriculum because of benefits in student agency, climate change literacy, and social skills. These benefits can be used as justification when pushing for the integration of food systems education into institutions and act as opportunities for teaching topics.

Current Successes and Barriers

To best engage educators who may be unfamiliar with food systems, it is important to understand the successes individuals have already had when incorporating new subjects with their students. Our findings suggest that to have greater success educating students about food systems topics, educators need to integrate relatability and community connections into the classroom. Teachers saw greater success in engagement when they begin their discussions of new material with a tangible point of relatability. Beginning a discussion of the food chain with a food product that students are already familiar with and enjoy can act as a good entry point into understanding the larger complex system. These findings support the place-based learning tenet that to be able to generalize, students must first specialize by connecting to an idea or object that they are already familiar with from their local setting. Educators' responses continued to support place-based education studies by emphasizing how bringing local community members into the classroom increased student interest and engagement. Food systems are a global web of interrelated processes that, from the outside, can seem impossible to untangle and the complexity of their impacts can seem removed from students' daily life. Presenting complex systems to students through physical people and places is an effective tool for educators to increase student comprehension.

Effectively integrating food systems education into the classroom in a successful manner also requires addressing current barriers. Educators and stakeholders detailed barriers at the educator, institutional, and state levels. This project is specifically targeting mitigating aspects of the educator-level barriers that respondents highlighted: overworked, breadth, cross-communication, and lack of confidence. Through our Framework Document creation detailed in section IV, we hope to present food systems information in a concise yet informative manner that will allow overworked educators to quickly learn about a food systems topic of interest that connects to their subject manner. The Framework Documents provide useful resources to shorten the background research efforts and lighten the educator burden. Additionally, the documents contain relevant information for multiple subjects – not just science or nutrition – to hopefully enhance the capacity for cross-communication by providing educators with an understanding of how food systems topics can be integrated across subjects. Generally, the goal of our Framework Documents is to promote teacher confidence by breaking down the complexity of food systems in a usable manner that can be easily transitioned into the classroom. It is important to recognize that supporting educators is only one piece of supporting food systems education. If we would like to see full reform and the complete

integration of food systems education into K-12 classrooms, then it would require more extensive buy-in from administrators at the local, regional, and state levels.

IV. Creating Food Systems Resources for Teachers

Introduction

Learning and Teaching New or Unfamiliar Topics

Teaching is a demanding career, and educators must meet the growing demands of teaching diverse topics with engaging teaching methods all while meeting national and state standards and test mandates. In addition to basic content area knowledge and related skill sets, educators must be well informed on current content information in order to educate and support the next generation of students to be actively engaged citizens. While teachers may be interested to dive deeper into their content areas, time, limited resources, and other pressures can limit their ability to do so. For educators to successfully incorporate unfamiliar content areas into the classroom, they need to be provided with detailed materials to help them deeply understand the subject matter and see how the ideas connect across everyday life and different fields (Shulman, 1987). Although teaching methods will differ from individual to individual, it has been identified that educators best learn when allowed to study and reflect (Darling-Hammond, 1999). A formal introduction to new concepts with guidance is important for a general understanding, but the design of lesson plans and instruction should be left as the responsibility of the educators (Holmqvist, 2010).

Current Resources for Educators About Food Systems

Since the food system in the United States and globally is intricate and complex, it can be difficult for educators to find related information that pertains to their discipline and aligns with national and state standards. Additionally, for educators taking part in place-based education (PBE), there is the added burden of needing to find information about how the food system is shaped by and shapes the place they call home.

Currently, several organizations and universities have created K-12 curricula regarding food systems - namely lesson plans, activities, and other resources like glossaries. The Center for Ecoliteracy, based in California, creates informational resources for K-12 teachers that connect sustainability with educational topics, including food systems (*What We Do,* n.d.). Along with articles, they provide interactive e-books about food systems and climate change on their website (https://www.ecoliteracy.org/). For some resources, middle and high school standards are also included. Another resource is the *Just Food Educational Resource* through the University of British Columbia (https://justfood.landfood.ubc.ca/). Their website has seven learning modules explaining certain facets of the food system like equity and justice (*Learning Modules,* n.d.). These modules come with lesson plans, facilitator guides, and a glossary. While they do not explicitly say what age group their resources are aimed at, the activities are distinguished based on the students' prior knowledge of the subject. The Johns Hopkins University Center

for a Livable Future has a curriculum called *FoodSpan* (https://www.foodspan.org/) complete with lesson plans, activities, handouts, and slides for high school educators (*FoodSpan,* n.d.).

While all of these resources are helpful for educators and often aligned with national standards, they have limitations. For instance, many of these and other resources are made for middle and high school educators, leaving out elementary educators. Additionally, Ingram and Keshwani (2020) noted that food systems curricula and the use of school gardens have largely focused their contents on science, health and nutrition, and social studies. The exclusions of topics like math, art, English, and others keep students from being able to see food systems more holistically and how these systems infiltrate every portion of our lives. More resources need to be made available to reach multiple content areas and all grade levels in K-12. The creation of a resource packet explaining components of the food system and how these ideas can be incorporated into different content areas can assist teachers in their work to provide students with a greater understanding of food systems and systems in general.

The Need for New Types of Teaching Resources

To better help organizations like the Great Lakes Stewardship Initiative and university extensions like Michigan State University Extension engage teachers in place-based food systems education, Framework Documents can be distributed so teachers will not need the added burden of finding resources and materials themselves. Such materials provide content general enough that educators from all disciplines and grade levels can take information from them and create lesson plans that align with their standards. Additionally, they should break up large, complex ideas into smaller portions with links to resources should a teacher want to learn more. Framework Documents work to eliminate some of the limitations of current food systems resources listed above. Ideally, these documents can be used with a school garden to help students get a well-rounded hands-on experience.

Findings

Presenting Information in Resources For Teachers

When asked “What aspects of informational documents are most helpful/beneficial to you when you develop a lesson?” teachers explained that the most important feature of informational documents is clarity, especially when dealing with a potentially overwhelming topic like food systems. Other comments included being careful with wording surrounding potentially polarizing topics. For example, when discussing topics like climate change or genetically modified organisms (GMOs), it is important to share relevant facts without showing favoritism to a certain political agenda or steering people to a particular conclusion.

In the focus group and interview conversations, teachers’ workload was consistently brought up when making suggestions for effective learning materials. As such, they described preferring documents with key points and visuals before being provided extensive details. Furthermore, they suggested that rather than providing teachers with a PDF of these documents, it could be useful to provide the information in

slides so teachers might directly incorporate the information on the screen during their lessons. For example:

> *"[I like] things that are visual. Not really wordy. You know what I mean, like something that I can get the main bulleted points from… a big article is helpful, but if that information is already pulled out, those keynotes are already pulled out, that makes it 10 times more helpful."*

Incorporating How to Engage Students

When teaching students, educators stated it is also imperative to make sure that the information is succinct and given in a way that is appropriate for the age group. Focus group members discussed how they get students intrigued with a topic by creating a "hook." One simple way to accomplish this is by making the material relatable to students. For instance, one person shared that educators could talk about how familiar foods can be utilized in different ways,

> *"...I love tomato examples because there's something that everyone's somewhat familiar with. And if you've had ketchup before, so I mean just knowing what those different things are used for, and where they come from, and there's a wide variety..."*

Another mentioned that students could look at current issues like food recalls, either locally or nationally, food prices, or food labels,

> *"I think food safety is easy because of the fact they hear about recalls all the time on the news like you can't eat Romaine. And so I think food safety, because it's a topic that's in the news, it's easy to discuss why those things happen."*

Teachers also encouraged bringing in food, talking about recipes, using fun facts, and active rather than passive learning. One interviewee described a lesson he taught with students that led to a broader discussion about plastic waste:

> *"...action before content. So them doing something, and then circling back to understand the content behind that. So like, if you're gonna talk about marine debris, the students pick up trash and make observations and explore…and then you can circle back into the content piece of marine debris as an issue, and how it relates to human-environment interactions in an ecological system, disruptions, and all of the stuff you want to teach, but you're doing the action first."*

Lastly, educators mentioned that while field trips are exciting educational opportunities, they are not always feasible. However, multiple interviewees suggested educators create community connections and invite visitors into the classroom. Bringing in community farmers, fishermen, chefs, food co-op owners, and more can create nontraditional learning experiences which allow students to explore careers within the food sector and anything else they could learn from them.

Discussion

Because food systems are an exceedingly broad and potentially overwhelming topic, interviewees and focus group members reiterated the importance of information being clear and concise. They stated that visual aids, summaries of important points, and possible hands-on learning experiences like field trips or

bringing in community members could help them coordinate food systems topics with standards that must be met in their curriculum. Ideas surrounding student engagement were also shared. For instance, making food systems lessons relevant to students' lives and learning outcomes was suggested by both teachers and interviewees.

The K-12 Food Systems Resources Packet

One goal of this research was to help educators see the relevance of food systems throughout all content areas for K-12 grade levels. We wanted to make sure teachers of varying levels of understanding about food systems would feel that our resources were accessible and comprehensive. Based on the information, ideas, and questions discussed in focus groups and interviews, along with the needs and wants to benefit the educational facilitators at the Great Lakes Stewardship Initiative, a resource packet was created for educators. The K-12 Food Systems Resources included an Overview Document, Framework Documents, a list of ways to incorporate food systems topics into the classroom, and a Garden Design Guide (discussed in section V). The 3-page overview of food systems supports educators who are interested in incorporating food systems into their lessons but would like more background information first. For teachers wanting to dive deeper into certain topics, two different Framework Documents were developed. Each document was five to seven pages long and incorporated the different presentation styles described above. Given the workload that teachers have, the Framework Documents have written sections and related visuals that summarize the main ideas from the document for teachers to quickly learn. The sections also give teachers the opportunity to dive deeper into the details if time allows or if they see the relevance to their classroom. The two topics covered in the Framework Documents are 1)the relationships between food and climate change and 2) local food systems. Lastly, throughout all interviews and focus groups, educators mentioned ideas and examples of how different food system topics could be involved in different subjects. Given this, we found it imperative to make educators of any content area feel that they could utilize this information in their subject area. These ideas and examples were compiled into a "list of topics" for educators to easily skim if they were looking for connections between food systems and their teaching area. The entirety of the documents including the Overview Document, both Framework Documents, the list of topics to incorporate in the classroom, and the Garden Design Guide can be found in the K-12 Food Systems Resources at the end of this report. Overall, it is important to note that even though the food system is intricate and complex, it is okay to work through those intricacies with students of all ages as long as it is done, as one interviewee mentioned, *"in a developmentally appropriate way."*

V. School Garden Design

Introduction

Clean and perfect in shape and color, the food that reaches our plates does not reflect the intricacies of food systems including the growing process and what we purchase at the store to bring home to our tables. Many people, including students, are removed from food production and distribution. Yet, we all have roles and connections in the food system as consumers. Everyone has to eat, and school gardens are the best solution to expand the conceptualization of our role beyond the supermarket and see ourselves as part of a greater system. Sutter et al (2019) states that:

> Food education—defined here as education that supports learning about food, nutrition, and the role that food plays in one's life, relationships, culture, communities, environment, and in history and society—has the potential to help youth develop the critical thinking skills necessary for making healthy choices in everyday life.

School gardens can act as an effective entry point into understanding food systems and how food grows. School gardens act as a microcosm of our much larger food systems – they require collaboration, experience successes and failures, are sites of novel strategies, and reflect the environment in which they are built where students can learn about all that goes into the food that gets to our plates.

School gardens have long been utilized to teach concepts in science, health, and environmental studies (Ozer, 2007). They also state that there are multiple rationales for the value of school gardens, such as outdoor “learning laboratories.” Claiming they are aesthetically pleasing spaces for students to play, and, most recently, as places to promote the consumption of fresh produce among a youth population with markedly elevated rates of obesity and type 2 diabetes. Others note that gardening in a school setting, or even at home, promotes the health, curiosity, and development of students (Budowle, et al, 2019; Ozer, 2007). Although Ozer’s review of school garden impacts shows that while there is limited literature about school gardens, current literature points to a positive influence of school gardens on students with benefits including better cooperation, psychosocial development, and increased curiosity.

Across the country, there is growing support for building and using gardens in K-12 education. From increasing content knowledge (like biology and health), to supporting mental health (by providing outdoor green spaces), school gardens are thought to play multiple roles in K-12 educational settings that support student learning and personal growth. There are many examples of both urban and rural schools utilizing school gardens to increase learning opportunities for students. Designing appropriately for a particular school site (size, location, access, educational focus) facilitates and supports the sustainability of the garden and its use. School gardens can also be a tool for learning and can support a large range of topics from standard curricula practices to place-based education. Many K-12 educators that engage in place-based education and utilize school gardens do so as a way to connect with the local community and environment, all while exploring educational opportunities for food-specific learning. Explorations are often limited in their scope of search focusing on the science of plant growth and/or health and nutrition.

The Great Lakes Stewardship Initiative (GLSI) and Michigan State University Extension (MSU-E) seek to expand the ways teachers can increase local connections and the impacts of school gardens. They do this by tying those explorations to local food systems and Michigan's agricultural economy, and by extension, the importance of the Great Lakes in our region.

Despite the many advantages of having a school garden, there are also many barriers to creating and maintaining one. For school staff, school gardens come with innate challenges because while they offer novel learning experiences, they also require a level of comfort with related subject knowledge, ongoing maintenance, and funding. Educators may be unfamiliar with the concept of teaching outdoors or find it difficult to integrate outdoor activities into their already full schedules. For example, Ingram & Keshwani, 2020 state that the greatest barrier for Nebraska teachers working with school gardens was the ability to take care of the garden during the summer and other breaks (Ingram & Keshwani, 2020). Related challenges include maintenance over the summer months, the cost of tools, soil, access to clean water, etc, and in Michigan, the growing season does not match the school year. Often managed by teachers from either younger age groups, where the curriculum is less constrained, or by upper-level biology teachers, for whom the content connections are clear, gardens are often championed by one or two people. It is difficult to build broad support among other teachers, school staff, and administration for using the garden as an educational tool in the classroom. This makes their sustainability uncertain in times of staff changes. Additional problems include limits in funding, time, and adequate space (Ingram & Keshwani, 2020; Ozer, 2007).

Furthermore, while many share the positive sides of school gardens for getting students outdoors, there is limited research and understanding regarding how school gardens may move beyond "how to grow a tomato." While research indicates that school gardens offer learning benefits, there are also significant challenges to making these gardens sustainable for long-term use. Increasing teachers' understanding of how to utilize such spaces and connect gardens to broader social, environmental, and economic issues (and subsequently, education content standards) may increase the sustainability, utilization, and care of these spaces. As mentioned in section III, we hope to lay the groundwork for an educational framework that will communicate how and why understanding food systems are important to building climate resilience, ending food insecurity, and strengthening local economies. Furthermore, we want to provide design options for educators by creating a garden design toolkit so that they themselves can create a school garden that reflects their needs.

Findings

Evaluation of Teaching Gardens

Teachers and schools need resources to design school gardens that are effective for their particular teaching needs. In general, to create a garden design, designers begin with research. They talk with experts, ask questions, and use the information and site analysis gathered to create a design idea. Following this information-gathering process, they create a sketch depicting what methods work best for that space. We used this process for the creation of our Garden Design Guide. Part of our research process was gathering information from teachers on how they have or would like to use gardens as teaching tools.

We then looked for examples of successful garden designs that could be applied in Michigan and Great Lake regional contexts.

To that end, we interviewed and held focus groups with educators from multiple locations in Michigan. We asked them to share how they could imagine teaching food system topics and what elements of a school garden they thought are necessary for teachers to best use the garden as an educational tool. After discussing design approaches with our interviewees and focus groups, the successes of using school gardens for food systems education and the barriers to maintaining or the utilization of school gardens emerged. Throughout the interviews, we heard that gardens can have positive impacts on social-emotional, cognitive learning benefits, and PBE learning. The barriers to implementing these gardens were physical, regulatory, and cultural concerns. Dividing the positive impacts and maintenance/construction barriers shows what can be learned and the concerns that follow school gardens in K-12 settings.

Successes with School Garden Education

When analyzing the interviews and focus groups, the following themes emerged: social-emotional learning, cognitive learning benefits, and PBE contexts. Each of these was connected to the successful use of a school garden. Social-emotional benefits include students' social interaction skills, confidence building, problem-solving, independence, negotiation skills, and creativity. The cognitive learning benefits include focus, motivation, concentration, and working memory skills. The last category, PBE contexts, highlights the understandings built throughout a PBE approach to using gardens as a learning tool. They included an understanding of natural, geographical, cultural, and historical contexts and issues. More information and specific examples of these can be found in tables 4a-4c and 5a-5c.

Social-Emotional

Success	**Quote**
Mental Respite	"I know that there were some teachers who would take their students out to the school gardens, really more as kind of like a brain break of like, 'All right, explore for a little bit and you know, pick a tomato and eat it,' or something like that."
Independence & Ownership	"I imagine it being like this space that those students kind of see as their own. So I see it kind of being like an area of pumped up child-like wonder…"

Success	Quote
Problem-solving	"...And I think there's a lot of models, for, you know, like a school farmers market or farm stand where the students are growing and selling um, or, you know, giving away the food that's grown in the school garden kind of really making it that full circle, you know, educational opportunity about food systems."

Table 4a: Social-Emotional Successes for School Garden Design

Cognitive Learning

Success	Quote
Long-term Memory Retrieval	"But in any case, these kids had done poorly in math, and rather than being in summer school, they put them in a project to build things all summer. These were tenth graders who didn't know how to use a ruler or didn't know how to use a measuring tape. And so we measured boards and we cut them. And in that process we're doing a lot of math right? Subtraction, addition, thinking about weight, all those kinds of things. But it was in context of doing something very applied."
Concentration	"...And I think there also have to be really interactive elements. I know some of the people I've worked with…we've done signage for activities, so that the kids can rotate through stations in the garden and do everything from exercise activities to touch[ing] this plant, you know. See, what does it feel like? Smell this plant. What does it smell like? Kind of right through the senses. So they're almost like living sensory stations for the kids to interact with."

Success	Quote
Motivation	"We planted in the garden, [it] was pretty successful. The student engagement was high. They really wanted to listen and focus on what is the best way to plant each of these plants and the spacing and labeling them out. And like why we were putting the tomatoes on their own, because they spread, you know, or they kind of get bushier, or like the cucumbers and things like that. I think they were really engaged in that hands-on aspect."

Table 4b: Cognitive Learning Successes for School Garden Design

Place-Based Education Context

Success	Quote
Traditional Indigenous Knowledge	"So we're trying to teach them from the Indigenous perspective. Not that I'm in any way native or whatever, but using native voice to teach about their perspective on maple sugar and looking at data, and how they shipped sugar back East, and who did, and how they made it. So there's a lot there that I think is workable."
Identity in Relationships	"I also think that there is an identity benefit in terms of students becoming aware of the place that they live. Aware of their interconnectedness to it, and oriented within that place in a way that increases feelings of belonging, safety... getting a real sense of the ripples and intersecting ripples and communities in relationships."
Cultural	"We actually did a whole activity around trying foods that were grown locally. And then those same counterparts that you bought at a grocery store. So for example, like we take some of our apples that we

Success	Quote
	had grown on site, and they would taste one of those apples and then taste like an apple that came from Washington or something like that. And then we'd also track the foods so if we had a can of green beans, we would try to figure out okay, where did those green beans come from?"

Table 4c: Place-Based Education Context Successes for School Garden Design

Barriers with Using School Gardens

The barriers to using school gardens were shared by educators and were organized into the following three categories: regulatory/system, physical, and cultural/societal. Subthemes found in the category of physical barriers included time, maintenance, seasonality, and accessibility. Regulatory barriers included funding, training, staffing, curricula, inconsistency, and health and safety concerns. Lastly, cultural barriers included familiarity, emotional and social disconnect, communication, and diversity.

Regulatory

Barrier	Quote
Funding	"...time and money resources kind of dictate how much care goes into the school garden."
Understaffing	"You gotta have a champion or you gotta find a way. Most school gardens survive because they have a champion. The problem is when that champion walks out the door right?"
Inconsistency with Maintenance	"...there are also issues with consistency for managing school gardens...there can be some issues just with that summertime break and keeping consistency in a garden growing crops that fit that unusual schedule because the best growing season is when they're not at school…"

Barrier	Quote
Health and Safety	“They can't bring their produce from the garden in the school line or even what they're serving out…So the red tape I think is definitely a barrier because that process is long and you have to be willing for that enduring process just to make small steps in order to make an eventual big difference.”

Table 5a: Regulatory for School Garden Design

Physical

Barrier	Quote
Time	“But the big barrier is the people [who] have barriers beyond the actual gardening and the time that they have allowable. And not just when I talk about teachers and what they have on their plate, but that's families as well.”
Maintenance and Materials	“One of the hard things about gardens is the constant maintenance and if you don't maintain them they look like crap or they collect rats or they are really practical things that a stretched school community doesn't have time to deal with.”
Seasonality	“And I think the other challenge [is] there's so much literature out of California about how great school gardens are. It's like sixty-five degrees in January there, people! You know, not sixteen degrees.”
Accessibility	“...because I also have students with physical disabilities and they're limited in their ability to

Barrier	Quote
	reach the dirt or be able to dig the hole.”

Table 5b: Physical Barriers for School Garden Design

Cultural

Barrier	Quote
Unfamiliarity	“I think people can be really intimidated with it, but that also shows the unfamiliarity. But just getting out there I think can show that…there's a lot of things that can go into gardening and, like I say, other educational opportunities.”
Disconnection in Process	“Schools tend to have contracts with super food providers, like certain food providers for their cafeterias. [So there are issues with] Maybe the kids participate in helping grow some vegetables, but actually integrating them into their local use, or even getting them to the kids homes.”

Table 5c: Cultural Barriers for School Garden Design

Designing Teaching Gardens Approach

After gathering data from the teachers and focus groups, we began the design research process. We took the data obtained and created scenarios that we believed to be beneficial to K-12 educators, beginning with looking for similar school garden projects that were successful to help guide our design. At the beginning of the design process, precedents or case studies were used to provide possible schoolyard designs. Similar to a case study, precedents are a reference used to explain and communicate the vision for a future school garden with another. Specific projects can be found on websites such as https://www.landscapeperformance.org/, where the viewer can narrow their search by the benefits a project does for its specific site (like water, land, habitat, etc.), what type of project they're looking for, and much more. As an example, The Willow School in New Jersey (https://www.landscapeperformance.org/case-study-briefs/the-willow-school) was used as a study for our project because of the environmental and social educational impacts it has on its students.

When designing a space, a site evaluation is conducted, which is a method of noting the on-site elements that support or hinder a design. Such supporting or hindering elements can include existing structures and plant materials, site views, water access, sunlight, physical access, etc. Site evaluation and analysis are key components of a successful project. However, as our client was working with multiple schools, the analysis was based on GLSI's area of focus, Michigan. Instead of site-specific conditions, Michigan-specific constraints such as weather, soil, and hardiness zone were evaluated for proper vegetation to be considered.

After the initial site evaluation, the design process started with charrettes or parti-diagrams. Sketches were drafted from the interview analysis to explore and share a broad diversity of design ideas. This process leads us to our toolkit solutions. For example, one educator says,

> "*...we would then talk about [the] theme of a garden like, 'Did you want the gardens to feel a certain way' or 'how would you translate the feeling of restfulness or peace into a physical space?' And then I would come in and do the design work, and we'd talk about plants and that sort of thing. [We] would have them write poetry about place, and then we'd come back and move back and forth that way.*"

This led to a new category in our design toolkits that we labeled as "Health Components," implementing garden design strategies with mental, physical, social, and well-being activities.

Discussion

Successes in Social-Emotional Learning, Cognitive Learning Benefits, and PBE Contexts

In our focus groups, teachers expressed that school gardens support the social-emotional well-being of their students. They noticed that working in the garden caused students to take time and mental breaks. Teachers noted that students would go out into the garden and do what they wanted, whether it was playing in the garden or relaxing by the base of a tree. Independence was another trait noted, when students get to go out into a garden and get their hands dirty - doing what they can't do inside or at home - because it builds their confidence and develops independence. Lastly, problem-solving skills were expressed by educators. For instance, they described the learning and confidence created by students planning their own gardening schedules based on size or season.

Cognitive learning benefits were also mentioned by teachers that attended our interviews and focus groups. Students that participated in school garden activities developed informational gathering and memory skills. Concentration with students being taught outdoors was also brought to our attention; students who excelled in being outdoors instead of in a confined area showed promise in participation. High levels of concentration can lead to motivation, as one teacher stated:

> "*[I] helped the kids plan the garden … and [for] what the kids wanted to put out there… I kind of let them take over.*"

Other educators agreed that when they themselves let the students take charge the results of student engagement were higher. Finally, when discussing connections to the curriculum, this set of teachers thought that all subjects taught in Michigan curricula could be taught in a school garden

The last set of successes using a school garden in K-12 education was connected to place-based education contexts. Educators relayed that working in the garden expanded both their own and their students' understanding of traditional Indigenous knowledge. Indigenous knowledge should not be confined to history lessons, as educators stated that they are often practiced today. Such knowledge comes in many forms like, but is not limited to, learning about foraging and also about sustainability. One educator who teaches Indigenous knowledge states:

> *"So every day we're eating and prepping and harvesting and foraging, and it's a food class. So there's four different quarters of ecology right now that we're in native tech. So we're looking at Indigenous technology. And there's a lot of food stuff in there, too that's really interesting."*

Having a student go out and gather their food in a school garden can also provide lessons in relation to the place they live. Students can learn and identify with the place that they reside in by understanding the community that they are in. One such connection that can be made is with agriculture. Several teachers expressed that community members and local businesses loved participating in school events or teachings. One teacher said,

> *"...you're putting community partners/agricultural partners, together with teachers…Connections are important, I think, and I feel like that's an untapped opportunity."*

Students that participated with the community in events like farm/site visits or selling produce from their school garden stand have a better understanding of connection to the community and the role they play.

The Regulatory, Physical, and Cultural Barriers to Implementing School Gardens

The regulatory or system-level barriers related to the successful use of school gardens include funding, understaffing, inconsistency, and health and safety regulations. Respondents repeatedly expressed how funding is a major barrier to school garden construction and upkeep. Funding, in combination with staffing, influences how much care can go into a school garden. Without a consistent champion or money, a school garden can easily fall into disrepair. Such inconsistency in care can lead to unsightly gardens and be a barrier to staffing and administrative prioritization. If school gardens or aspects of school gardens are not consistently prioritized, then the momentum to upkeep them can wane. Designated programs, like FoodCorps, work with schools on food systems education and school gardening. However, such programs and many schools have high rates of staff turnover leading to a potential shift in priorities year by year. Lastly, health and safety regulations may make administrators apprehensive at the prospect of building a

school garden from which students may eat the food they have grown. The complications around what food students can eat can seem like a risk for the administration.

Physical accessibility can act as a physical barrier in school gardens. One interviewee states

> "*... [I] have students with physical disabilities, you know, like, and they're limited, and in their ability to reach the dirt, you know, or be able to dig the hole .... They don't really want to get, their hands dirty, you know?*"

Designing a garden to be usable and safe for all members of a community can seem like a barrier because while educators want the garden space to be inclusive, they may not have the resources or experience to design a space to be universally accessible. Alternatively, accessibility can act as a leverage point for creative explorations and use of space making school gardens interactive for all students.

Michigan poses unique challenges for school gardens. Unlike other parts of the United States, the growing season in Michigan is shortened because of the early season freezing and late season thaws. The majority of these days take place outside of the school year. One interviewee stated,

> "*we're only limited to a certain window, and unfortunately, by the time things start growing my kids are going home, you know, not up in school.*"

Seasonality can act as a barrier in school gardens in Michigan because it requires educators to be more creative in how they balance planting or cover cropping with educational activities of the calendar year. This can lead to a lack of support from administrators wondering why to put in the effort to build and maintain a school garden if the students cannot interact with it during the growing season.

The last set of barriers expressed by respondents was cultural or societal barriers. These barriers may be the most complex because they have the least tangible leverage points with which to address the problem. One barrier to school gardening is the act of gardening itself. Being willing to get dirty, use your hands, make mistakes, and take on responsibility for a certain level of mess is not something all administrations, educators, or students are interested in. Additionally, there can be some fear associated with gardening and being outside in general for teachers and students. Some teachers expressed interest in gardening but shared they are concerned about starting something they are unfamiliar with. Overcoming these barriers may be a slower process and require the lead of a champion who feels confident in the garden space or training for educators. School gardens are perceived as requiring constant maintenance and dedicating an adequate amount of time to their upkeep can seem overwhelming. There was a fear associated with school gardens surrounding both maintenance and engagement with the garden itself. A lack of confidence around working or feeling safe in the space can prevent individuals from engaging with it.

Given the potential impact of gardens on student learning creating strategies to mitigate these barriers could expand learning possibilities and deepen students' understanding of the role of "place" and how they can relate complex topics to their own environment. Here, we present options for school garden designs in our Garden Design Guide that are geared towards hands-on learning to facilitate food systems education rather than the gardens solely as sites of production. Our design is targeted toward mitigating some of the common challenges associated with school gardens.

Designing Teaching Gardens

The Garden Design Guide provides visual opportunities so that any teacher can utilize the components to scaffold the creation of their own school garden. A series of design solutions/scenarios/choices were created from what we learned from our focus groups and interviews on how to make a school garden successful. Understanding that our garden design was not designated to a specific area, we propose the use of a design toolkit. This project was designed to support Michigan teachers using place-based education pedagogy to integrate gardens into their food systems curriculum. Thus, the utilization of The Great Lakes region's habitats were also heavily involved to promote PBE. This is somewhat unusual, as generally, a design is site specific. As we were designing generally and not to a specific site, we compiled data and information acquired from the research conducted on school gardens instead. This research included literature reviews and interviews/focus groups. These conversations were our primary source of design solutions. From these conversations, we heard about the success or barriers educators had experienced. This information formed the basis of our design solutions.

A design toolkit is a set of visual assets to provide solutions for particular projects. This was our solution to the challenge of providing design options for multiple schools in the Great Lakes region. The design toolkits in our K-12 Food Systems Resources provided a set of inspirational drawings for teachers to use as they plan their gardens. The design options are organized first by activity - the way in which students and teachers might use the space for learning about food systems. These activity labels included: outdoor, indoor, health, and ecosystem activities or tools. Each diagram displayed an evaluation, including the complexity of the project, meaning how hard it is to construct, a reference to size, and how it relates to the season of the garden. More information regarding the toolkits may be found in Appendix C: Garden Design Guide Resources.

In addition to the garden design, the toolkits included garden scheduling graphs that display Michigan's native flora and compatible vegetables. These graphs help teachers make plant choices that will be successful in their particular place and climate. The graphs showed which plants are good for full sun to shade, their color across the seasons, and their bloom time. These graphs relayed what crops will do well in the warm season versus the cold. More information regarding the listed plants may be found in Appendix C: Garden Design Guide Resources.

Lastly, two design scenarios were displayed, visually communicating the Garden Design Guide's intended purpose. The designs utilized components from the design toolkits illustrating how a teacher might combine design options from the toolkits to create a garden that best suits their teaching needs. The visuals showed how this can work for schools that have either a plethora of space to use to ones that have limitations.

VI. Conclusion

Food systems topics and place-based education (PBE) are valuable, these emerging topics are critical for educating the next generation in their decision-making skills. With food systems knowledge, a healthy food systems relationship that is beneficial for the next generation's health and sustainable for the environment and the economy will be formed. For this practice to occur and be successful, educators need the necessary support via informational materials and educational tools to properly prepare their students for this challenge. These topics have been limited to the standard science and nutrition classes, but food systems must be integrated across all disciplines. The object of this research project was to understand and address the need for the integration of food systems topics in K-12 education. By conducting focus groups and interviews with food systems educators and school garden advocates, we were able to understand the respondents' approaches to addressing food systems and the use of school gardens. All participants vocalized the importance of school gardens in educators' approaches to building connections from broad concepts for their students.

Food systems can be difficult to understand by the average person, and the usage of school gardens for PBE has some limitations to the sciences and health classes. When paired with a lack of understanding, teaching these unfamiliar topics can become a daunting experience for teachers. From this research project, we created resources for educators to develop their understanding and make connections between school gardens and food systems education. The benefits of using school gardens for place-based education and teaching food systems topics to grade-level students discussed in the interviews and focus groups served as a basis for the creation of K-12 Food System Resources. This packet was designed to provide educators with concise resources to engage with school gardens, food systems, and climate change in the Great Lakes Region through an Overview Document, Framework Documents, a Garden Design Guide, and a list of food system topics.

This research project is an initial step to increasing food systems education in K-12 grade levels. Further research projects exploring food systems specific to the Great Lakes Region and the Midwest are necessary because of the region's unique climate, diverse agricultural industry, and these projects could provide educators in Michigan with the context to make relatable and personalized connections and examples for their students that are relative to the region in which they live. Current literature on food systems topics is primarily studied in the Great Plains and Western regions of the United States. The challenge taken in this project was to provide Michigan teachers with the content necessary for integrating food systems into the classroom. Through the process of speaking with educators, it was evident that challenges beyond the scope of this project could harm successful integration. Most educators mentioned having limited and unreliable resources for starting and maintaining their school gardens, and they rely mainly on donations of building and garden materials from community donations. Some of the school gardens are limited to being an after-school activity, or they are used by a small number of teachers. With a lack of support from school administrators (at the school, county, and state levels), undertaking a task like integrating food systems education can be difficult to garner interest and support from fellow educators. Addressing the challenges mentioned could serve as a basis for the sustainability and longevity of school gardens and food systems education being taught in the education system. Some recommended next steps are securing adequate funding and training for educators to learn

about food systems and school garden usage, the establishment of state-wide recognition of food systems education standards, and general support from school administrators at the county and state levels.

VIII. Appendices

Appendix A: Focus Groups

Focus Group Flyer

ARE YOU A K-12 EDUCATOR WITH SCHOOL GARDEN EXPERIENCE?

Make your voice heard!

Please join us for an hour and a half-long conversation via zoom to discuss food systems education. Your valuable contributions will be used to develop content for teachers to implement food systems education into their classrooms.

TOPICS OF INTEREST:

LOCAL FOOD SYSTEMS
CLIMATE CHANGE
FOOD SECURITY
JUSTICE AND EQUITY

Your thoughts and ideas will help to create content and school garden designs for educators and community partners for further development into k-12 curriculum

As a thank you for your participation in the discussion, you will be gifted with a $20 Amazon e-gift card!

Dates: November 2nd, 7th, 9th, 10th
Sign up with your availability here

Questions? Contact UMSEASFutureFood@umich.edu

Erin Holland is studying environmental justice.
erinlh@umich.edu

Sarah Eldridge is focusing on environmental justice and geospatial data science.
sareld@umich.edu

Katherine Francois is studying environmental justice and public health.
kmfran@umich.edu

Keely St.Andrew has a focus on landscape architecture.
kstandre@umich.edu

SEAS SCHOOL FOR ENVIRONMENT AND SUSTAINABILITY UNIVERSITY OF MICHIGAN

GREAT LAKES STEWARDSHIP INITIATIVE

MICHIGAN STATE UNIVERSITY | Extension

Google Form: Focus Group Sign Up

Come join us for a one-hour conversation about food systems and their integration into K-12 education!
--Discuss your successes, areas of interest, and the place-based approaches to food systems education.
You will receive a $20 Amazon e-gift card for your participation in the discussion.

For additional contact information and a project overview, please click here.

* Required

Email* _____

Name* _____

School Name _____

School District* _____

What county do you teach in?*_____

What grade level(s) do you teach? _____

What content area(s) do you teach? _____

What time(s) works best for you? Please select all of the times that you might be available. (You can choose more than one, but you will only be scheduled for one conversation.)*

- ☐ Monday, November 7th (4-5:30 PM EST)
- ☐ Monday, November 7th (5-6:30 PM EST)
- ☐ Wednesday, November 9th (4-5:30 PM EST)
- ☐ Wednesday, November 9th (5-6:30 PM EST)
- ☐ Thursday, November 10th (5-6:30 PM EST)
- ☐ Other: _____

If none of these times work for you, please let us know what times work in your favor!

_____

Is there anything you would like to share with us about school gardens or food systems before you join us for this conversation?

_____

Focus Group Informed Consent

Integration of Food Systems and School Gardens into Michigan K-12 Education

Purpose

You have been invited to participate in a focus group sponsored by the UM Future Foods team of the School of Environment and Sustainability (SEAS) at the University of Michigan under the guidance of faculty advisor Dr. M'Lis Bartlett. This study is in partnership with the Great Lakes Stewardship Initiative and Michigan State University Extension. The purpose of this study is for the research group to learn about your interest in food systems and place-based education. The information learned in this focus group will be used to create content documents for educators and community partners on food systems topics that can be incorporated into curricula and the development of methods to incorporate placed based education with the usage of school gardens.

Procedure

As part of this study, you will join a group of 8 – 10 individuals on a moderated Zoom call for a 60-minute discussion. A moderator will facilitate the discussion and ask you several questions approved by the University of Michigan's Institutional Review Board. This focus group will be recorded, and a note-taker will be present. However, your responses will remain confidential, and no names will be included in the final report or transcriptions. You may choose not to participate, or you may withdraw your consent to be in the study, for any reason, without penalty, at any time. There are no right or wrong answers to focus group questions and the Future Food Group encourages everyone to contribute their thoughts, as they are comfortable doing so.

Benefits and Risks

Your participation may benefit you and other educators by assisting the research group to create documents to assist in connecting food systems topics across multiple subjects and incorporating the usage of school gardens for place-based education. There are no anticipated risks beyond those experienced during an average conversation.

Confidentiality

Should you choose to participate, you will be asked to respect the privacy of other focus group members by not disclosing any content discussed during the study. Researchers within SEAS Future Food will analyze the data, but—as stated above—your responses will remain confidential, and no names or identifying information will be included in any reports or transcriptions. All data information including but not limited to name, school affiliation, email address, zoom recording, and transcription will be stored on a password-protected server or password-protected electronic device.

Contact

If you have any questions or concerns regarding this study, please contact the research group at UMSEASFutureFood@umich.edu or the project advisor at mlis@umich.edu.

By selecting yes, you are acknowledging to the Future Food Group you are willing to participate in the focus group and you are giving consent for the Future Food Group to record you and your responses via Zoom.

* Required

Name* _____

Email* _____

Do you consent to the above information? By selecting yes, you are acknowledging to the Future Food Group you are willing to participate in the focus group and you are giving consent for the Future Food Group to record you and your responses via Zoom.*

Yes

No

Appendix B: Interviews

Interview Informed Consent

Integration of Food Systems and School Gardens into Michigan K-12 Education

Purpose

You have been invited to participate in an interview sponsored by the UM Future Foods team of the School of Environment and Sustainability (SEAS) at the University of Michigan under the guidance of faculty advisor Dr. M'Lis Bartlett. This study is in partnership with the Great Lakes Stewardship Initiative and Michigan State University Extension. The purpose of this study is for the research group to learn about your knowledge in food systems and place-based education. The information learned in this interview will be used to develop insight for focus groups with teachers and later create content documents for educators and community partners on food systems topics. These topics can then be incorporated into curricula and used with school gardens.

Procedure

As part of this study, you will join a moderated Zoom call for a 60-minute discussion. A moderator will facilitate the discussion and ask you several questions approved by the University of Michigan's Institutional Review Board. This interview will be recorded, and a note-taker will be present. However, your responses will remain confidential, and no names will be included in the final report or transcriptions. You may choose not to participate, or you may withdraw your consent to be in the study, for any reason, without penalty, at any time. There are no right or wrong answers to questions, and the Future Food Group encourages everyone to contribute their thoughts, as they are comfortable doing so.

Benefits and Risks

Your participation may not directly benefit you, however, it will benefit educators by assisting the research group to create documents to assist in connecting food systems topics across multiple subjects and incorporating the usage of school gardens for place-based education. There are no anticipated risks beyond those experienced during an average conversation.

Confidentiality

Should you choose to participate, researchers within SEAS Future Food will analyze the data, but—as stated above—your responses will remain confidential, and no names or identifying information will be included in any reports or transcriptions. All data information including but not limited to name, organization affiliation, email address, zoom recording, and transcription will be stored on a password-protected server or password-protected electronic device.

Contact

If you have any questions or concerns regarding this study, please contact the research group at UMSEASFutureFood@umich.edu or the project advisor at mlis@umich.edu.

* Required

Name* _____

Email* _____

Do you consent to the above information? By selecting yes, you are acknowledging to the Future Food Group you are willing to participate in the interview and you are giving consent for the Future Food Group to record you and your responses via Zoom.*

Yes
No

Interview One-Pager

Integration of Food Systems and School Gardens into Michigan K-12 Education

Gap: Most food-related curriculum has been tied to school gardens and focuses on science, social studies, and nutrition or health. There is an opportunity to include food systems education over various grade levels and content areas, especially through hands-on learning in existing or future school gardens.

Project Goal: Create framework documents for educators and community partners with information regarding various components of the food system such as local economy, climate change, and justice issues for further development into the curriculum. Also, the documents will provide a rationale for including food systems education in the classroom. These documents can be used in conjunction with a school garden for hands-on learning opportunities if such resources are available.

Project impact: We hope to expand the understanding of food systems through place-based education (PBE) in Michigan K-12 school settings. This will be accomplished by providing educators of varying ages and content areas with food system basics to then be developed in their curricula. Additionally, our framework documents could serve as an example for other PBE topics in the region. Lastly, we will create a design for school gardens that could work at various levels of education and funding.

Objective 1: Create and develop framework documents
Our framework documents will help K-12 educators connect food system concepts to place-based learning through school gardens. These documents will feature topics such as climate change, local food production, and food security, that can be used to engage students to make informed decisions and advance their understanding of food systems.
Objective 2: Create a design plan for school gardens
Create a design plan(s) scenarios that will act as a framework for educators who would like to implement outdoor learning into their curriculum. These will be specifically tied into food system education by being used as a tool or guide.

Research Questions:

RQ1: How are teachers currently using school gardens and presenting food systems components? What information is needed for teachers to address food system issues in the classroom?

RQ2: What are the barriers and opportunities to teaching food systems in a K-12 setting? How can school gardens supplement teaching/learning?

RQ3: How can we ensure the best communication format for educators to understand the framework documents? How can we get every grade (K-12) interested and intrigued so they will want to use it?

Questions? Email UMSEASFutureFood@umich.edu

Appendix C: Garden Design Guide Resources

1. How-to-Read: Garden Design Guide
2. Garden Scheduling Guide
3. Farming Guide

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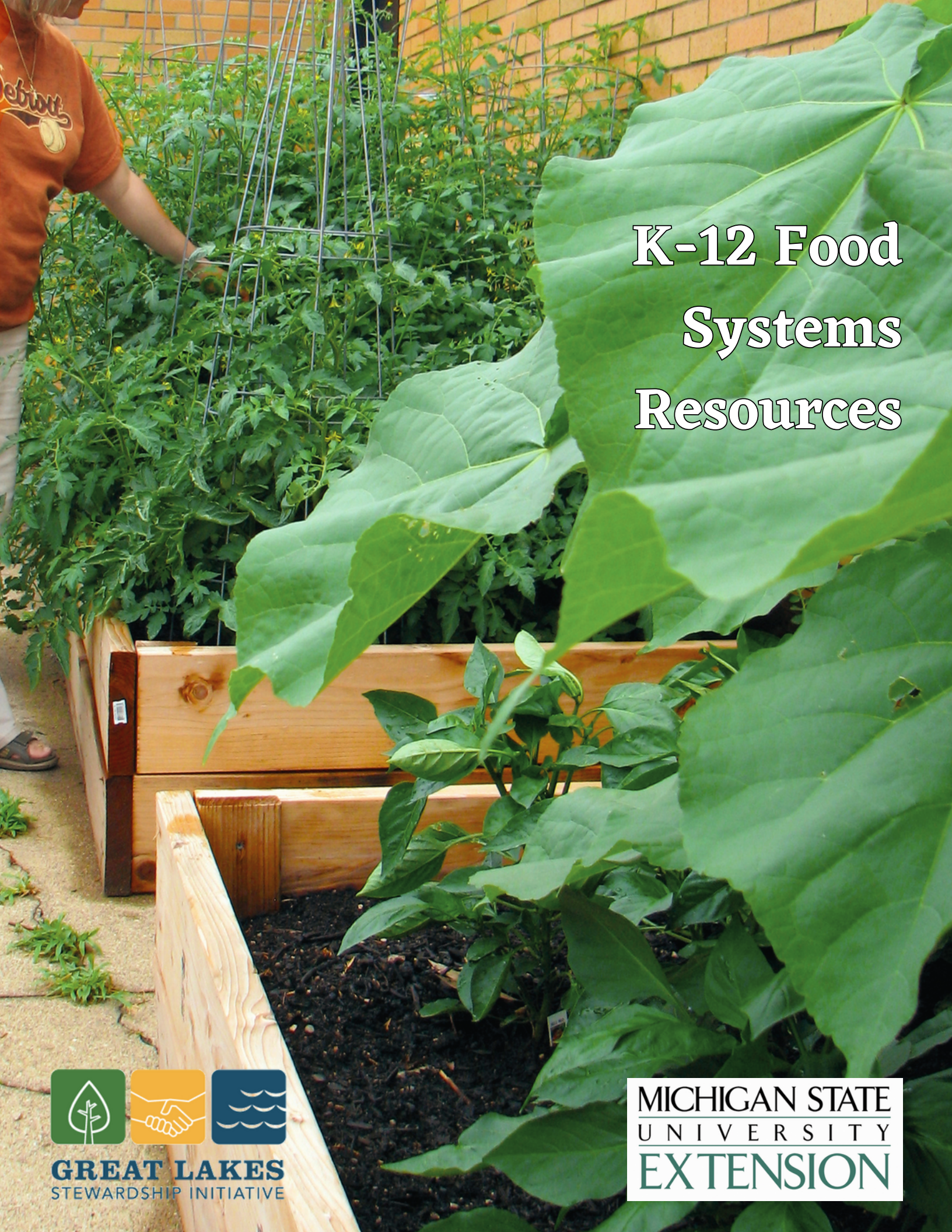
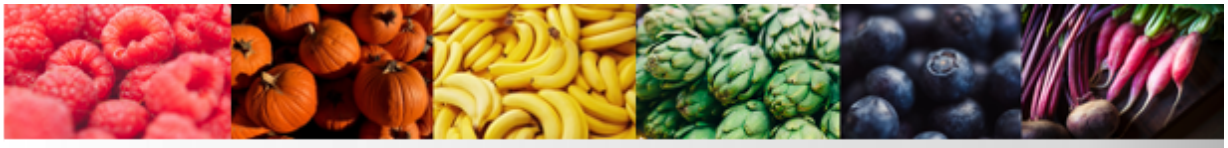
X. K-12 Food Systems Resources



K-12 Food Systems Resources

GREAT LAKES
STEWARDSHIP INITIATIVE

MICHIGAN STATE
UNIVERSITY
EXTENSION



Food Systems Overview and Definitions

What are Food Systems?

As defined by the Food and Agriculture Organization of the United Nations,

> "*Food systems encompass the entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption, and disposal of food products that originate from agriculture, forestry, or fisheries, and parts of the broader economic, societal, and natural environments in which they are embedded.*"[1]

In simpler terms, the USDA defines food systems as "*everything from farm to table.*"[2]

A sustainable food system (SFS) is a food system that delivers food security and nutrition for all in such a way that the economic, social, and environmental bases to generate food security and nutrition for future generations are not compromised.[3]

Figure 1: "Our Food System" - a Food System Overview[4]

Things to remember:

- There is no singular definition of the food system and the provided visualizations may break down the stages, levels, or aspects of the food system in differing ways.
- For our purposes, *agriculture* is the growing and harvesting of crops and livestock.
- The food system is often presented as a chain or a sequence of linear processes, but it is important to think of the food system as more of a web. (*Example:* Disposal of food waste occurs at every level of the food system.)

Components of a Food System:

Production: ***growing of crops and raising of livestock***

The production stage of the food systems encompasses all elements related to growing crops, raising farmed animals such as cattle or farmed fish, or fishing.[5] These processes include livestock breeding, soil management, crop management, and harvesting.[6] Within this document, production is referred to as *agriculture*.

Aggregation: ***gathering food from multiple sources***

Food aggregation refers to the bringing together of food products from multiple sources to create a larger and more consistent supply to meet consumer demand. This process requires the coordination of product sourcing from different producers to establish reliable supply chains. Depending on the type of food, aggregation is either the final step before distribution or aggregated goods are sent on to processors.[7]

Processing: ***transforming raw plant and animal materials***

After the harvesting of crops and the slaughter of animals, the food commodities are sold to processors to transform them into finished products. Processors turn raw goods into products we are more familiar with by cutting and canning fruit, washing and bagging vegetables, freezing products, juicing fruits, grinding nuts, etc.[7] The steps of processing a single good are often automated through specialized machinery or employees that perform singular repetitive tasks to increase efficiency. There may be multiple steps in the processing of a good, as one product may be combined with other goods to create the products we then buy at the grocery store – like baked goods, pre-cooked meats, or other ready-to-eat meals.[5]

Distribution: ***transporting the food***

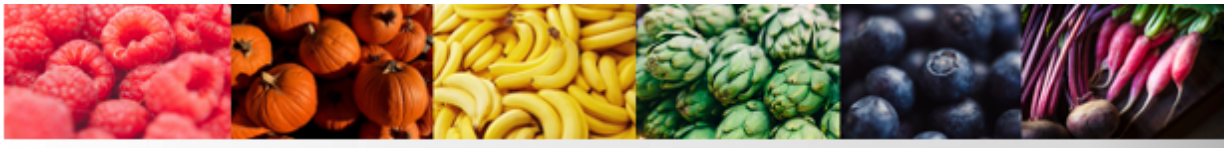
The distribution of food completes the connection to consumers by moving products from aggregation, processing, or storage facilities to their place of sale like grocery stores, farmers markets, restaurants, or wholesalers serving institutional markets (e.g. schools, hospitals, corporate cafeterias). Distribution requires specialized equipment like refrigerated trucks to facilitate the safe transport of goods. Depending on where food was aggregated or processed the distribution of goods occurs by truck, boat, train, or plane.[5]

Consumption: ***preparing, cooking, and eating***

Consumption is a stage everyone partakes in. When it is time to purchase the food produced, it is the consumer who decides what items to buy and consume. Depending on the region, season, preferences, culture, budget, accessibility, or family traditions, individuals will consume different food products. Consumption also includes the preparation and cooking of food items and making sure the items are safe to eat.[8]

Disposal: ***discarding the waste***

Disposal refers to getting rid of food either pre or post-consumer. Disposal of food normally occurs because of spoilage or damage and exists in every aspect of the food system. Disposal requires having systems in place to transport unused goods to landfills or composting facilities for unused food to decompose. The disposed of food was grown using water, land, fertilizers, and transported varying distances using energy among other inputs.[9]



The Relationships Between Food and Climate Change

Key Ideas

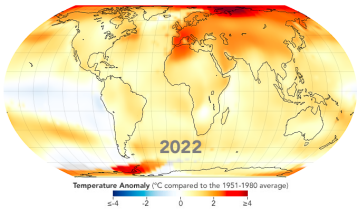
- Food both affects and is affected by climate change.
- **The food system's impact:** The food system accounts for about 26% of greenhouse gas emissions. The majority of food-related emissions come from livestock, soil turnover, food transportation, energy for refrigeration, and food waste.
- **Weather and water:** Changes in weather patterns can greatly affect how food is grown and how much is yielded. Both heavy precipitation and lack of it can change how well food grows and how much water is available to grow it.
- **Methods for growing**: New practices like agroecology can help rebuild healthy soil and lower emissions. Overuse of chemical fertilizers not only hurt the soil but also pollutes our waterways and contributes to greenhouse gasses.
- **We are not stuck:** While this can be overwhelming, there are actions we can take and people/organizations whose examples we can follow!

> Check out this video created by the Center for Ecoliteracy to get you thinking about food and climate change.[10]

A few notes before getting started:

- Review the Overview and Definitions document to ground yourself in the different components of the food system.
- The majority of the information provided here is a U.S. (and particularly the Great Lakes region) context with some global facts.
- Greenhouse Gases (GHGs) are associated with the food system, particularly carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). These gasses differ mainly in how much energy they absorb and how long they last in the atmosphere.[11]

Global temperatures are rising, but what does food have to do with it?



The earth's temperature is rising at the fastest rate it ever has, but the warming is not constant. When it occurs over land, it can pose a real problem to food growers. Check out this page to see how the temperatures have changed.

Figure 1: Global temperature anomalies in 2022.[12]

Overall, food production, from growth to disposal, is driving biodiversity loss and air, freshwater, and seawater pollution.[13] It is also one of the major greenhouse gas emitters globally.[14] As of 2019, the food system accounted for 26% of GHG emissions.[15] In 2020, the agricultural sector accounted for about 11% of GHG emissions - a 6% increase from 1990.[16]

In temperate countries like the United States, fruit and vegetable yields are decreasing due to changes in weather and land management.[14,a] In Michigan, because the winters are getting shorter and warmer, plants start to grow and trees start to bud earlier in the year. Additionally , there has been an increase in the frequency of spring freezes leading to a higher loss of crops.[17]

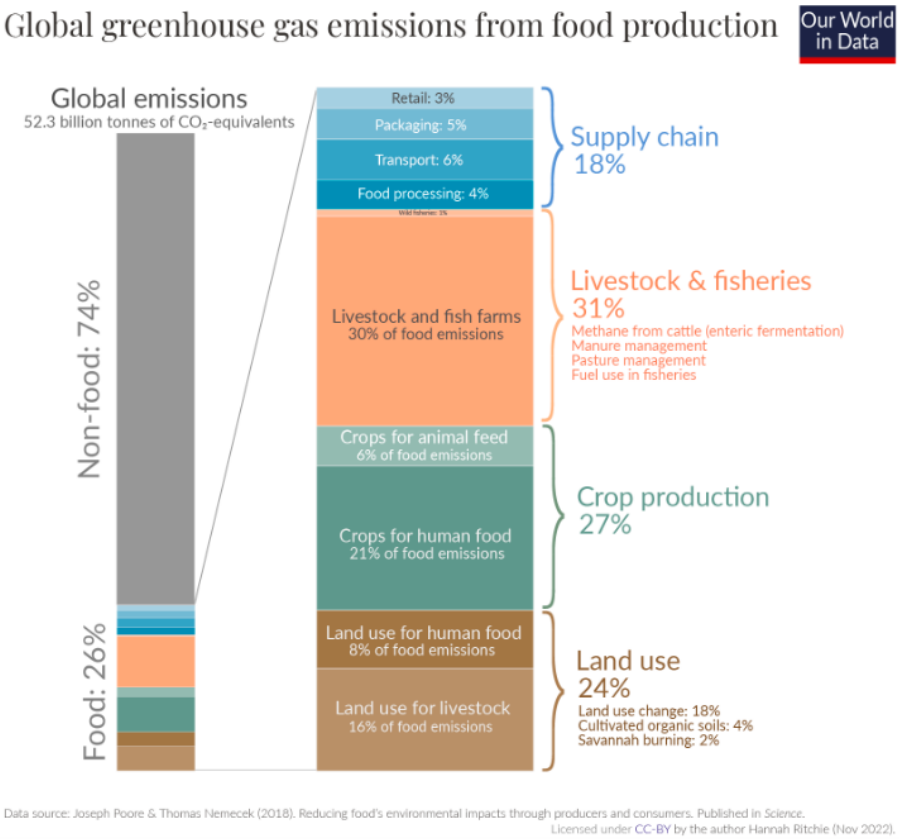


Figure 2 : The various ways the food system produces greenhouse gas emissions.[15]
**Note that waste is not included in this graphic.*

DISCUSSION QUESTION

The major crops in the Great Lakes regions are: corn, soybeans, and wheat (southern and western); and fruit, nuts, and specialty crops (northern and eastern parts).[17] In Michigan, corn and soybeans are grown on 75% of land used for agriculture.[18] Which of your favorite foods could be affected if these crops are jeopardized?

EXAMPLE

Sugarbushing is an important practice to many Indigenous peoples, including the Anishinaabe people in the Great Lakes region.[19] However, the flow of sap is dependent on temperature to the point of reducing the amount of sap produced by maple trees to be boiled down into maple syrup.[20]

What can farmers do?

- Changing pollination periods, planting dates, and crop selection help fight vulnerability to weather changes or new pests and diseases.[17]

How agriculture is using - and sometimes hurting - the land

About 50% of habitable land globally is devoted to crop and livestock production. Habitat destruction - particularly deforestation - is a common byproduct of food production.[13,21] The

removal of these habitats can take away from other types of food gathering like foraging or hunting.

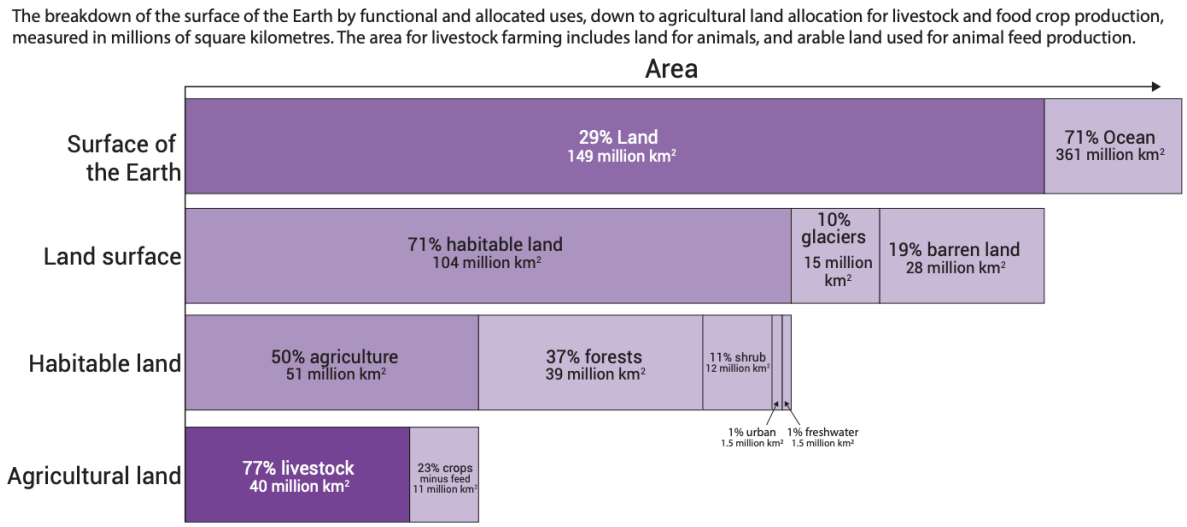


Figure 3: Global area allocation for food production[13]

Globally, raising livestock occupies 80% of the land used for agriculture. Out of the remaining land used for crops, one-third is used to produce crops for feed.[13] The EPA has stated that the increase of GHGs related to livestock is due to the waste conditions in factory farms.[22]

What can farmers do?

- Rotate livestock between pastures to avoid overgrazing and use less industrialized livestock production.[23]

Why is healthy soil important? How can it affect climate change?

Soil can store carbon, thereby reducing the amounts of CO_2 in the atmosphere and mitigating the effects of climate change. However, many factors contribute to how much carbon can be stored.[24] It has been estimated by the Intergovernmental Panel on Climate Change (IPCC) that soils used for agriculture have lost 50-70% of their organic carbon.[25]

The loss of carbon storage is often attributed to the disruption of the ecosystems in the soil. For instance, plowing and tilling (turning over the soil) expose soil microorganisms to more oxygen which then respire CO_2 adding to the amount in the atmosphere.[24]

What can farmers do?

- Lessen the use of chemical fertilizers[26]
- Decrease the amount of tilling needed by leaving crop residue in the field.[27]

Action Item

Unhealthy soil can be rejuvenated by composting! Learn more about how and what you can compost.[26]

Do fertilizers contribute to climate change?

About 50% of global food production uses nitrogen-based fertilizers.[28] While the process to make them revolutionized food production, the making of ammonia requires high temperatures and pressures which is extremely energy intensive. It is estimated that the industrial synthesis of ammonia (NH_3) for these fertilizers accounts for 1-2% of global CO_2 emissions.[29,b]

Crops only take up about half of the nitrogen given by these fertilizers. The remainder either gets washed out into waterways, or microbes in the soil break them down into nitrous oxide, another greenhouse gas.[30]

What can farmers do?

- Agroecology[c] uses technologies and natural systems to give higher yields, control pests and weeds, and increase soil health.[31]
- Some agroecology techniques:[31]
    - Instead of fertilizer, use nitrogen-fixing crops, animal waste, or crop residues
    - Use intercropping where multiple crops are grown together
        - Example: The Three Sisters (corn, beans, and squash)
    - Agroforestry where trees and shrubs are near the crops
    - Have animals (like ducks) eat the arthropods (insects and arachnids) and other pests
    - Use cover crops[32]
        - Cover crops are often grown directly after a harvest
        - They provide protection from erosion, retain soil moisture, serve as food and habitat to many (micro)organisms, enrich the soil with carbon and nitrogen
        - Common cover crops are nitrogen-fixing legumes and clovers

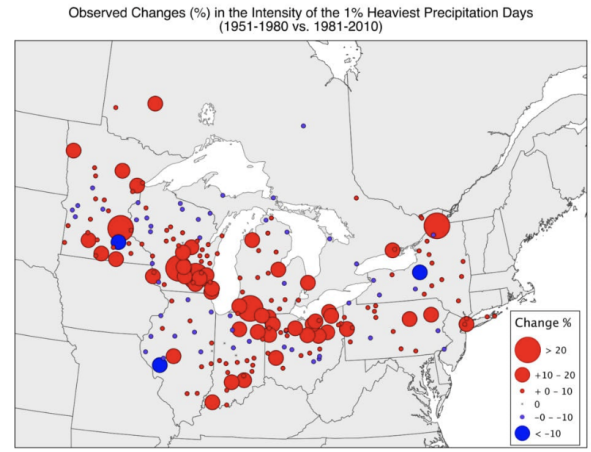
Water is a key component of the food system. How is climate change affecting water?

Water in the form of precipitation

Climate change is causing more intense precipitation.[d] In the western Great Lakes region, about 50% of rainfall occurs over 10 days per year, and the amount of precipitation has also increased by 20-30%.[33] In fact, the Great Lakes region is modeled to have more total precipitation than other places in North America.[34]

Increased precipitation can lead to other factors like the decrease of workable field days during planting and harvesting, increased erosion, and more fertilizer runoff leading to water pollution. Wet and humid conditions may also lead to more fungus and bacterial plant diseases.[26] Overall, too little water (drought) and too much water from precipitation (flooding) kill crops. Learn more about how fertilizers can pollute our waterways and affect other ecosystems.[e]

Figure 4: The observed changes in precipitation intensity in the Great Lakes Region[34]



Change in intensity of the heaviest 1% of daily precipitation events for GLISA quality-controlled GHCN-Daily stations in the Great Lakes region.

Tying Things Together

Soil is less likely to hold water because it gets degraded by chemical fertilizers, pesticides, and herbicides. By holding less water, crops become more vulnerable to droughts. Another factor affecting soil's water capacity is the use of heavy machinery leading to soil compaction.[24,27] All of these factors could lead to less food being grown.

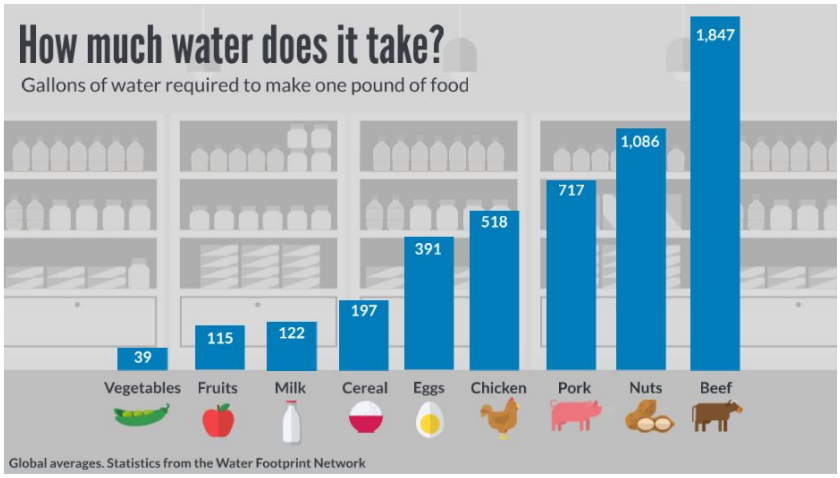
EXAMPLE

Look at how precipitation and freezes are affecting tart cherry farmers in Michigan: Souring Climate[35]

Water used for growing crops and raising livestock

The agricultural sector accounts for about 70% of freshwater withdrawals. Overexploitation of groundwater is leading to the depletion of groundwater aquifers.[13] With more drought and fewer groundwater reserves, some areas may have to stop growing certain foods.

Figure 5: Graphic showing the gallons of water necessary to make one pound of certain foods.[36]



What can farmers do?

- Using crop residue instead of fertilizers will help decrease the amount of water evaporated from the soil and improves water infiltration to decrease runoff.[27]
- Use more efficient irrigation systems.[17]

Action Item

Learn more about how much water is used to grow food here! What actions can you take to decrease the amount of water you "eat"? What about a meatless day of the week or using oat milk instead of almond milk?

What happens to food after it is harvested?

In order for food to be processed and consumed, it usually needs to be transported. Globally, about 20% of cropland is used to grow foods that will be consumed in other countries.[13] Depending on how it was transported - international waters, inland waters, train, truck, or air - makes a large difference in the number of emissions, not solely how far the food had to travel.[37]

For household food, transportation accounts for about 11% of GHG emissions, but 83% is due to production including packaging, refrigerating, and preparing food.[34,38] Another component of emissions comes from the fact that 40% of the energy required during distribution is for refrigeration. Not only is refrigeration needed during processing, but also during transport and possibly in the stores that sell them and the homes that use them.[39]

DISCUSSION QUESTION

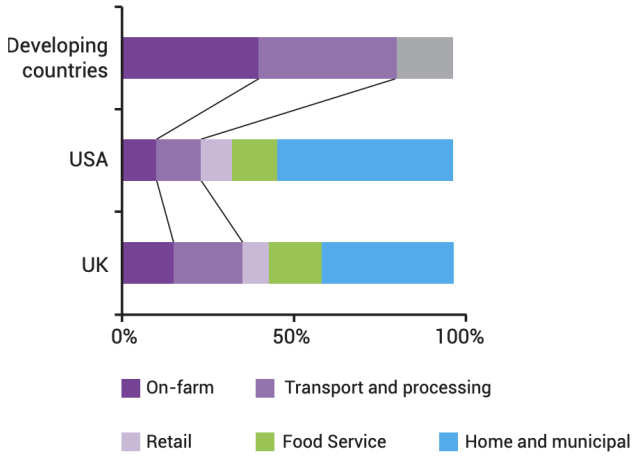
Think of some of your favorite foods that can't be grown in Michigan. How far did they have to travel to get to you?

EXAMPLE

Have you ever noticed that eggs from a farm are not refrigerated but eggs from a store are? In the U.S., eggs are washed before getting to a store, which removes a natural coating. Without the coating, the eggs are more susceptible to Salmonella. Refrigerating them after washing helps protect them and us! If they are not washed, it is fine to keep them at room temperature.[40]

What happens to all the food that doesn't get eaten by humans or animals?

Figure 6: Makeup of total food waste in developed and developing countries.[13]



Note: Retail, food service and home and municipal categories are presented together for developing countries.

Source: Godfray *et al.* (2010).

The total waste from all stages of the food system contributes about 8-10% of the global GHGs.[f] This figure comes from the fact that 97% of food waste sits in landfills

and generates the GHG methane (CH_4) from anaerobic respiration.[14,41]

According to the United Nations, the food waste generated in the home is over 160 lbs per year.[42] About 30-40% of the food grown and processed does not even get eaten.[43]

Action Item

What can you do with your food waste? Turn it into compost or use it to feed livestock.[14,26] How can you decrease the amount of food you waste? By better understanding food labels like "use by," "best before," and "sell by," and by eating food considered "ugly" - misshapen or blemished.[26]

How will the effects of climate change on food impact people?

Unfortunately, the effects of climate change will have a great impact on people in natural resource sectors like agriculture and on those already at an economic disadvantage.[13] However, agroecology does more than help restore soil! The Center for Ecoliteracy states that "agroecological practices are labor-intensive and community-oriented, thereby reducing poverty and social exclusion. In these ways, agroecology can raise agricultural productivity in ways that are economically viable, environmentally benign, and socially uplifting."[31]

Tying Things Together

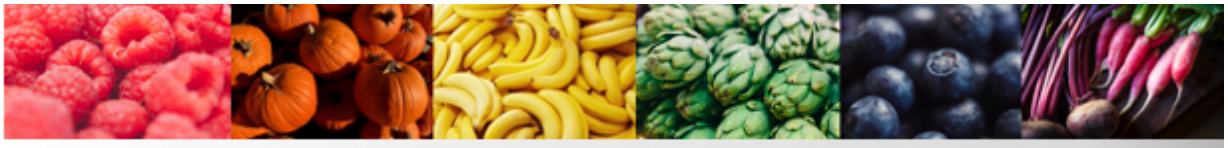
Climate change will affect food security in three main ways: *availability* as yields decrease, *stability* due to extreme weather changes, and *access* as food shortages may lead to higher food prices.[44]

EXAMPLE

Fish are quite sensitive to temperature changes. Different species thrive in different temperature ranges. With rising water temperatures in the Great Lakes, fish are moving around to find cooler water. This movement could jeopardize peoples' livelihoods who rely on fishing.[45]

Who can we look to for inspiration?

- Center for Regional Food Systems (Michigan State University)
- Sustainable Food Systems Initiative (University of Michigan)
- D-Town Farms (Detroit, Michigan)
- Georgia Street Community Collective (Detroit, Michigan)
- La Via Campesina (International)
- Department of Environment, Great Lakes, and Energy (EGLE) (Michigan)
- Detroit Chefs (Detroit, Michigan)
- CGIAR (Consultative Group on International Agricultural Research) research on Climate Change, Agriculture and Food Security (International)
- Food and Agriculture Organization of the United Nations (International)
- Food and Water Watch (Washington D.C.)
- National Sustainable Agriculture Coalition (Washington D.C.)
- Rodale Institute (Kutztown, Pennsylvania)



Local Food Systems

Key Ideas

- **Social Benefits:** Supporting small-scale farms can create a sense of community, deepen connections to place and the surrounding natural landscape, preserve the agricultural heritage and culture of the region, and improve one's ability to make informed decisions about their food choices.[47]
- **Economic Benefits:** Local food keeps local land in production and continues to circulate money in the community. Small-scale farms mean they can sell directly to consumers, offering great autonomy and independence for farmers.[48]
- **Environmental Benefits:** Locally sourced food travels a shorter distance which can reduce transportation-related greenhouse gas emissions (GHGs).[48] Locally sourced food is often produced on a smaller scale. Small-scale agriculture may require fewer pesticides, herbicides, antibiotics, and fertilizers which all have a host of negative environmental impacts.[49] Lastly, smaller-scale agriculture allows greater creativity in crop rotation or other types of regenerative agriculture which benefits soil quality and carbon sequestration.[50]

Challenge Action/Get Involved

You can participate in the local food system by first familiarizing yourself with your environmental landscape and exploring what types of crops your local environment can support. Additionally, try to consume locally sourced foods when accessible. Read the labels on your food, you may surprise yourself by learning what foods you already eat are local goods!

A few notes before getting started:

- Review the Overview and Definitions document to ground yourself in the different components of the food system.
- The majority of the information provided here is a U.S. (and particularly the Great Lakes region) context with some global facts.

Check out this short video exploring some of the benefits of local food. Can you think of any other benefits of local food?[51]

What is a local food system?

There is no unified definition of what a “local” food system is, but the general radius is between 100 and 400 miles from the origin of the product.[48] The United States 2008 Food, Conservation, and Energy Act defines local food as “a locally or regionally produced agricultural food product” that travels less than 400 miles from its origin.[52]

Local food is sold at farmers markets, roadside stands, and U-pick operations, through community-supported agriculture (CSAs), Farm to School programs, and food hubs that distribute food to restaurants, hotels, or other businesses.[48]

Challenge Action/Get Involved

You can participate in the local food system by hunting, foraging, or growing your own food! Here is a beginner's guide to getting started.[53] If you do not have the space for a full garden you could begin with a small pot or container or look for available space elsewhere – is there a community garden you could join? Does your school have a garden space?

What is the scope of the local food system?

Local food systems include everything from personal and commercial food production to processing; marketing; distribution, retailing, and consumption of food products; and handling of food waste.[54] Personal production of food is the most basic connection to our food because individuals produce or forage it, cook or preserve it, and then eat it. Home gardeners can grow their own food based on their needs and wants. Home gardeners can increase their knowledge of seasonality and the complexity of food production – information they can then share with others. School gardens can act as an entry point into personal production.

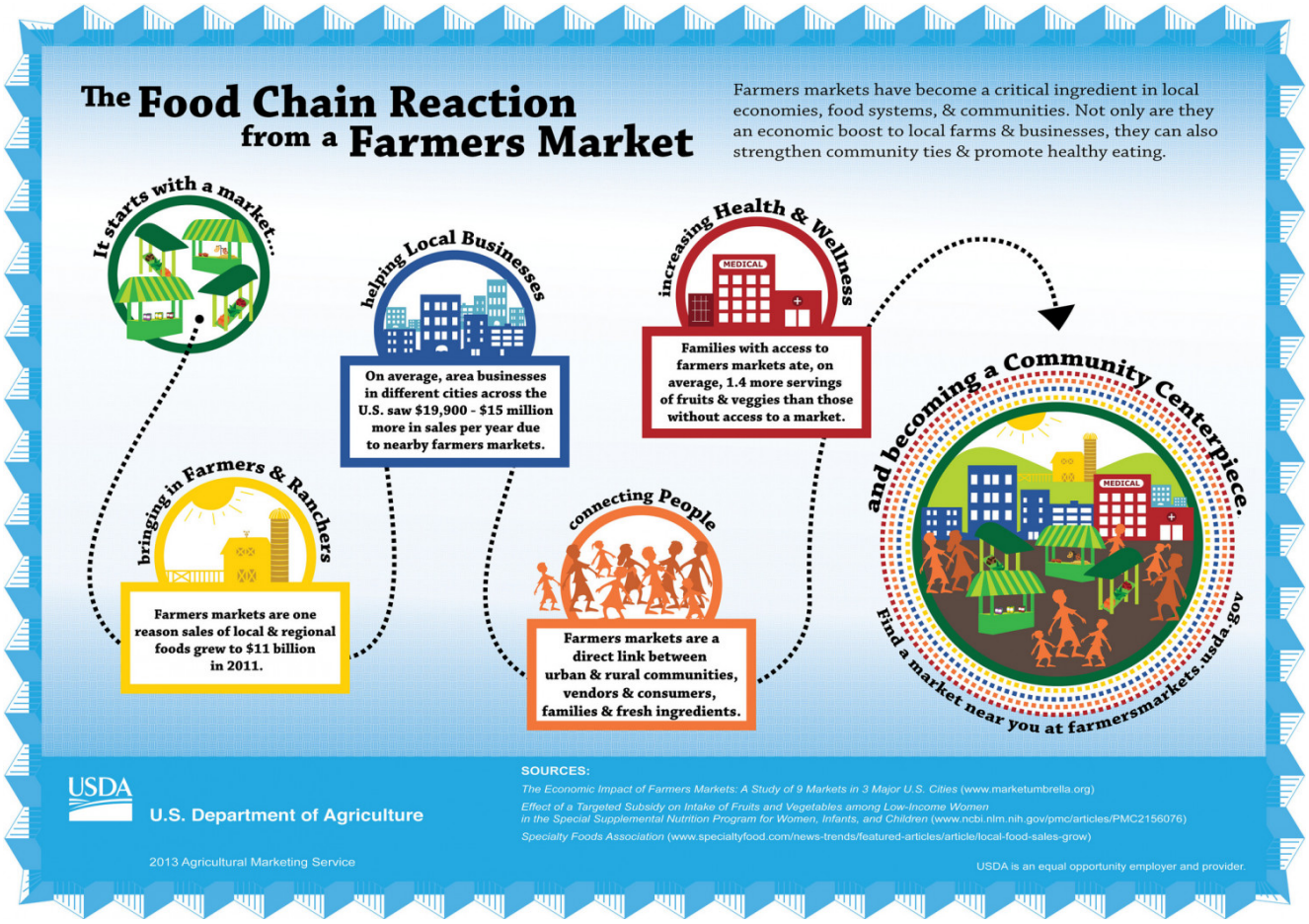


Figure 1: The Food Chain Reaction from a Farmers Market[55]

Food producers at a larger scale than a home garden can sell their locally grown and produced foods at farmers markets, roadside stands, U-pick operations, and through community-supported agriculture (CSA) farms.[48] Farmers markets can play a critical role in local economies as is captured in Figure 1.[55] The US Department of Agriculture (USDA) has a database of farmers' markets where you can search for one near you.[56] And Michigan has a state-specific link for finding a farmers market near you.[57] Farmers markets allow farmers to sell a small volume of produce at a price they set themselves – a level of autonomy not always granted in larger operations.

DISCUSSION QUESTION

Is there a farmers market in your area? Have you ever spoken directly to the person who grew your food?

EXAMPLE

Community Supported Agriculture (CSA) allows consumers to purchase shares from local farms before harvest season for products during the season (like a subscription box)!

Follow this link to find a local CSA![58]

Farmers can also partner with grocery stores, local restaurants, hospitals, and school food services to bring local food to individuals in many different situations. Selling to institutions requires a scaling up of farmers' production for their products to be distributed at larger volumes. Even at a larger scale of production, local foods can be utilized with a focus on farm identity, traceability, and clear values communicated to consumers through labeling and point-of-sale merchandising.[54]

Why is eating locally sourced food beneficial?

There are social, economic, and environmental benefits to eating locally sourced foods.

Social Benefits

Supporting small-scale farms fosters a sense of community and place.[48] Since everyone has to eat, food can act as a universal connector. Food is also a means of retaining cultural identity. Food reflects one's personal beliefs, values, and customs. We engage with food through multiple senses, allowing us to remember some of our most meaningful memories. Food is much more than nutrition or calories; it can act as a way to celebrate, show emotion, and connect to our personal and familial narratives.[59]

Figure 2: The Local Crops of Michigan and Where in the State They are Grown[62]

Buying food locally can build relationships with local food producers, help strengthen community resiliency, increase social interactions, and encourage behaviors like consuming more fruit and vegetables.[60] For example, only 10% of US adults reach their daily recommended fruit and vegetable servings. [61] Increasing the number of local farms and access to locally grown food can allow individuals to make more informed food decisions.

DISCUSSION QUESTION

Do you have a memory associated with a certain type of food or dish? Does your family have a traditional meal or food that they eat for a special occasion?

EXAMPLE

Anishinaabe communities, an Indigenous tribe of Michigan, have an ecological, social, and cultural connection to Michigan's wild rice, Zizania palustris and Zizania aquatica. They know the plant as manoomin or mnomin. Wild rice is under threat in Michigan for a variety of reasons including climate change, habitat loss, uninformed harvesting practices, and degraded water quality. Follow this link to learn more about Michigan's Wild Rice Initiative.[63]

Economic Impacts

Supporting local food systems by buying locally sourced food is beneficial economically for farmers, their families, and the local economy. Michigan's farmers are the second largest influencers of Michigan's economy. Agriculture is Michigan's second-largest industry employing nearly 1 million people which is almost a quarter of the state's workforce and contributes more than $100 billion to the state's economy. Locally sourced food keeps local land in production and increases local employment, supporting the circulation of funds within the community. Michigan's farms are 95% family-owned, either as single-family businesses or family partnerships.[64]

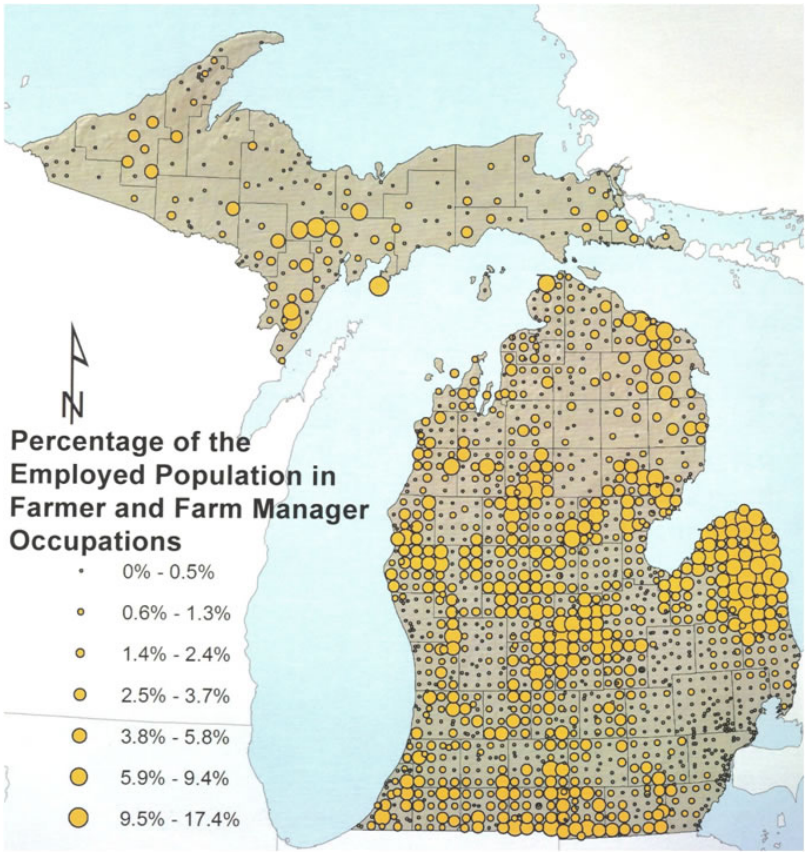


Figure 3: The Percentage of the Employed Population in Farmer and Farmer Manager Occupations[62]

Similarly to farmers across the country, financial insecurity is an issue in Michigan, and 37% of farmers rely on off-farm income to support their businesses.[65] By supporting locally sourced food, there are fewer people involved in distribution between the farmers and consumers. Fewer middlemen mean farmers are able to sell directly to consumers giving them more agency and better control of their profits.[48]

Environmental Wins

Globally, food systems are responsible for over a quarter of our total greenhouse gas emissions.[47] Agricultural production provides the goods that flow through our food systems. Agriculture is the act of cultivating the soil, growing crops, and raising livestock – the physical aspects of producing food. Buying locally produced food can reduce the average consumer's greenhouse gas emissions by 4-5%. Transportation is a contributor to emissions, especially by air and truck as compared to rail or water which are more energy efficient.[48] During transport, food is refrigerated to preserve its longevity. Food traveling a longer distance requires longer refrigeration, resulting in more greenhouse gas emissions. Buying locally produced food is one way of shortening the transportation of goods from producer to consumer. Eating foods that are

in season and eating organic or less processed foods can further reduce one's greenhouse gas emissions.[47]

Scaling up agricultural production often means using more harmful practices to maximize production. Larger-scale agriculture relies on monocultures, overuse of pesticides, herbicides, antibiotics, and fertilizers, a lack of crop rotation, and a host of other degrading practices. These farming practices can lead to long-term ecological impacts like eutrophication, soil degradation and erosion, and pesticide, herbicide, and antibiotic-resistant organisms.[66] Buying food locally, organic, or on a smaller scale can act as ways of mitigating these harmful practices. Knowing how and where your food is produced is an integral part of being an informed consumer.

Additional benefits include enjoying seasonally relevant foods at the peak of their season. Locally grown foods can be found in supermarkets, but some of the best varieties can be seen at a local farm or farmer's market. This PDF details Michigan's produce availability in the calendar year so you can explore when certain foods are in season.[67] Consumers benefit from knowing and learning exactly where their food comes from and how it is grown. And while a locally grown crop is not explicitly more nutritious than one that may have been imported, the assistance of community advocates and supporters helps individuals make informed decisions for quality food.[68]

DISCUSSION QUESTION

Michigan is the second most agriculturally diverse state in the nation producing over 300 crops annually including apples, tart cherries, blueberries, asparagus, and cucumbers. Farmers markets are a great way to build community connections and access some of Michigan's local seasonal produce. Do you know what season your favorite locally sourced food is grown in?

EXAMPLE

Did you know that Michigan produces the most asparagus of any state in the US? Michigan is home to the Asparagus Capital of the World in Oceana County along Lake Michigan. Asparagus harvest traditionally begins in mid-April making the month of May Michigan's Asparagus Month. Follow this link to learn more about the history and relevance of Michigan's asparagus![69]

What are the limitations of local food production?

Local food is one method of benefiting the social, economic, and environmental landscape of a region but it has its limitations. Buying local food can be time-consuming and expensive. It takes effort to learn where and when local food is available. Selections of goods may be limited at certain markets, and it may be inconvenient to make multiple trips to different locations weekly. And while buying local food has environmental benefits like reducing food miles, transportation accounts for less than 10% of carbon emissions associated with food production.[47] Local does not necessarily mean better. Participating in your own local food system is one leverage point as we continue to work to enhance communities' capacity for resilience.

Tying Things Together

Our global food system is fragile and complex – climate change among other unforeseen events may disrupt our system across the supply chain. Local food systems are one method for strengthening our communities resiliency through social, economic, and environmental support. Integrating food systems into local places will continue to require community efforts, infrastructure, economic incentives, and education.

EXAMPLE

Beginning with education is the key for food systems longevity. One method for engaging with food systems is through Place-Based Education (PBE). Follow this link to explore some PBE resources to spark curiosity and interest in the complexity of our food system.[70]

How is justice related to local food systems?

Michigan's Commitment to Food Access

The localization of food systems is valuable for increasing equity in the food systems and ensuring all people have access to safe, nutritious, and affordable food. Like many governments around the world, Michigan officials are seeking solutions to combat climate change in addition to minimizing the negative effects on the people. In April 2022, the Michigan Healthy Climate Plan was released by the Michigan Department of Environment, Great Lakes, and Energy. This plan outlined Michigan's methods for combating climate change including its impact on food. By 2030, Michigan hopes to reduce food waste by 50% and start a "Buy Michigan Agriculture Campaign" to combat food insecurity and help encourage the purchase of Michigan products to promote healthy food systems.[71]

In 2009, a Michigan non-profit, the Fair Food Network, developed the Double Up Food Buck program dollar to dollar match donation for the purchase of fruits and vegetables for residents using Supplemental Nutrition Assistance Program (SNAP) benefits. The program began with matching up to $20 per day in fruit and vegetables purchases in local farmers markets in Detroit. Currently, the program matches up to $10 per day in over 250 local grocery stores across the state of Michigan. Persons with a Bridge Card (MIchigan's SNAP benefit) can enroll into the Double Up Food Buck program at a participating grocery store. This program is currently not available at large grocery stores like Kroger and Meijer, but it is available at local grocery stores and farmers markets in effect to support MIchigan agriculture. Since its founding, over 18 million pounds of healthy foods have been purchased.[72]

Safe Working Conditions

A safe environment is a human right. Regardless of race, gender, or socioeconomic status, all people should feel safe whether they are at home or work. In the United States, employers are required to follow work safety guidelines as outlined by the Occupational Safety and Health Administration (OSHA) to create and maintain a safe work environment. All farm employers are legally obligated to adhere to the safety guidelines as outlined by the OSHA. However, farms with fewer than 10 employees cannot be cited or inspected by OSHA for safety violations.[73] Because there is no measure to hold small farm employers accountable for their employees safety, issues surrounding proper breaks and access to drinking water throughout the workday

may be more prevalent. With environmental conditions related to climate change, agricultural workers are more prone to having heat-related illnesses including heat stroke, exhaustion, dehydration, and in severe cases death.[74] Some agricultural workers are paid based on the number of crops per piece they gather rather than an hourly wage.This can cause workers to ignore signs and symptoms of heat induced illnesses by continuing to work for an increased daily pay.[74] Workers advocating for themselves can further be impacted by the individual's educational level (as of 2017 less than 20% of agricultural workers have a college degree), and language barriers as nearly 70% of agricultural workers are foreign-born and may speak little to no English.[75] Furthermore, migrant workers contribute billions of dollars to the agriculture industry. Migrant workers are prone to work-related injury and are more likely to leave incidents unreported in fear of income losses or deportation.

The nature of the work required in agricultural work wears on the human body. The work often involves prolonged hours in awkward positions, heavy lifting, bending, poor posture, and a lot of hand movements. Over time these constant strains cause deterioration in the body leading to neck, back, leg, and hand pain which have caused loss of work, due to limited mobility from chronic pain.[76] Agricultural workers are at a great risk for personal injuries from doing the daily tasks of their job. Common injuries include eye damage, crushing of body parts from equipment, and falling from equipment often due to employers providing a lack of training and safety measures for their employees.[76] Other risks include constant exposure to pesticides which can result in skin and eye irritation during dermal contact.[76] Chronic exposure from dermal contact and inhalation of pesticides can lead to cancer or death in severe instances. In addition to physical harm, workers' risks include workplace violence, experiences in discrimination and racism, and low wages.[76] Some of these inequalities have historical roots related to colonialism, imperialism, and neo-liberalism in the United States, but local foods have the potential to help create a socially equitable work environment.[77] In a socially just food system, power and resources are shared equitably with the community's needs being met, and individuals can live with security and dignity. Mistreatment of the employees is in direct opposition to the idea of a socially just food system.[76] To build socially just relationships in the local food systems, there must be an evaluation and understanding of how political versus cultural forces have molded the current food systems.Political figures must be willing to prioritize local food systems and help move the communities towards social justice.

Indigenous Communities

In discussing Indigenous food systems, activist Dawn Morrison states "Indigenous food systems include all land, soil, water, air, plants, and animals, as well as Indigenous Knowledge, wisdom and values."[78] These remarks are well aligned with the cultural beliefs shared amongst many Indigenous groups.

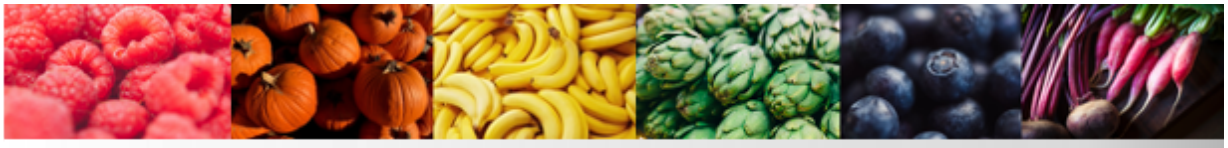
DISCUSSION QUESTION

For the Anishinaabe, factors like climate change and land loss can threaten the retention of their native foods. Have you tried traditional indigenous foods? Are there any food items you could incorporate into the meals you prepare at home?

EXAMPLE

Food is an important element of culture to Indigenous communities, as it helps maintains their connection to the land while honoring the food of their ancestors. Check out this **cookbook** featuring traditional Anishanbee meals.[79]

For thousands of years, the Great Lakes region has been home to numerous Indigenous groups including the Ojibwe and Potawatomi, who maintained their food and cultural identity by hunting, fishing, and gathering on the lands.[80] Food is a universal connector for people and for Indigenous people, who have historically experienced so much loss in the United States. One way to maintain cultural identity is a connection to the land and through the foods they eat. Land relationships are sacred to Indigenous peoples as it holds traditions, spirituality, ancestral history, and food.[81] Due to colonization, Indigenous groups have lost 99% of their lands.[82] With this land dispossession, Indigenous people face challenges in maintaining food sovereignty. Indigenous people and the land are resisting the pressures of polluted soils and waterways, deforestation, and corporate politics all of which have affected the food accessibility and quality for Indigenous people.[83] Food sources are further threatened by environmental challenges related to climate change exacerbating issues surrounding the health of the soil, animals, water, and humans.[84]



Incorporating Food Systems into the Classroom

Based on Content Area

History

- Spice wars
- Chinese Exclusion Act of 1882
- Alien Land Law (1913)
- Fannie Lou Hamer farming
- Food movement during Westward expansion

Math

- Dividing garden areas into quadrants
- Constructing raised beds
- Calculating the amount of soil needed
- Calculating the amount of animal feed needed
- Growth rates
- Square footage and perimeter of the garden
- Incorporating food into word problems
- Calculating recipes and ratios
- Creating graphs/plots
- Carbon footprints

English and Language Arts

- Reading a seed packet
- Writing descriptive essays about what is in the garden
- Writing summaries/journaling of what was done in the garden
- Fundraising/grant writing
- *Grapes of Wrath* (John Steinbeck)
- *Seed People* (Jacquelyn Small)
- *Seedfolks* (Paul Fleischman)

Science - Plants

- Plant parts
- Plant identification
- Indigenous names of plants
- Effects of soil type and soil health on plants
- Native plants
- Differences between fruits, vegetables, and gourds
- Habitats and spots for wildlife
- Plant life cycle
- Nutrient cycling

Science - Nutrition

- How to have a balanced plate
- How to read and understand a food label

Science - Pollinators

- Types of insects/arthropods
- Types of plants pollinators are attracted to
- Beekeeping

Art

- Drawing from observation
- Potato prints
- Photography
- Designing their own tree/flower/plant
- Crafts with pinecones (make birdfeeders)
- Making garden signs
- Painting a fence/picnic table with a plant mural

Laws/Regulations/Policy

- US Food and Drug Administration
- US Department of Agriculture
- Food safety

Business/Economics

- Why does food cost so much?

Based on Topic

Justice/Equity

- Worker wages
- Monoculture vs permaculture
- Deforestation to increase farmland
- Monopolies and subsidized food
- Food security and access (grocery stores vs convenience stores vs fast food)
- Use of pesticides, herbicides, and insecticides
- Labor laws

Food Production

- Tradeoffs: growing season and water availability (like Michigan vs California)
- Think of a hamburger: how do you make all the different parts? (bun, meat, tomato, lettuce, mustard, cheese…)
- Food preservation (like canning)
- Growing food together - the Three Sisters (corn, beans, squash)
- Foraging and hunting
- Sugarbushing for maple syrup
- "Hidden processes": aggregation, processing, distribution

Where Food Comes From

- Amount of water needed to produce food
- Local versus out-of-state or international
- Transportation - how did the food get there?
- What happens to food before it gets to your plate? (the process from farm to store)
- Economic development

Types of Growing

- Land preservation
- Container gardens → backyards → community gardens → urban farms → factor farms → industrial farms
- Monoculture vs Permaculture
- Greenhouse, hoop house, aquaponics, hydroponics, kitchen counter, aeroponics
- Seed saving/seed catalogs (growing crops specifically for the seeds)
- Propagation
- Raising animals (like chickens, cows, pigs)
- Fisheries
- Standard practices (i.e. crop rotations, cover crops, tilling)

Food Waste

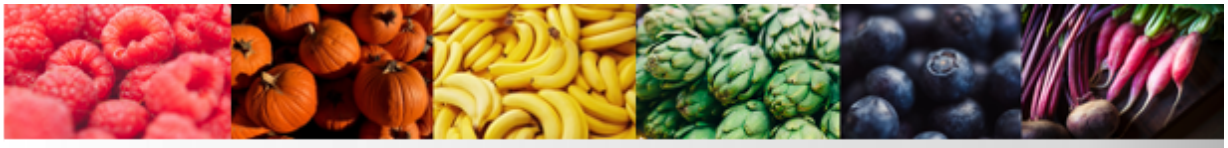
- What do we do with the trash? What can be composted?
- Packaging
- Decreasing waste through composting or using as animal feed

People Involved/Careers

- Who is growing, picking, transporting, selling, and cooking the food?
- Examples of people running food businesses like farms, co-ops, restaurants
- Food scientist
- Chef
- Landscape architect
- Linking food topics to possible careers of interest in your classroom
- How people are paid and what the labor looks like

Making Connections

- Food systems vs climate change
- Food vs nutrition and health
- The interconnectedness of humans with land
- How are food systems interdisciplinary? (Example: aquaponics mixes engineering, biology, ecosystems, and possibly economics)
- How food systems relate to the water cycle
- How food systems relate to the seasons and climate



How-to-Read: Garden Design Guide

There are three parts to the Garden Design Guide. Each section can stand alone or be used in conjunction with another section.

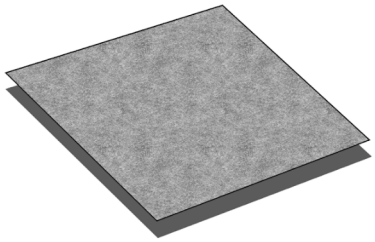
Part One: Design Toolkits

Each design toolkit shares the same components. Each has a cost*, season, complexity, and definition. The scale ranges from small “S”, medium ”M”, and large ”L” to tell the reader how much the suggestion takes up in the area. Seasons range from 1-4 (1=can only be used one season, e.g. winter) indicating how many seasons the suggestion is available in. Complexity ranges from easy “E”, medium “M”, and hard “H” to tell the reader how difficult this suggestion is to implement. A “blurb” briefly describes the idea, explaining why it is useful in certain school gardens. The picture displayed will visually show the toolkit.

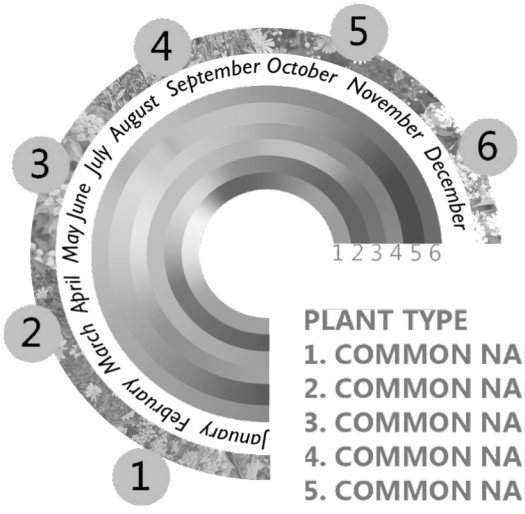
01
TITLE

SCALE:
SEASONS:
COMPLEXITY:

BLURB



*Disclaimer: Prices may vary based on the materials used.



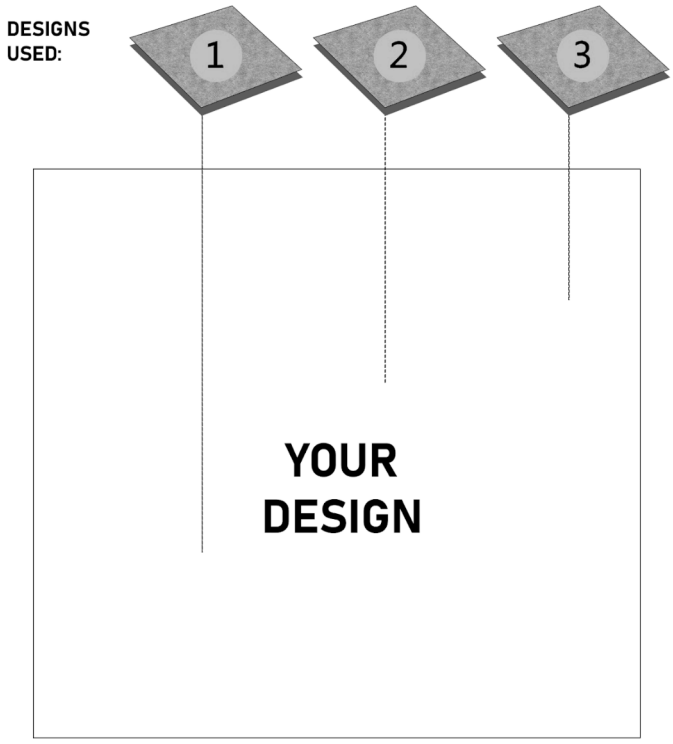
Part Two: Garden Scheduling

When reading the wheels, read from the bottom left to the top right (January to December). The colors indicate the color the plant will be in that month. At the end of each of the plant color cycle is a number ranging from one to six, to tell you which plant coordinates with the number key in the bottom right. The

key displays the plant type, which will range from perennials to trees, as well as shows the common name of the plant and its botanical name. Lastly, the circled numbers will help guide you through what plant image is displayed (not displayed here).

Part Three: Scenario Renderings

In these renderings, it is useful to think of the first part of the Garden Design Guide “Design Toolkits” as pieces to a puzzle. For example, marked in the picture below, you will see three “Designs Used” marked. These are representative of a set of toolkits that are being brought together to make a cohesive design. This puzzle-piece method allows schools to experiment with design options that best fit their environment.



Tool Kits

Outdoor Components

01
BASICS

SCALE: **S**

SEASONS: **3**

COMPLEXITY: **E**

Gardening tools are necessary when starting a school garden.

02
GARDEN BED/PATCH

SCALE: **S M**

SEASONS: **2**

COMPLEXITY: **E M**

Plots and raised beds maintain garden cleanliness and organization. Available for all-abled students.

03
SEATING/SURFACES/ACCESSIBILITY

SCALE: **S**

SEASONS: **4**

COMPLEXITY: **E M**

Benches, picnic tables, and raised beds allow students of all abilities to be involved.

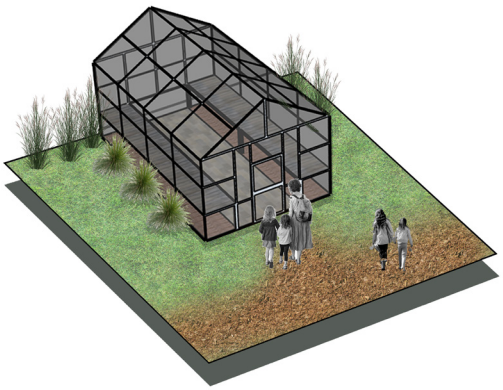
04
STRUCTURES

SCALE: **S M L**

SEASONS: **4**

COMPLEXITY: **E M H**

Structures like hoop houses, greenhouses, and low tunnels can help extend growing seasons.



Link to How-to-Read: Garden Design Guide

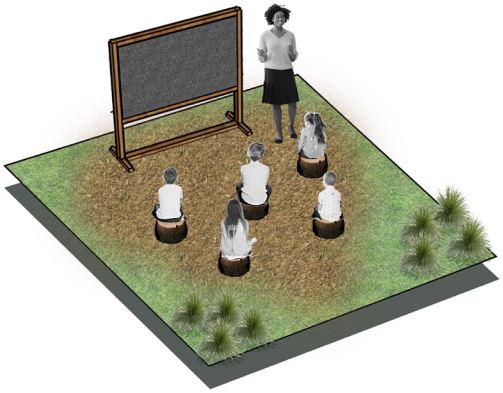
Health Components

01
COGNITIVE LEARNING AREA

SCALE: **S M**

SEASONS: **2**

COMPLEXITY: **E**



A specified area, like an outdoor classroom, can help students with learning activities.

02
PHYSICAL ACTIVITY AREA

SCALE: **S M**

SEASONS: **4**

COMPLEXITY: **E M**

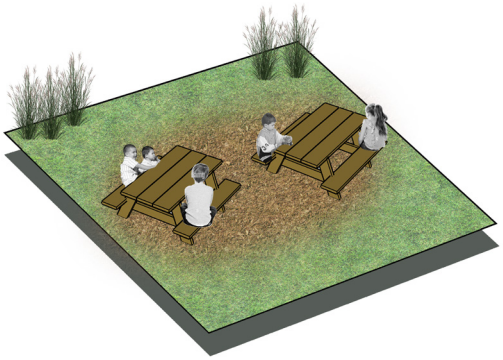
A physical activity area with games can let students practice physical health.

03
SOCIAL ACTIVITY AREA

SCALE: **S M**

SEASONS: **4**

COMPLEXITY: **E**



An area where students can gather in a circle or at a table to talk provides a sense of belonging.

04
WELL-BEING AREA

SCALE: **S**

SEASONS: **3**

COMPLEXITY: **E**

Students find comfort and peace when relaxing in a natural area, like a sensory garden.

Link to How-to-Read: Garden Design Guide

Ecosystem Components

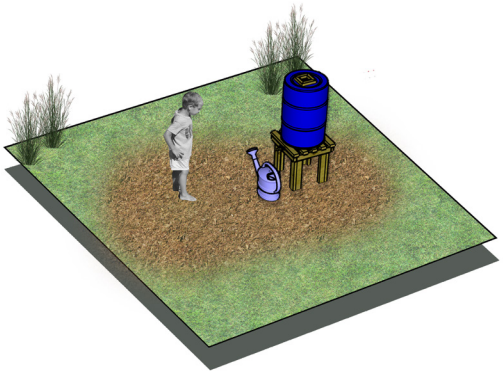
01
WATER

SCALE: **S**

SEASONS: **4**

COMPLEXITY: **E**

Dedicated water sources, like a pump or a rain barrel, are a necessary source of life for plants.



02
SOIL

SCALE: **S**

SEASONS: **3**

COMPLEXITY: **E M**

Areas for composting or soil testing show students the health and types of their soil.

03
HABITAT

SCALE: **S M L**

SEASONS: **3**

COMPLEXITY: **E M H**

A themed garden (e.g. pollinator garden), provides students with knowledge of the ecology in their area.

04
ANIMALS

SCALE: **S M**

SEASONS: **4**

COMPLEXITY: **E M H**

Chickens or bee boxes allow a wider range of education in food production.

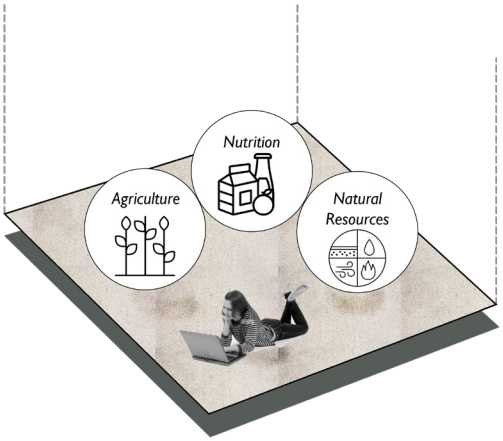
Link to How-to-Read: Garden Design Guide

Indoor Components

01
ONLINE LEARNING

SCALE: S
SEASONS: 4
COMPLEXITY: E

Online learning expands on food system topics that cannot be brought into the classroom.



02
TAKE-HOME LEARNING

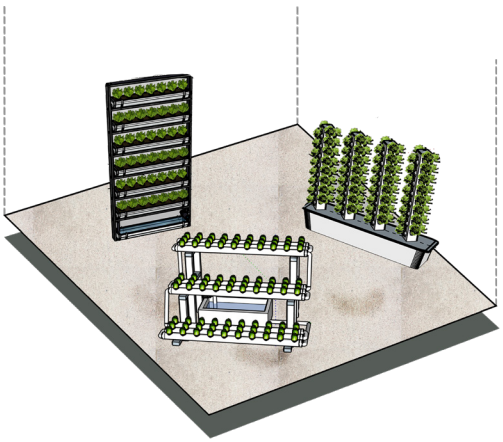
SCALE: S
SEASONS: 4
COMPLEXITY: E

Students can take home plants or food to share with their parents or other members of the community.

03
SYSTEMS

SCALE: S M L
SEASONS: 4
COMPLEXITY: E M

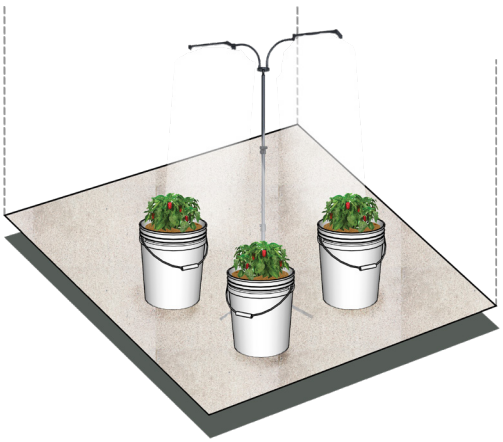
Aeroponic, aquaponic, and hydroponic systems are becoming inreasingly popular in classrooms.



04
TRADITIONAL

SCALE: S M
SEASONS: 4
COMPLEXITY: E M

Teachers can grow plants/herbs indoors by using grow lights and pots throughout the year.



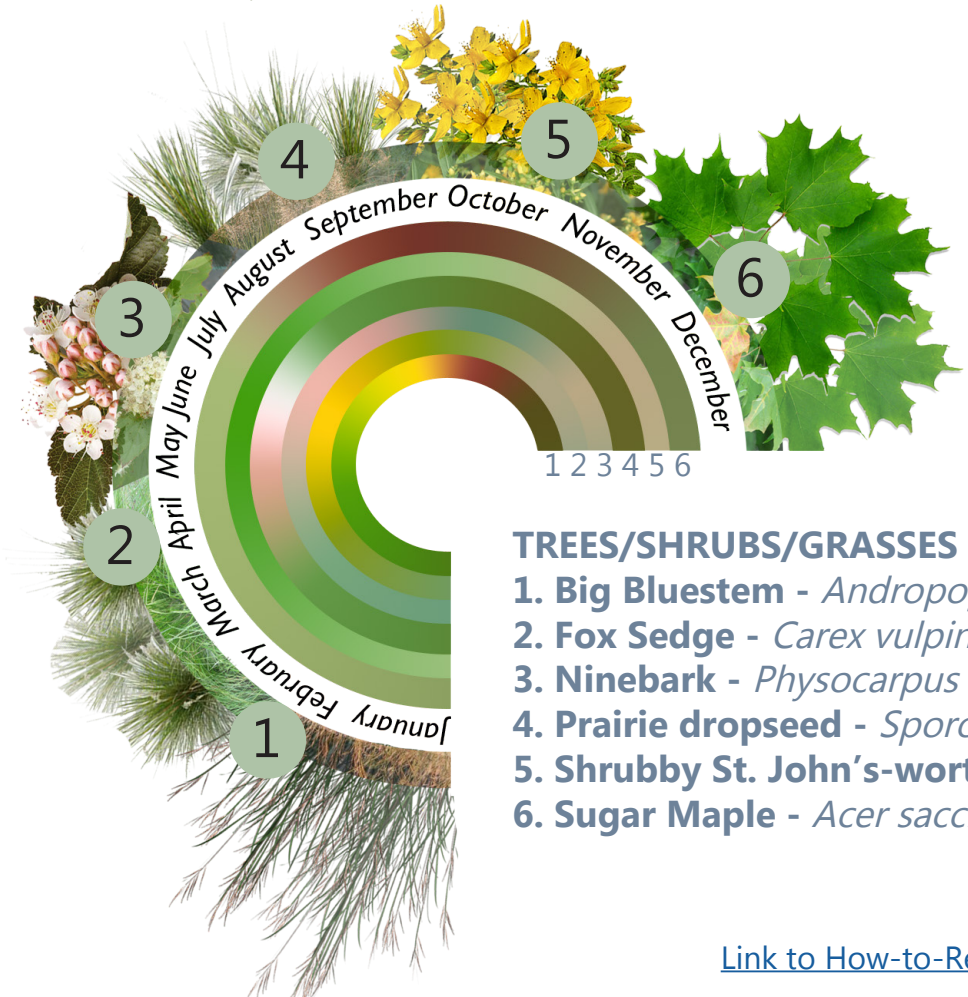
Link to How-to-Read: Garden Design Guide

Garden Scheduling

Full Sun to Partial Sun

PERENNIALS

1. **Butterfly-weed** - *Asclepias tuberosa*
2. **False Sunflower** - *Heliopsis helianthoides*
3. **Golden alexanders** - *Zizia aurea*
4. **Showy Goldenrod** - *Solidago speciosa*
5. **Smooth aster** - *Symphyotrichum laeve*
6. **Swamp Milkweed** - *Asclepias incarnata*

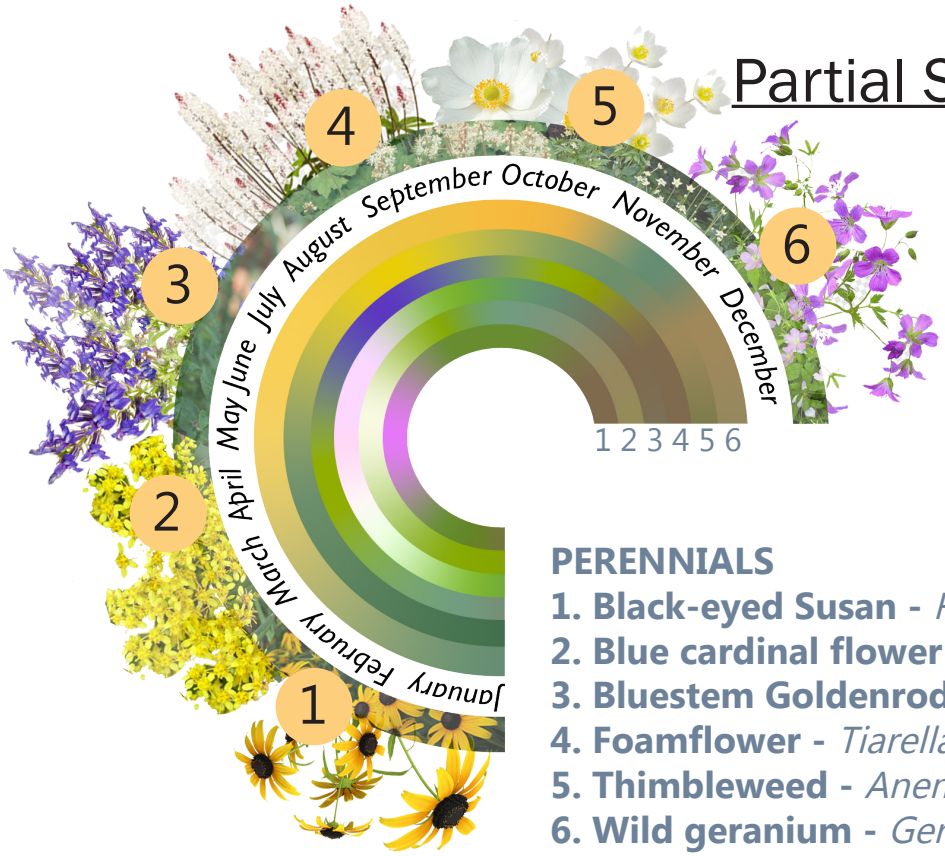


TREES/SHRUBS/GRASSES

1. **Big Bluestem** - *Andropogon gerardii*
2. **Fox Sedge** - *Carex vulpinoidea*
3. **Ninebark** - *Physocarpus opulifolius*
4. **Prairie dropseed** - *Sporobolus heterolepis*
5. **Shrubby St. John's-wort** - *Hypericum prolificum*
6. **Sugar Maple** - *Acer saccharum*

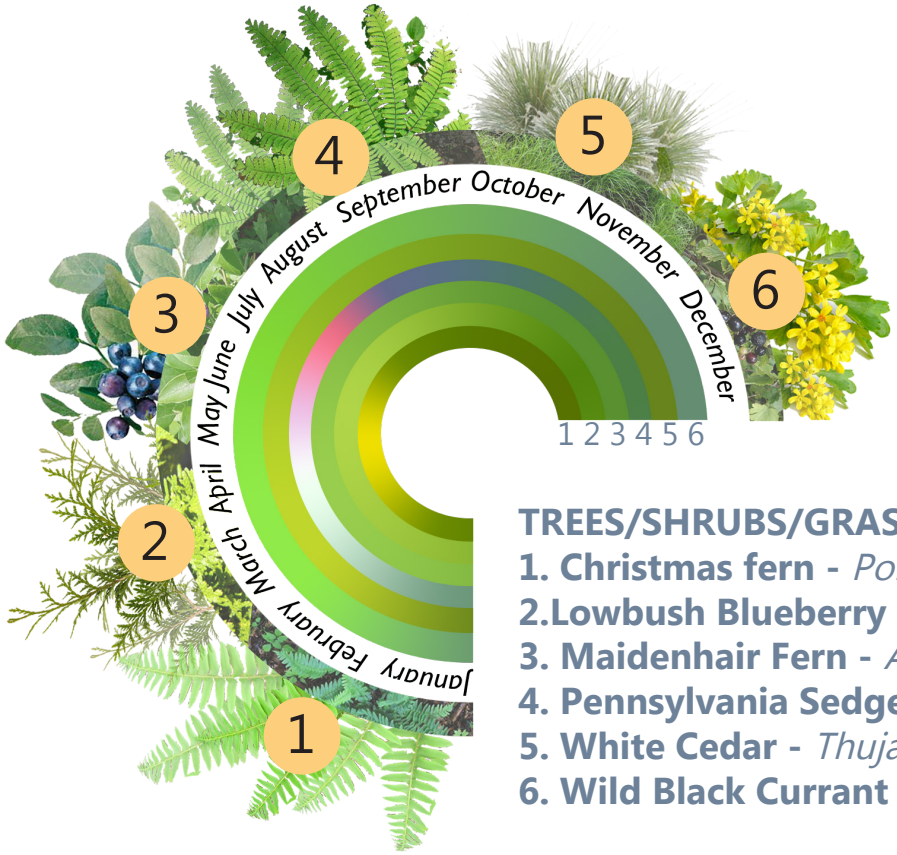
Link to How-to-Read: Garden Design Guide

Partial Sun to Shade



PERENNIALS

1. **Black-eyed Susan -** *Rudbeckia hirta*
2. **Blue cardinal flower -** *Lobelia siphilitica*
3. **Bluestem Goldenrod -** *Solidago caesia*
4. **Foamflower -** *Tiarella cordifolia*
5. **Thimbleweed -** *Anemone virginiana*
6. **Wild geranium -** *Geranium maculatum*



TREES/SHRUBS/GRASSES

1. **Christmas fern -** *Polystichum acrostichoides*
2. **Lowbush Blueberry -** *Vaccinium angustifolium*
3. **Maidenhair Fern -** *Adiantum pedatum*
4. **Pennsylvania Sedge -** *Carex pensylvanica*
5. **White Cedar -** *Thuja occidentalis*
6. **Wild Black Currant** - *Ribes americanum*

Link to Garden Scheduling Guide
Link to How-to-Read: Garden Design Guide

Warm Season Farming

1. Cantaloupe	April-June
2. Corn	June-Sep
3. Cucumbers	June-Sep
4. Peppers	April-Sep
5. Snap beans	June-Sep
6. Strawberries	June-Sep
7. Tomatoes	May-June

Cool Season Farming

1.Carrots	Aug-Nov
2.Garlic	June-Sep
3.Lettuce	March-June
4.Onions	April-July
5.Potatoes	May-July
6.Pumpkin	May-July
7.Snap peas	March-May

Link to How-to-Read: Garden Design Guide

Herb Farming

1.Basil	May - July
2.Chive	May - September
3.Cilantro	May - October
4.Mint	May - October
5.Oregano	May - October
6.Rosemary	May - June
7.Thyme	May - October

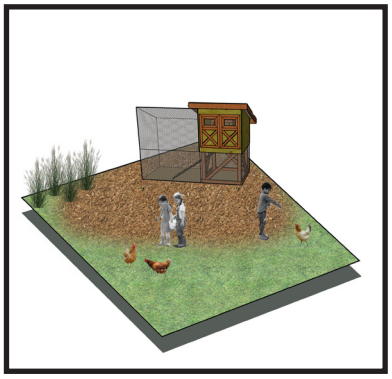
Sensory Farming

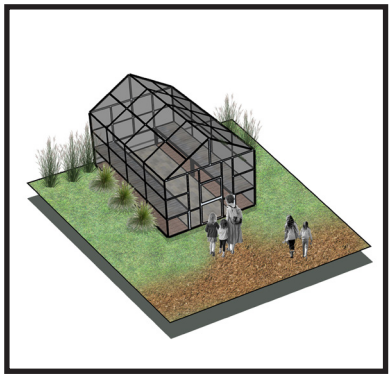
Auditory	Edible	Olfactory	Tactile	Visual
Bottlebrush grass	Allegheny serviceberry	Bellflower	Quill Sedge	Black Eyed Susan
Little bluestem	**2.Black Raspberry**	Nodding onion	Rattlesnake Master	Butterflyweed
1.Prairie grass	Common blackberry	Rose Mallow	Rough blazing star	**5. Cardinal flower**
Prairie cordgrass	Red Mulberry	**3.Virginia mountain mint**	**4.Showy goldenrod**	Smooth aster
Switchgrass	Wild Strawberry	Wild Geranium	Yellow giant hyssop	Wild Red Columbine

Link to Farming Guide
Link to How-to-Read: Garden Design Guide

Scenarios

Designs used:

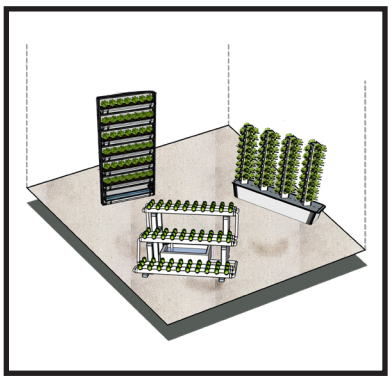


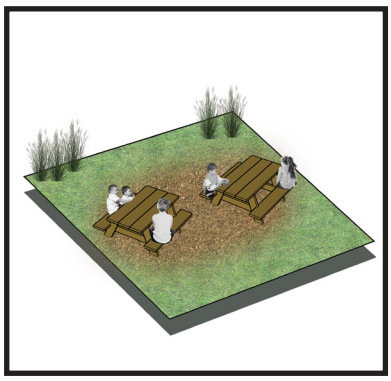


In this scenario, a school has a large unused area. The toolkits chosen were the "garden bed/patch", "animals", and "structures". The teachers have collaborated and decided they want a large farming area so the students may learn about agriculture. They wanted a garden area to connect to the many subjects taught.

Link to How-to-Read: Garden Design Guide

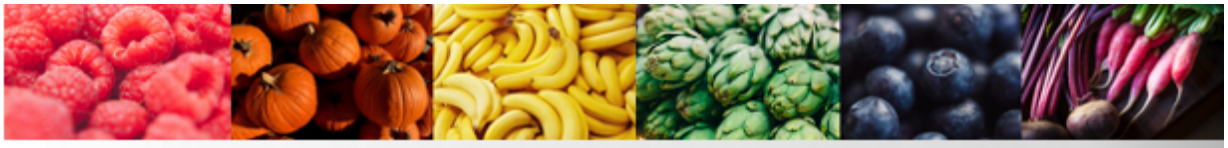
Designs used:





In this scenario, a school has a small unused area. The toolkits chosen were the "seating/surfaces/accessibility", "systems", and "social activity area". The teachers have collaborated and decided they wanted a garden area for education and play.

Link to How-to-Read: Garden Design Guide



Notes and References

Notes

a. However, because there are higher amounts of carbon dioxide in the atmosphere available to plants, some plants, like soybeans, will likely have higher yields for some time.[13,17] If the temperature continues to climb, yields will then decrease due to heat stress.[17]

b. Many fertilizers have NPK values: Nitrogen (N), Phosphorus (P), and Potassium (K). The nitrogen in fertilizers is often in the form of ammonium (NH_4^+) or nitrate (NO_3^-) - these are known as mobile sources of nitrogen. Although nitrogen is the most abundant gas in the atmosphere, it is not readily available for plants to use.[29] There is an industrial process called the Haber-Bosch process which converts atmospheric nitrogen (N_2) into ammonia (NH_3) which can easily be converted to ammonium or nitrate. In fact, more than 75% of ammonia made via the Haber-Bosch process is used for making fertilizer. To get usable hydrogen for the conversion of nitrogen into ammonia, a combustion reaction is done with natural gas, coal, or oil, which gives off CO_2 as a byproduct.[28]

c. Agroecology is defined by the Food and Agriculture Organization of the United Nations as “a holistic and integrated approach that simultaneously applies ecological and social concepts and principles to the design and management of sustainable agriculture and food systems. It seeks to optimize the interactions between plants, animals, humans and the environment while also addressing the need for socially equitable food systems within which people can exercise choice over what they eat and how and where it is produced.”[46]

d. Due to rising temperatures, the atmosphere is wanting more moisture as warm air holds more moisture. More moisture is thus leaving the earth through evaporation (via water bodies, soils, land cover) and transpiration (via plants).[34]

e. After precipitation, the water moves either over the land surface or through the soil to the nearest waterway, taking the added nutrients with it. This movement leads to high levels of nitrates and phosphates in our streams, rivers, lakes, and oceans. Increased levels of nitrogen and phosphorus can lead to the overgrowth of algae and the depletion of oxygen in the water. The lack of oxygen prohibits other organisms from thriving, leading to dead zones. The abundance of nutrients in the water is known as eutrophication.

f. It is estimated that about 14% of food (globally) is lost after harvest but before retail. About 17% is wasted in retail and at the consumption level.[14]

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