



Health and Environmental Impacts of Midwestern Specialty Crops

*A Landscape Analysis to
Inform Future Work*

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About Us

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Founded in 1973, the Gretchen Swanson Center for Nutrition is a national nonprofit research institute providing expertise in measurement and evaluation to help develop, enhance and expand programs focused on healthy eating and active living, improving food security and healthy food access, promoting local food systems and applying a health equity lens across all initiatives. The Gretchen Swanson Center works nationally and internationally, partnering with other nonprofits, academia, government and private foundations to conduct research, evaluation and scientific strategic planning.

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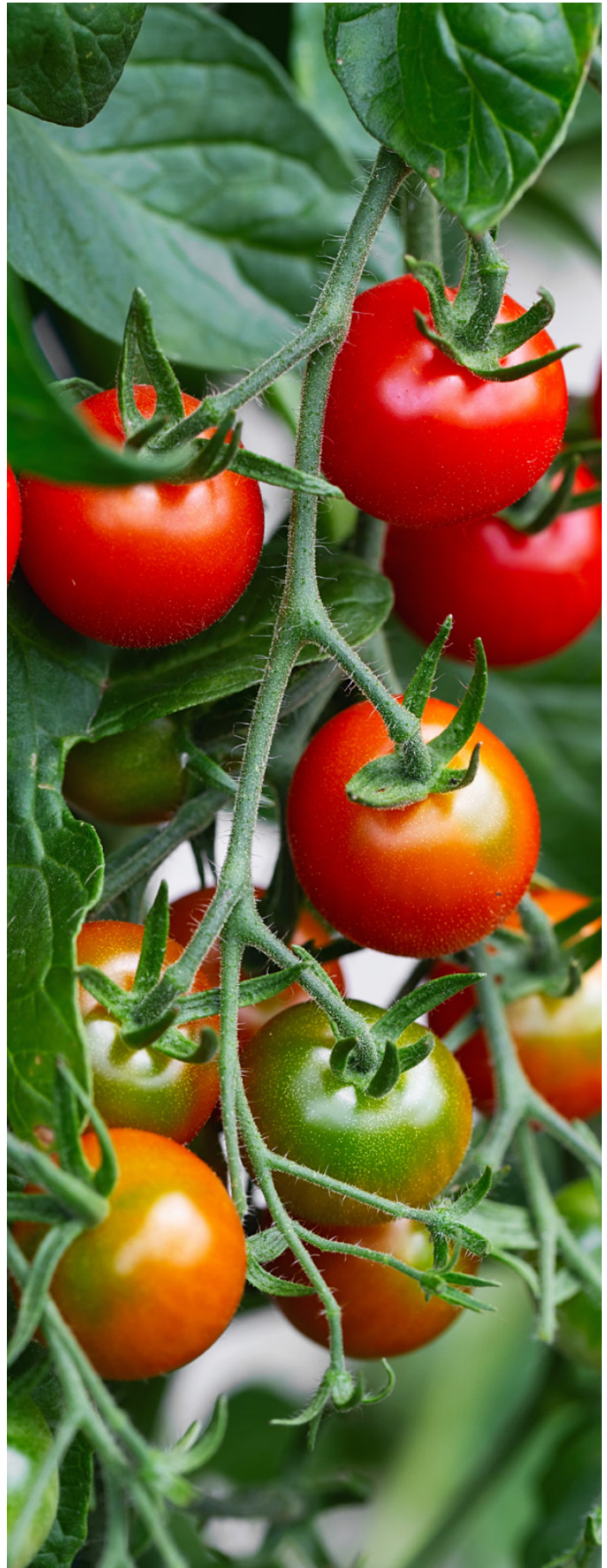
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Health and Environmental Impacts of Midwestern Specialty Crops: A Landscape Analysis to Inform Future Work

Introduction

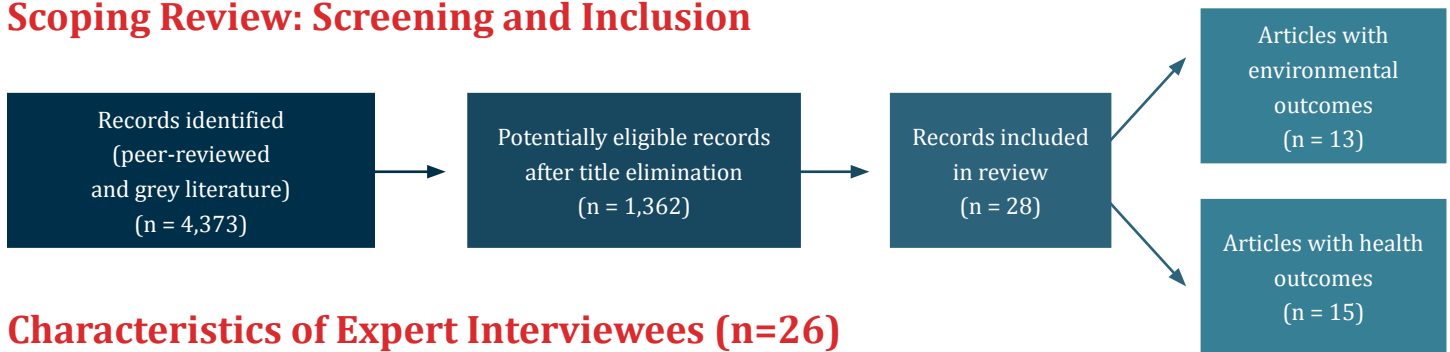
The United States' reliance on large-scale monoculture has negative consequences for both human health and the environment. Monocropping has led to reduced dietary diversity, contributing to nutrient-deficient diets and an increased risk of chronic diseases. Additionally, monocropping depletes soil nutrients, resulting in reduced nutrient availability and contributing to environmental problems such as soil erosion and greenhouse gas emissions. Transitioning to specialty crop production, such as fruits and vegetables, has the potential to improve both human health and environmental sustainability by diversifying agriculture and reducing negative impacts.

The goal of this study was to conduct a landscape analysis of the health and environmental impacts of specialty crops in the Midwest.

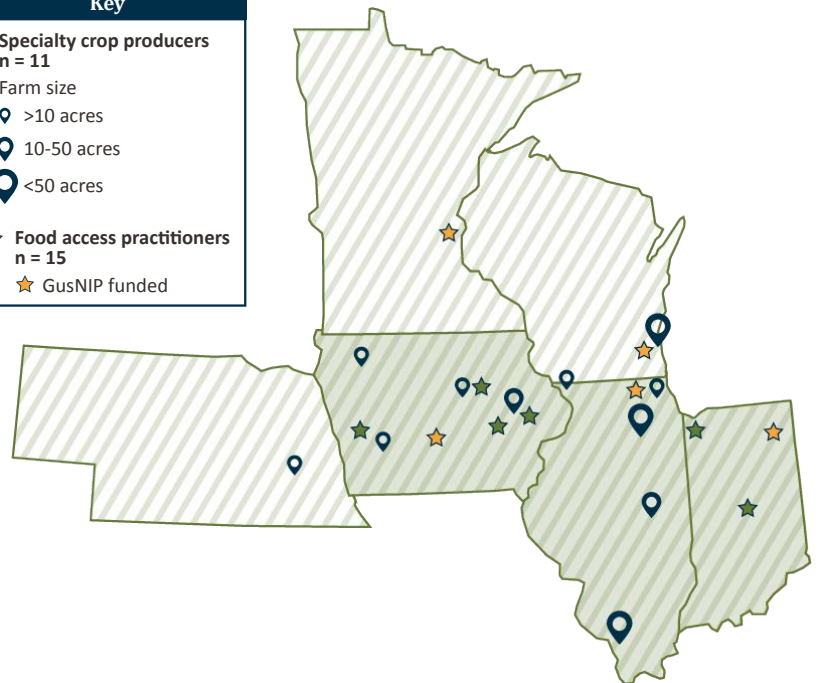
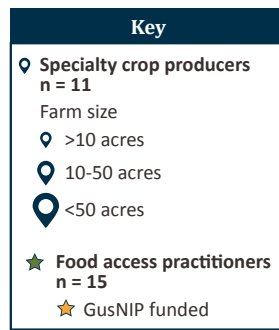
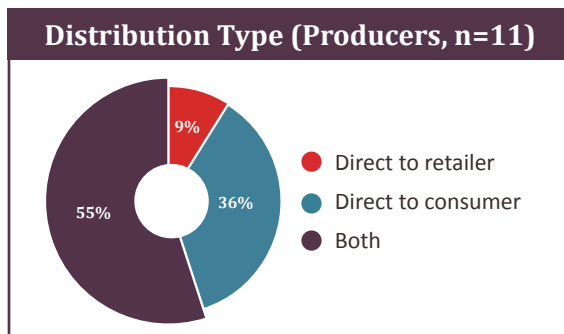
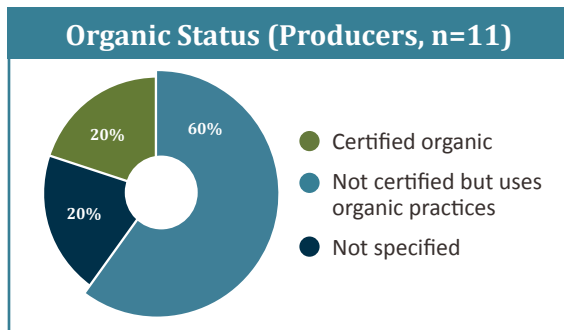
Methods

The landscape analysis included two components: a scoping review and in-depth expert interviews. The RE-AIM (reach, effectiveness, adoption, implementation, maintenance) framework was used to guide data collection and interpretation for both components. Scoping review records were screened and data was extracted from those that met inclusion criteria.

Scoping Review: Screening and Inclusion



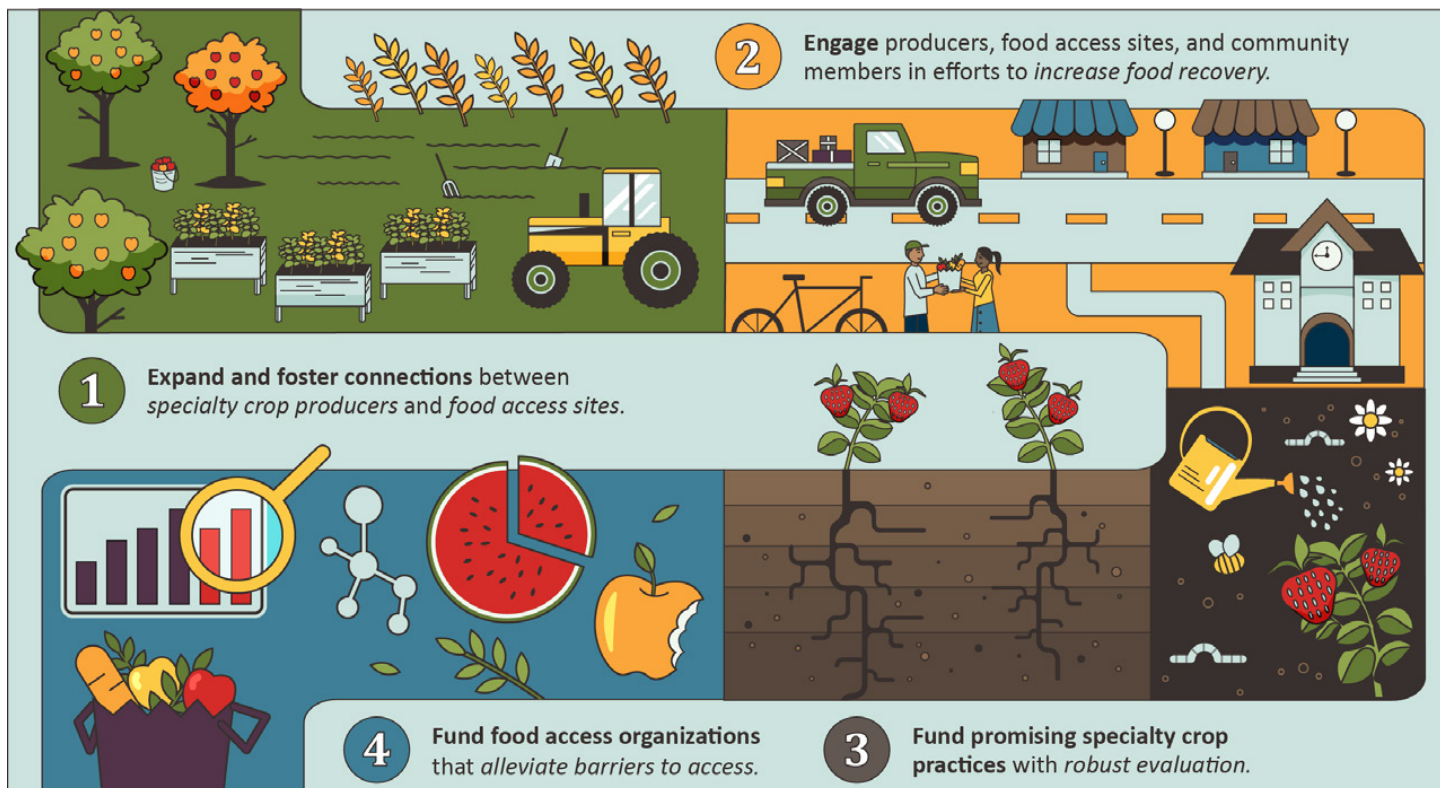
Characteristics of Expert Interviewees (n=26)



Results

RE-AIM Dimension	Environmental Outcomes	Health/Nutrition Outcomes
Reach	<ul style="list-style-type: none"> • Specialty crops were distributed through gardens, farmers' markets, restaurants and CSAs. 	<ul style="list-style-type: none"> • Food access organizations used tailored approaches to reach community members with low incomes or food insecurity, primarily through community gardens and farmers' markets.
Effectiveness	<ul style="list-style-type: none"> • High tunnels and hoop houses improved soil and plant health. • The effectiveness of soil amendments and specific production practices were mixed. • Reducing food waste is a promising practice. 	<ul style="list-style-type: none"> • Program evaluation ranged from nonexistent to formal research. • Most studies assessed participants' fruit and vegetable intake and found positive results.
Adoption	<ul style="list-style-type: none"> • Producers noted various reasons for producing specific types of specialty crops including consumer preferences, market demands, profitability and practicality 	<ul style="list-style-type: none"> • Practitioners adopted food access programs because of commitment to organizational missions and the community they serve.
Implementation	<ul style="list-style-type: none"> • Diverse types of specialty crops were grown to meet community members' needs. • Cover cropping, crop rotation, and high tunnels/hoop houses were used to increase yield and preserve soil. 	<ul style="list-style-type: none"> • Theories, frameworks, or models were not commonly used to develop or evaluate interventions. • Limited information was provided on the types of fruits and vegetables provided to participants.
Maintenance	<ul style="list-style-type: none"> • Producers desire to continue specialty crop production but noted the labor-intensive challenges of doing so. 	<ul style="list-style-type: none"> • Lack of funding was the primary barrier to maintaining food access interventions.

Recommendations



Background and Overview

The United States (U.S.) food system, with its reliance on large-scale monoculture, leads to negative impacts on both human health and the environment. Monocropping (i.e., single crops grown continuously, such as corn and soybeans) was initiated to feed the growing U.S. population and resulted in increased yield and reduced costs. However, these advances came at the expense of human and environmental health. The practice of growing a single species of crop in mass amounts has been shown to decrease dietary diversity and in turn contribute to the overconsumption of nutrient-deficient staple crops.¹ The reduced availability of diverse, nutrient-rich foods contributes to an increased risk for developing chronic diseases, such as obesity and cardiovascular diseases.² As well, monocropping depletes soil nutrients over time, leading to reduced nutrient availability in the food supply.³

As for environmental impacts, monocropping systems can cause significant erosion and alter the microbial landscape of the soil.⁴ To counteract soil nutrient depletion, synthetic fertilizers are often added to monocrops to encourage plant growth. Production of these fertilizers relies on fossil fuels, which contribute to greenhouse gas (GHG) emissions and can leave harmful residues that accumulate in the soil and leech into water systems.^{5,6} In addition, farming practices commonly associated with monocropping such as mechanical tillage and use of heavy equipment can cause soil compaction and contribute to erosion, eventually resulting in a loss of soil fertility and reduced carbon sequestration.⁵ Furthermore, compaction can reduce water absorption and increase runoff, which leaves soils prone to drought.⁴

Related, changes to the food system are necessary to respond to the increasing impacts of climate change.⁷ Conventional growing practices rely on fossil fuel use throughout the growing and production processes – from producing field equipment and pesticides to transporting food to markets across the globe. Adopting more sustainable, environmentally sound practices is critical to addressing challenges caused by climate change, including increases in temperature, changes in precipitation, and extreme weather events, which can destroy crops, alter the length of the growing season, and disrupt food distribution channels.⁸ Transitioning to specialty crop production and away from monocropping has the potential to alleviate these challenges and respond to the impacts of climate change.

Specialty crops are defined as fruits and vegetables, tree nuts, dried fruits, and horticulture and nursery crops that are produced for human use (as compared to monocrops, which are produced primarily for animal feed and biofuels as well as highly processed foods for human consumption).⁹ Producing specialty crops diversifies agricultural production systems and could enhance impacts on both human health and the environment. Human health and nutrition could be improved by increasing the availability of fruits and vegetables, which are currently lacking in the average U.S. diet.² Detrimental impacts on the environment could be avoided by reducing erosion, maintaining soil health, and engaging in practices that reduce GHG emissions.

Additionally, there is growing interest in local food systems as a method of distributing specialty crops.^{10,11} Local food systems have the potential to increase access to nutritious foods and improve health and environmental outcomes, but these benefits depend on the supply chain, product type, and local context.¹¹ Distributing specialty crops locally could potentially benefit human health and the environment through decreasing transportation outputs.^{10,11} However, little is known about the environmental and health impacts of specialty crops, including those that are distributed locally.^{10,11}

To begin answering these questions, focusing on the Midwest region of the United States is key. The Midwest region (Michigan, Ohio, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri, Kansas, Nebraska, South Dakota, and North Dakota) is a major producer of agricultural products in the U.S. For example, Iowa, Nebraska, and Minnesota are in the top five agricultural-producing states (with California and Texas); they collectively contribute to over a third of agricultural output value.¹² However, there is an existing disproportionate share of acreage between monocrops and specialty crops in the Midwest.¹³ Seventy-five percent of the 127 million acres of agricultural land in the Midwest is used to produce corn and primarily for animal feed and ethanol feedstock, while the other 25% is used to produce specialty crops including apples, asparagus, grapes, cherries, cranberries, blueberries, and pumpkins, along with multiple other types of fruits and vegetables.¹⁴ Therefore, investigating the impacts of specialty crop production in the Midwest could contribute to the body of knowledge and lead to implications expanding specialty crop production in the region.

Taken together, a deeper understanding of the potential health and environmental impacts of locally distributed specialty crops in the Midwest is necessary to inform next steps for expanding specialty crop production. Thus, the goal of this study was to provide the Builders Initiative and Walton Family Foundation with a landscape analysis of the health and environmental impacts of specialty crops in the Midwest. The Builders Initiative works towards sustainable solutions to societal and environmental challenges.¹⁵ The Walton Family Foundation is an organization committed to tackling tough social and environmental problems to create access to opportunity for people and communities.¹⁶ Together, the two organizations are embarking on an initiative to inform their work in local food systems in the Midwest region.

Methods

The landscape analysis includes two components: a scoping review and in-depth expert interviews. This methodology was selected to first understand the existing evidence base of specialty crop health and environmental impacts through the scoping review, and then expand on and explain the findings through the expert interviews.

RE-AIM (reach, effectiveness, adoption, implementation, maintenance) is the theoretical framework that guided data collection and interpretation for both components of the study.¹⁷ RE-AIM was developed to speed the translation of research to practice by considering both the individual and organizational factors that determine overall impact of interventions in real world settings.¹⁷ RE-AIM dimensions were operationalized as: primary reach: food access points; secondary reach: number, proportion, representativeness of community members served through these access points; effectiveness: impacts on the environment or community member health; adoption: number, proportion, representativeness of producers initiating specialty crop production; implementation cost: cost of producing specialty crops (vs. row or other crops); implementation fidelity: consistency to core components and adaptation; individual maintenance: long term impacts on the environment or community members' health; organizational maintenance: institutionalization of specialty crop production after six or more months.

For example, interview questions guided by RE-AIM ask about specialty crop producer and food access organizations' reach, or their clients, the effectiveness of their programs and impact on their clients and the community, how they decided to adopt and implement their practices or programs, and how they maintain their existing operations. Using this theoretical framework and interviewing two different groups, the study highlights specialty crop producers and food access practitioners' efforts to produce or distribute food locally in the Midwest region of the United States.

Scoping Review

We selected scoping review methodology to examine links between diverse fields of study (agriculture, environment, human health and nutrition) and provide flexibility in investigating complex relationships between factors across disciplines.^{18–20} We followed the PRISMA-ScR (Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews) guidelines.²¹

Data Sources

The scoping review of peer-reviewed and grey literature was conducted in March 2023. The search for peer-reviewed literature was conducted through searching the databases Cab Direct, PubMed, Environment Complete, and Academic Search Complete for search terms developed in consultation with a research librarian. Key search terms focused on the agricultural production practices (e.g., local food systems, short food supply chains, specialty crops, and alternative food networks), location (i.e., the Midwestern states), and impacts (e.g., nutrition, health, chronic disease, economic benefit, rural development, environmental impact, climate change). See **Appendix** for the complete search strategy. The search for grey literature was conducted through a customized internet and database search.^{22–25} Search terms were modified from the peer-reviewed literature search, as the website and database search engines do not have the ability for complex search syntax.

Thus, we searched for “specialty” or “local” or “supply chain” in the Land-Grant Impact Statements database, North Central Sustainable Agriculture Research and Education (SARE), Center for Rural Affairs, and Specialty Growers’ Associations and Cooperative Extension System websites for each of the Midwest states. Searches were adapted based on each website’s area of focus and search function capabilities; for example, the Land Grant Impact Statements database allowed filtering by region, and the SARE website included search parameters for specific commodities and year of publication. Events, staff member biographies, and marketing posts were removed from initial search results.

Study Selection

Peer-reviewed literature and grey literature sources were included if they 1) were focused on specialty crop production (i.e., fruits and vegetables, tree nuts, dried fruits, horticulture, and/or nursery crops),²⁶ 2) included environmental or health outcomes, 3) took place in the Midwest (MI, OH, IN, IL, WI, MN, IA, MO, KS, NE, SD, ND)²⁷; 4) included local product distribution, 5) were written in English, and 6) were published between 2004-2023 (to align with the initiation of the Specialty Crops Competitiveness Act of 2004).²⁶

Two authors independently reviewed each peer-reviewed publication’s title for inclusion or exclusion. Authors met to resolve discrepancies and used a senior researcher to assist with resolving, if necessary. Next, for the included articles, two authors reviewed each publication’s abstract, coded for inclusion/exclusion, and resolved using the same process. Finally, for the included articles, two authors reviewed the full text, determined inclusion/exclusion, and resolved.

As grey literature typically does not contain a descriptive abstract, we used a simplified approach. Two authors independently reviewed the title of each grey literature publication, coded for inclusion or exclusion, and met to resolve discrepancies. For included grey literature, two authors reviewed the full text, determined inclusion/exclusion, and resolved.

Data Charting

Data was extracted using a coding guide based on the RE-AIM Framework.¹⁷ RE-AIM variables were operationalized as detailed above.

Additional variables included the implementation outcomes acceptability, appropriateness, and feasibility, which can lead to improved intervention adoption, implementation, and maintenance.²⁸ Critical appraisal of evidence quality was not included due to the pragmatic nature of the research, inclusion of grey literature, and broad nature of the research topic.¹⁹ Two teams of two authors independently coded two sources, then met to discuss and resolve discrepancies. The data charting form was then refined based on items that were deemed unclear. Next, two authors independently coded and met to reconcile the remaining sources.

Expert Interviews

Participants and Recruitment

Data were collected from two groups: specialty crop producers and food access practitioners. Specialty crop producers were defined as growers that distributed locally in the Midwest region and focused on specialty crops (as defined by USDA). Food access practitioners were defined as individuals who work in local food distribution channels to improve community members’ food access, e.g., food pantry staff, school food procurement staff. Purposive and snowball sampling were used to recruit participants through a collaborative approach with the project partners. Participants were recruited by an initial email. If no response was received from the initial email after one week, a follow-up email was sent. If phone numbers were available, phone calls were also used to follow up. A maximum of two follow-up emails or calls were made.

Data Collection

Semi-structured interviews were conducted via Zoom video meetings from April to June 2023 and lasted 30-60 minutes. Interviews were conducted by LB, WFU, KN, ES, and MI, who each have been trained in qualitative methods and have experience conducting interviews. The semi-structured interview guide was based on the RE-AIM Framework.¹⁷ See **Table 1** for semi-structured interview questions by RE-AIM dimension for each interviewee type.

Table 1: Specialty Crop Producer and Food Access Practitioner Interview Questions

RE-AIM Dimension	Specialty Crop Producer Interview Questions	Food Access Practitioner Interview Questions
Reach	<ul style="list-style-type: none"> Where do you market your crops? How much of it stays in the local community? Can you describe who you reach through this distribution channel? 	<ul style="list-style-type: none"> Can you describe who you reach through your intervention? What type of transportation does the population you serve use to get to your site(s)?
Effectiveness	<ul style="list-style-type: none"> What environmental impacts do you think your specialty crops have? Have you tried diversifying your crops? 	<ul style="list-style-type: none"> What is the overall goal or desired outcome of your intervention? What metrics or measures do you use to determine if you are effective in meeting those goals?
Adoption	<ul style="list-style-type: none"> Can you tell me how you decide to grow the chosen primary crops? 	<ul style="list-style-type: none"> Can you walk me through how your organization decided to begin your local food access intervention/program?
Implementation	<ul style="list-style-type: none"> What are the primary crops you produce? Compared to other regions of the country, have you had to make any changes to your production practices to succeed in the Midwest? 	<ul style="list-style-type: none"> Can you describe the specific components of the intervention you've implemented? What partner organizations were involved? Is there an education component included? What considerations or changes did you have to make to your programming to be effective for the community you serve? How was the intervention financed?
Maintenance	<ul style="list-style-type: none"> Will you continue to focus on specialty crop production? 	<ul style="list-style-type: none"> Do you expect your intervention to continue permanently? What barriers to the sustainability/maintenance of the program?

Data Analysis

A rapid deductive approach was used to interpret the data.²⁹ Two data collection templates were developed based on RE-AIM dimensions in alignment with the interview guide for specialty crop producers and food access practitioners. Two researchers independently coded the first two interviews to ensure consistent note taking styles and refine the template. Subsequently, interviewers served as primary coders through taking notes and adding exemplary quotes into the template during or after each interview. Following each interview, a second coder listened to the interview recordings and revised or added to the primary coders' notes. Coders met to reconcile discrepancies as needed.

Saturation

The research team checked for saturation (i.e., the point during analysis at which additional data would produce little or no relevant information) using a process adapted from Guest et al.'s simple method.³⁰ After an initial set of interviews (six to seven) was conducted for each group (specialty crop producers and food access practitioners), the data was reviewed to determine the presence of unique themes. This was done through a team-based approach with saturation reached once the team agreed that no new information or themes were generated and common patterns were clear across all interviews.



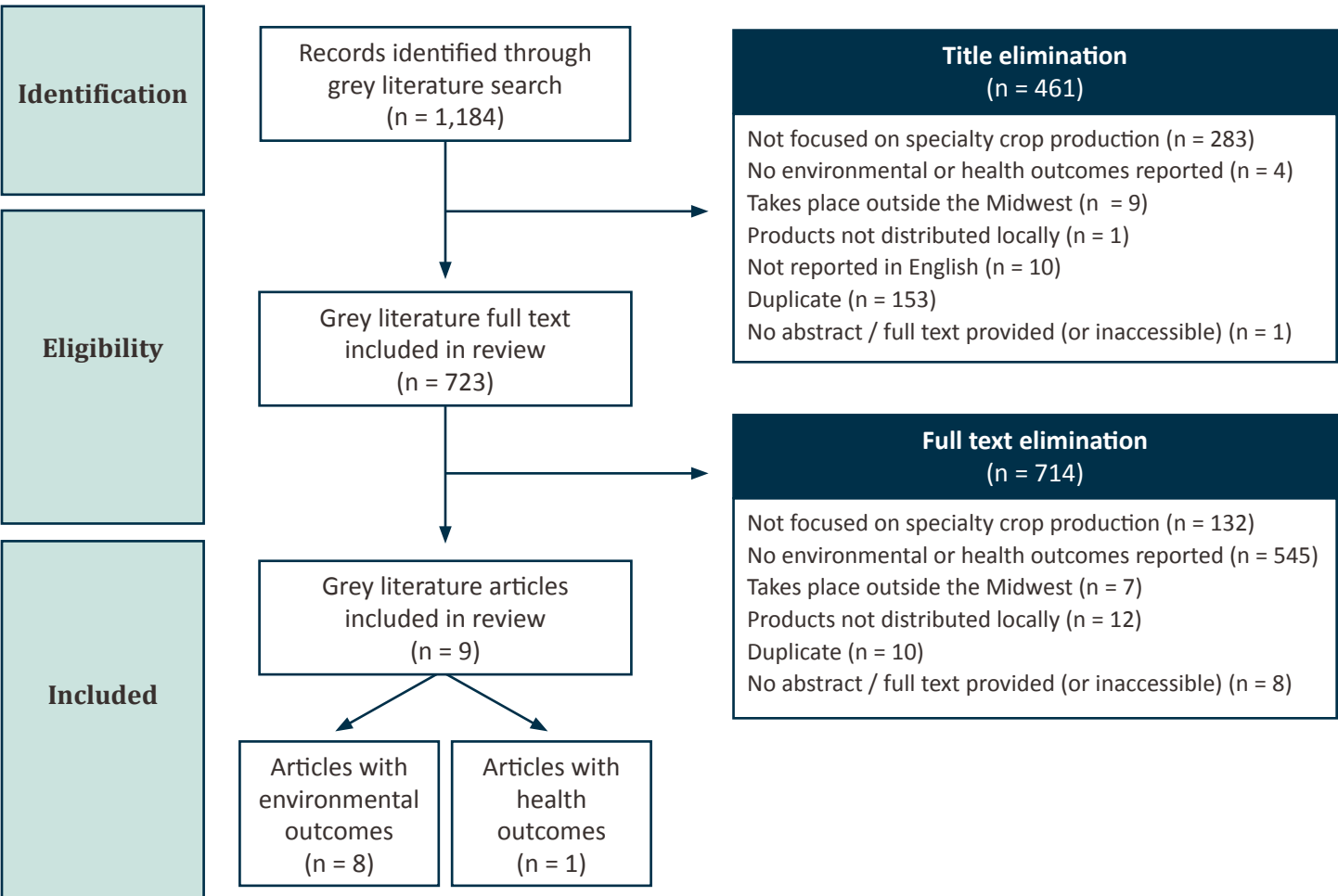
Key findings from one interview question (RE-AIM dimension construct) of the first interview were reported by the primary coder to the rest of the research team. Primary coders for each subsequent interview reported findings for the same construct, adding only new information to the discussion. When findings from all interviews had been shared, the team determined whether new information had been generated through the last interview reported. This process was repeated for each construct. Saturation was determined for each RE-AIM dimension across all interviews. Since not all constructs reached saturation in the first set of interviews, the research team reassessed saturation after a second set of interviews were conducted. The team came to a consensus that all constructs met saturation after 11 specialty crop producer and 15 food access practitioner interviews had been conducted.

Results

Scoping Review

The initial search for grey literature sources yielded 1,184 articles. Article titles were screened and 461 were excluded because they did not focus on specialty crop production (n=283), were duplicates (n=153), were not reported in English (n=10), took place outside the Midwest (n=9), did not report environmental or health outcomes (n=4), did not focus on products that were locally distributed, or were inaccessible (n=1). This left 723 articles that underwent full text screening, and 714 were excluded because they did not report environmental or health outcomes (n=545), were not focused on specialty crops (n=132), did not focus on products that were locally distributed (n=12), were duplicates (n=10), were inaccessible (n=8), or took place outside of the Midwest (n=7). The screening process resulted in nine articles that were eligible and included in this review (see **Figure 1**).

Figure 1. Eligibility and inclusion of grey literature in scoping review

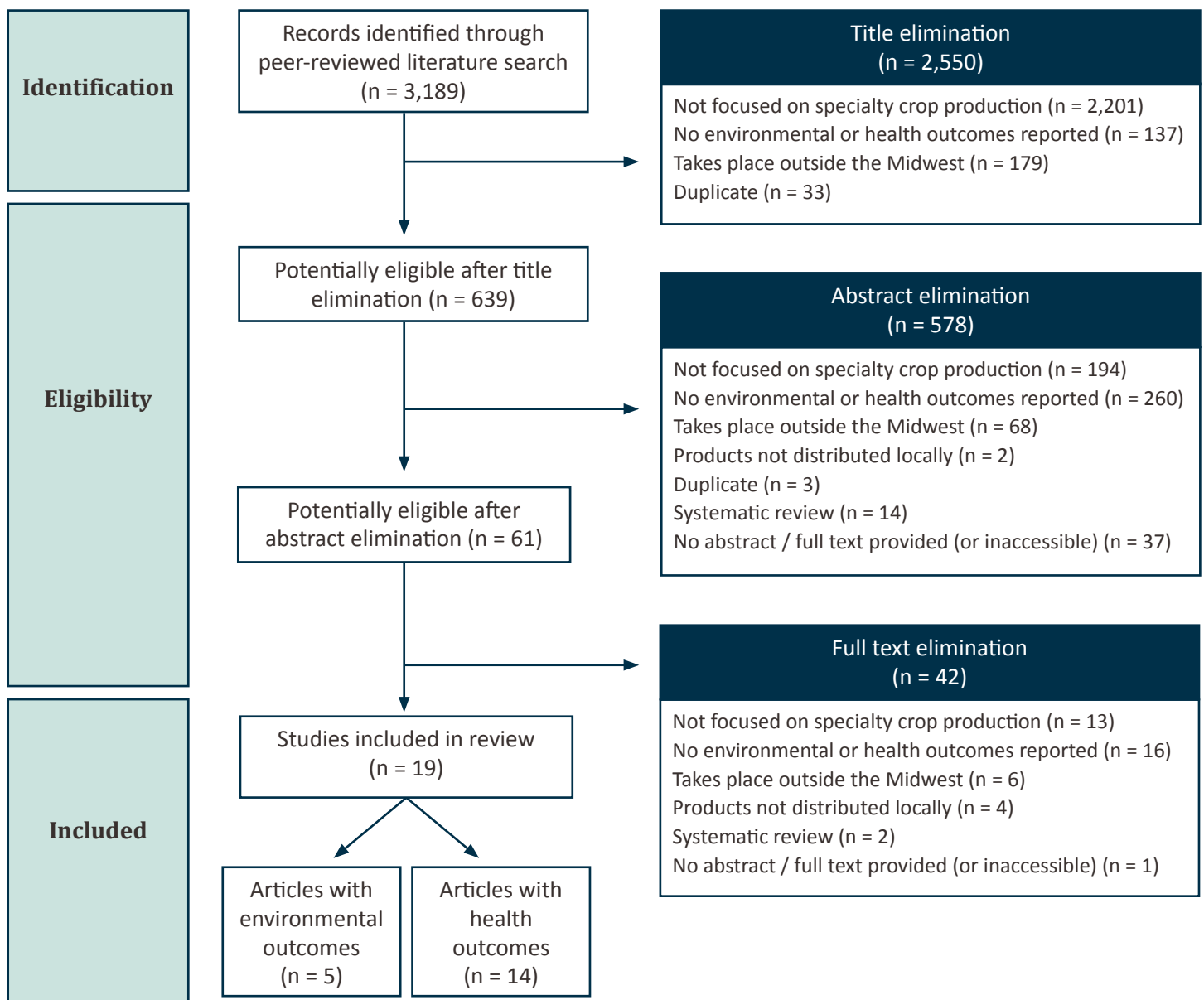


The initial search for peer-reviewed literature yielded 3,189 articles. Study titles were screened, and 2,550 articles were excluded because they were not focused on specialty crop production (n=2,201), they took place outside the Midwest (n=179), they did not report environmental or health outcomes (n=137), or were duplicates (n=33). This left 639 article abstracts that underwent screening, and 578 were excluded because there were no environmental and health outcomes reported (n=260), they were not focused on specialty crop production (n=194), they took place outside of the Midwest (n=68), were inaccessible (n=37), were systematic reviews (n=14), were duplicates (n=3), or did not focus on products that were distributed locally (n=2).



Abstract screening left 61 articles that underwent full text screening, and 42 were excluded because they did not report environmental or health outcomes (n=16), were not focused on specialty crop production (n=13), took place outside of the Midwest (n=6), did not focus on products that were locally distributed (n=4), were systematic reviews (n=2), or were inaccessible (n=1). The screening process resulted in 19 articles that were eligible and included in this review (see **Figure 2**).

Figure 2. Eligibility and Inclusion of peer-reviewed literature in scoping review



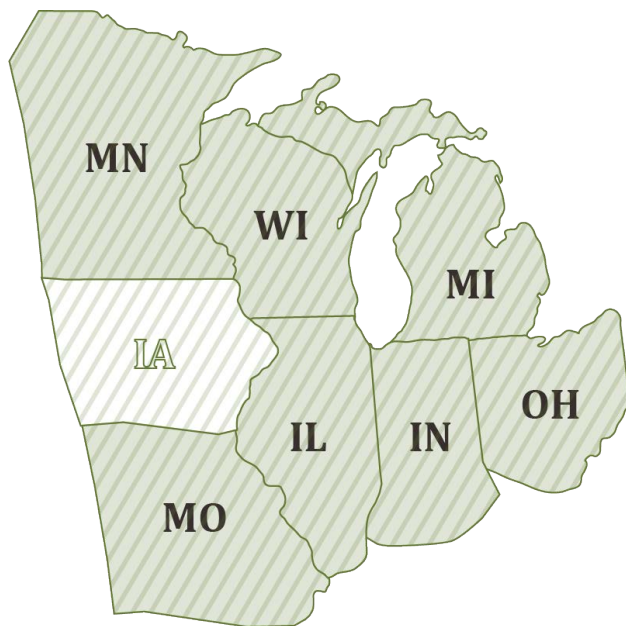
Finally, during the data charting phase, the included articles and reports (herein, “reports” is used to refer to both) were classified into either environmental impacts or health/nutrition impacts based on the study outcomes. Of the grey literature reports, eight included environmental outcomes and one included health outcomes. Of the peer-reviewed articles, five included environmental outcomes and 14 included health outcomes. Thus, for data charting and analysis, reports were organized by environmental outcomes (n=13) and health/nutrition outcomes (n=15). Scoping review data is organized by RE-AIM dimension for each type of report in the following sections. Results by dimension for robust data (i.e., reported in most sources) are detailed in **Tables 2-5 in the Appendix.**

Environmental Impacts

Reach

Studies took place across the Midwestern states: Minnesota,³¹ Indiana,^{32,33} Wisconsin,³⁴ Michigan,³⁵ Ohio,³⁶ Missouri,³⁷ and Illinois.^{38,39} Consumer distribution channels varied across studies. Most commonly, channels included gardens (private, community, and institutional) and farmers’ markets.^{31,39,40} Less commonly, studies described other methods of distribution including food system venues, urban farms, community supported agriculture (CSAs), a you-pick operation, restaurants, food pantries, and campus dining halls.²⁸⁻³¹

Figure 3. Locations of reports included in the scoping review detailing environmental impacts



Effectiveness

The thirteen included studies varied in their aims and research designs. Study aims included understanding properties of home and community gardens,^{31,39-41} assessing impacts of specific production practices (e.g., hoop houses or high tunnels),^{32,42} amendments (biochar or other organic amendments, decomposition specialty fungi),^{33,34,37,38,43} pest control (e.g., copper fungicides),³⁵ and food waste reduction.³⁶ No studies compared environmental outcomes of specialty crops compared to monoculture/commodity crop systems. Research designs were observational and experimental, with approaches including paired comparison,^{31,33-35,37,38,40,41,43} split-plot designs,⁴⁴ as well as pragmatic pre-post test or single timepoint assessment designs.^{32,36,39,42}

The studies focused on diverse environmental outcomes including soil health and quality, greenhouse gas impact, and plant quality. Soil health and quality was assessed through measures including chemical, biological, and physical properties including texture,^{31,40,41} density,³¹ aggregate stability,³¹ nutrients,^{31,34,35,37,39,41} pH,^{31,34,37,39,41} organic matter,^{31,34,39-41} heavy metals,⁴¹ water infiltration rate,^{31,41} hydraulic conductivity,³¹ microbial activity,^{34,40} nematode trophic composition,^{39,40} and insect biodiversity.³¹ GHG impact was primarily assessed indirectly through these soil measures (i.e., soil’s ability to store GHG that would otherwise be released into the atmosphere). In addition, one study assessed GHG impacts through measuring reduction of food waste, while another compared kilograms of carbon dioxide emitted through production in two different climatic zones.^{36,42} Plant quality was assessed through plant size and productivity, disease presence and management, and pest issues.^{32-35,38,40,43} Finally, two studies assessed crop diversity, one among community gardens and one among high tunnel users.^{32,41}

As for the study results, soil health and quality outcomes were mixed, depending on the production practices used. Two studies found improvement to soil pH through the use of biochar,^{37,38} while another study found no difference.³³ No improvements were seen from using wine cap mushrooms as a soil amendment.³⁴ As well, no improvements in copper accumulation were found using hyperaccumulating plants (alfalfa), but copper-resistant soil bacteria led to a decrease in soil copper levels.³⁵

Regarding comparisons between production sites, one study found that market gardens (i.e., larger, non-subdivided tracts managed as a unit by one gardener or by a group of people who work together under a common business plan) have better soil health than community gardens.⁴⁰ As for other observations of home and community gardens, two studies found mixed properties of soil health in urban home food gardens (phosphorus and potassium levels often far exceeded levels required for optimal plant growth, but soil organic matter and nematode trophic concentration were high),⁴¹ while another found that assessing existing soil quality when establishing new food production sites in urban areas is more important than applying specific amendments.³¹ Considering direct effects of greenhouse gas emissions, one study worked with farmers to reduce food waste by using seconds and between-market produce to create value-added products; this resulting in alleviating 12,000 pounds of potential food waste.³⁶

Regarding plant quality, primarily positive outcomes were found through the use of specific production practices. Tomato plant vigor and overall health were improved through the use of wine cap mushrooms as a soil amendment.³⁴ Disease management in cherries was improved through copper amendments.³⁵ Growth of fruit (apples, pears, persimmons) and nut (chestnut, hazelnut) trees was supported through biochar amendments.³⁸ High tunnels were also found to increase crop yields, which increased availability of local foods.³² Tomato yield was similar when comparing community and market gardens (without testing specific production practices).⁴⁰ Yield, plant size, and disease incidence were improved through the use of worm casting and azomite in greenhouses and gardens.³³ A combination of amendments (e.g., pine bark, coffee grounds) resulted in mixed results on the quality of blueberry plants.⁴³ Finally, as for crop diversity, urban home food gardeners from diverse backgrounds planted gardens with similar plant diversity,⁴¹ while farmers who self-funded high tunnels and those who received funding through the Environmental Quality Incentives Program planted similarly diverse crops.³²

Adoption

Characteristics of farms and gardens varied widely across reports. Several reports examined multiple farm plots, gardens, or hoop houses,^{32,36,39–41} whereas others focused on a single operation.^{33,34,37,38,43}

Amount of land dedicated to specialty crop production ranged from small urban gardens to a 40-acre commercial farm.^{33,34,39–41} Operations were established as early as 1906 and as recently as 2010.⁴⁰

While the number and characteristics of producers were not always specified, one report described demographic characteristics of the gardeners selected to understand crop diversity among urban home food gardens: 32% were Mexican-origin, 32% were Chinese-origin, and 35% were African American.⁴¹ Another reported that primarily male, historically underserved farmers with over 13 years of experience were included in an impact assessment of the USDA Natural Resources Conservation Service Seasonal High Tunnel Initiative.³² Production team size ranged from small teams of two (including one husband and wife team) to operations that included multiple owners and full-time workers plus a bookkeeper.^{37,43} Two producers reported being family-owned operations, one of which is run by a sixth-generation farmer.^{33,38}

Implementation

Production practices varied widely between reports, with the most common practice being the use of cover crops.^{31,34,37,38} Both tillage and no till approaches were described. No till or minimal till practices were highlighted in three reports,^{34,38,39} while tillage strategies were discussed in two.^{37,42} Although normal tillage practices are often used to aerate soil, one report discussed using this strategy as a way to activate biochar and add products including sulfur, rock phosphate, and sand to the soil.³⁷ General strategies around increasing soil nutrients were also reported, including soil enrichment^{33,37}; nutrient cycling, nutrient management, and use of organic fertilizers^{34,41}; soil amendments such as biochar and basalt^{33,37}; and compost practices.^{39,42} Few reports provided information about whether their production was organic or not. Of the three reports that shared this information, two used both organic and conventional production, and one mentioned growing organic fruits and vegetables.³³ One report mentioned a goal of becoming organic certified in the next few years.^{37,33}

To reduce climate change challenges, multiple reports detailed efforts to find innovative and sustainable ways to continue to grow Midwest specialty crops such as blueberries,^{36,37,43} cabbage,^{31,33,36,41} and strawberries,^{33,36} using strategies such as implementing soil amendment treatments to rebuild declining blueberry fields.⁴³

As for cost, many of the projects were funded through SARE grants. While the grant amount was reported for each SARE-funded project (and ranged from \$7,496 to \$198,529), the full costs of the studies or new production practices were not provided.

Maintenance

Maintenance was underreported across the scoping review. Two reports shared plans to continue data collection and develop additional goals following their initial findings on the impact of soil amendments on plant growth and vigor, and strengthening community relationships within the community, respectively.^{36,43} One detailed actual long-term results, noting that because of their findings on copper use for tart cherry management, regional copper use for cherry leaf spot control increased by 15% in a three-year period.³⁵

In addition to extracting data on maintenance of long-term production practices, data were also captured on producers' efforts to disseminate their work to scale practices to their peers. Multiple reports described sharing the concepts and results of research through multiple means including lectures, workshops, media, research presentations, and organization- and community-wide educational outreach.^{34,35,37,38,43}

Health Impacts

Reach

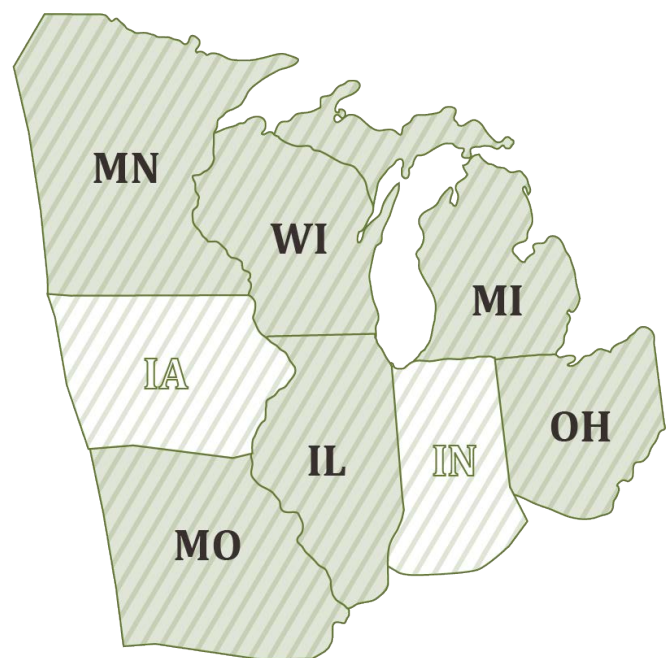
Reports focused on health impacts also took place across the Midwestern states: Missouri,⁴⁵⁻⁴⁷ Illinois,⁴⁸ Ohio,^{54, 55, 58-60} Minnesota,^{49,50} Wisconsin,⁵¹ and Michigan.⁵² One report detailed a study that took place in a small city in the Midwest with no mention of the city or state name.⁵³

Food access points and interventions detailed in the reports primarily reached consumers through community gardens^{45,47,49,53-56} and farmers' markets.^{48,50,52,54,57,58}

Other distribution channels included a CSA,⁵⁴ a local food hub (including a local produce market and healthy food café),⁵⁹ Fresh Stops (farmers' markets organized by community-based organizations),⁶⁰ and a sliding scale cooperative grocery store.⁴⁶

Reports indicated that specialty crops reached diverse populations through food access points including community members from racial and ethnic minority groups and those experiencing food insecurity. Of those that reported demographics, four studies primarily served African American residents,^{47,52,58,59} one was implemented in a Marshallese community,⁵³ and one surveyed a community of refugee and immigrant families (including Karen, Bhutanese, Hmong, Lisu).⁴⁹ The number of participants reached ranged from 120 community gardeners,⁵⁵ to 1,320 community members receiving SNAP (Supplemental Nutrition Assistance Program) benefits who participated in a farmers' market Electronic Benefit Transfer program.⁵¹

Figure 4. Locations of reports included in the scoping review detailing environmental impacts



Effectiveness

The majority of the 15 included reports aimed to understand the association between a specific food access point (e.g., a community garden) or intervention (e.g., incentives to use a farmers' market) and fruit/vegetable consumption.^{45,48-50,52-58} Less commonly, studies aimed to test innovative local food distribution models (e.g., turning a large neighborhood lot into a market garden to supply food to a cooperative grocery store).^{46,47,59,60}

Research designs were observational and experimental, including quasi-experimental,^{56,59} parallel,⁵³ pre-post,^{49,58} and cross-sectional or post-test only designs.^{45,48,50,52,55,57} Mixed methods studies were also conducted,^{47,54,60} although the outcomes of interest (i.e., impacts on community members' health or nutrition status) were typically captured through quantitative (pre-post or cross-sectional surveys) rather than qualitative methods. One study used a qualitative design to understand the outcomes of interest.⁴⁶

As for study outcomes, 11 assessed fruit and vegetable consumption and five examined food security.^{45-50,52,54,55,57-60} One study examined diet quality scores and total caloric intake,⁵⁹ while two assessed health metrics (blood pressure, body mass index, and hemoglobin A1c).^{53,56} Outcomes were typically assessed through self-report survey items, with nine studies using valid measures (e.g., the Healthy Eating Index Score, USDA Household Food Security Module, or Behavioral Risk Factor Surveillance Survey).^{45,47-49,52,54,55,57-59}

As for the study results, of those that assessed participants' fruit and vegetable intake, most found positive results,^{45,47-50,55,57,58,60} while one found no change.⁵⁴ Four studies found increases in food security,^{46,47,55,59} while one found no change.⁵² The study that assessed diet quality scores and total caloric intake found no difference,⁵⁹ while the two studies that assessed other metrics (blood pressure, body mass index, and hemoglobin A1c) found that they improved.^{53,56} Both types of study aims (understanding impacts of food distribution points or interventions) found primarily positive results.

Implementation

Reports detailing health and nutrition impacts included limited implementation data. Little information on study funding was provided, with two projects receiving funds through the USDA,^{51,60} and others from organizations such as SARE and the United States Healthy Food Financing Initiative (HFFI).^{46,59} Only two reports used a theory, framework, or model to guide intervention development or evaluation. One report described using a Community-Based Participatory Research approach for the study design in combination with the Social Cognitive Theory to guide intervention activities at both the individual level and environmental level.⁵⁶ The second report incorporated the Theory of Care-Seeking Behavior to impact individual health habits.⁵³

Finally, as for the specialty crops available to study participants, most sources mentioned fruits and vegetables without details on specific types.^{46,50,52-56,59} Two studies elaborated on the specialty crops available, which included melons, carrots, cucurbits, peppers, and okra.^{45,46}

Maintenance

Most reports provided little or no detail on long-term individual-level maintenance or program sustainability. Two studies mentioned a need for increased funding to continue or expand programming related to produce prescriptions and electronic benefit transfer (EBT) at farmers' markets.^{51,58} Furthermore, another study found that plans for Community Food Security Initiatives program sustainability were met with many challenges, especially concerning the hindrance of governmental policies on certain agricultural and land practices and lack of community representation in decision-making and leadership roles.⁵⁴ One study was developing a business plan that projected long-term viability,⁶⁰ while another shared that by the end of the study, most of the components detailed in the report were not maintained.⁵⁹

Expert Interviews

In total, 26 interviews were conducted with specialty crop producers (n=11) and food access practitioners (n= 15). Distribution channels, certified organic status, farm size, and crops grown by specialty crop producer interviewees are detailed in **Figure 5**. Detailed interview findings, in alignment with the interview guide and RE-AIM framework, are presented in **Table 6** for specialty crop producers and **Table 7** for food access practitioners. Overall summaries for each group are detailed below.

Specialty Crop Producers

Reach and Adoption

Collectively, specialty crop producers conduct their business with their clients, mission, and passion for farming and agriculture in mind. Because farms need to make profit (often their mission), producers pay attention to client preferences and requests while balancing the labor and time needed on the farm to grow certain crops.

Figure 5. Distribution Channels and Farm Characteristics of Specialty Crop Producer Interviewees

State	Distribution Channels										Farm Characteristics	
	On-farm sales	Farmers' markets	Food pantries	Grocery stores	CSAs	Hospitals	Wholesale	Schools	Restaurants	Certified organic	Farm size*	Crops produced*
IL												
IA												
IL												
NE												
IL												
IL												
IL												
IA												
IA												
IA												
WI												

*Farm size is defined as small: <10 acres, medium: 10-50 acres, and large: over 50 acres.

*Crop symbols represent vegetables (carrot), herbs (herb), and fruit (apple).

Several producers described customers as people who could afford more expensive, locally grown food, but most farmers donated excess produce when possible and often participated in local initiatives to support limited-income communities.

Most specialty crop producers already diversified their crops to meet client requests, and some incorporated row crops, often managed by hand rather than conventional tools and practices. All growers in the study distributed their foods locally and confirmed that they served mostly smaller towns and nearby areas that were more rural. They sold through a variety of venues including restaurants, farmers' markets, CSAs, and other institutions, and mostly marketed their business through word of mouth.

Implementation, Effectiveness, and Maintenance

With the focus of the study on the Midwest region, producers experienced similar weather-related impacts such as high winds, frosts, dry seasons, and massive rainfall as well as unique landforms such as hills and bodies of water. Often, producers adapted to weather conditions by adopting practices that extended the growing season. These practices included using high tunnels, greenhouses, hoop houses, interplanting (the practice of growing different types of plants in the same area to maximize efficiency and harvest), and plastic mulch.

Regarding environmental impacts, farmers were aware or acknowledged that any sort of agriculture or food production would impact the environment – whether positively or negatively. Several farmers mentioned they followed organic practices but were not certified organic, and some felt having the organic certification was not necessary. They perceived that specialty crop production and diversification of crops often benefited soil health and may contribute to positive environmental impacts. Few farmers reported measuring impact using formal methods, with most informally observing changes and reporting improved soil health, yield, and increased organic matter.

While farmers' awareness and adoption of practices to mitigate environmental impacts varied, many topics were shared across all participants including mentions of using limited or no-till practices and cover cropping or crop rotation to improve soil health, integrated pest management and limiting or reducing the use of chemicals (e.g., pesticides), drift control, adding soil amendments such as fungi and manures, mulching, introducing beneficial insects to preserve the natural ecosystem, water conservation and drip irrigation, recycling inputs and using rain water and solar panels, and controlled traffic farming. In terms of continuing their work in farming, producers genuinely had a passion and interest in maintaining their current production; however, many noted the physical demands of hard labor and the years they can realistically continue the work.

Food Access Practitioners *Reach and Adoption*

Comparatively, food access practitioners were mission-driven and often focused on implementing programs addressing specific health issues such as reducing food insecurity or improving health outcomes. Since most food access practitioners were staff from non-profit organizations, they discussed existing or new programs that distributed emergency food or offered other social services to the community. Often, these organizations mentioned close ties to local producers and agricultural partners, which meant their food donations were often sourced from local farms. Therefore, foods were dependent on the growing season and what foods they could provide through feeding programs. Being able to provide local foods was viewed positively, and practitioners had opportunities to seek feedback from clients to provide culturally relevant food.

Implementation, Effectiveness, and Maintenance

Most food access practitioners explained that they were very connected to the community and mentioned numerous community partners and ties with local agricultural parties. They mentioned partnerships with multiple sectors, ranging from education to government to Cooperative Extension, and noted the importance of collaboration for reaching their goals, implementing successful programs, and securing stable funding in the long run.

These partners also provided various resources including food, nutrition, and gardening education and other unique aspects of programming, e.g., an apprenticeship program. Empirical program evaluation ranged from nonexistent to formal research; however, most organizations did collect feedback in some way to inform and improve their programs and meet client needs. While practitioners wanted to continue programming and support populations in need of services, main barriers were lack of sustainable funding to offer services and the challenges of maintaining federal funds to cover all aspects of programming and operational costs.

Discussion

Reach

Primary reach (food access points)

In the scoping review and expert interviews, producers primarily reached community members through community gardens, farmers' markets, restaurants, and CSAs. Food access practitioners reached community members through community gardens and farmers' markets.

There was little mention of alternative distribution methods, such as food hubs or other innovative local distribution models. Sometimes, producers mentioned changes in distribution channels depending on market opportunities or other events, e.g., COVID-19, which resulted in the need to adapt to new distribution methods, such as starting delivery models or online farmers' markets. Supporting farmers to explore opportunities to increase additional channels of distribution or create targeted marketing approaches to specific audiences could increase accessibility, improve reach, and ensure diverse populations have equitable access to locally sourced produce.⁶¹

Secondary reach (community members served)

Overall, food access organizations (including nonprofit foundations and collaboratives, food banks, and county health departments) primarily served low income, food insecure, marginalized, disinvested, or underserved populations to address disparities.

Many organizations reached individuals who received governmental assistance from programs such as SNAP or WIC (Special Supplemental Nutrition Program for Women, Infants, and Children). Some organizations mentioned tailoring produce they grow and/or procure to reflect the cultural preferences of diverse communities they served. However, not all populations have easy access to gardens and farmers' markets - the primary food access points for specialty crops. For example, interviewees highlighted transportation barriers to accessing farmers' markets, especially in rural areas where public transportation systems are limited.^{47,62}

Additionally, local food distribution can help reduce food insecurity for community members, along with other benefits such as job creation, supporting local farmers, and keeping local dollars in the community.⁶⁴ Finally, through exploring place-based solutions, communities can decide on options such as community gardens, urban agriculture (e.g., rooftop production, hydroponics, and aquaponic facilities), and food hubs.^{65,66} It is important for communities to prioritize equitable distribution methods to reach community members experiencing health disparities. This could include increasing healthy food access through innovative solutions such as mobile markets, community partnerships, and subsidized nutrition incentive programs (e.g., Double Up Food Bucks) to ensure everyone benefits from access to fruits and vegetables.

Effectiveness

Environmental outcomes of specialty crop production

Overall, specific practices with the potential to reduce GHG emissions and improve yield and availability were identified, while areas in need of further research were also elucidated. First, producers used a number of practices to improve plant and soil quality and reduce energy use, including high tunnels and hoop houses. Both of these practices were found to increase the growing season and food production without expanding farms' carbon footprint.^{32,42}

These production practices also have the potential to help producers adapt to the ongoing effects of climate change through reducing disruptions related to extreme weather. Taken together, future research and practice should expand on these findings by increasing the use of high tunnels and hoop houses for specialty crop production and identifying positive environmental impacts. Additionally, one interviewee mentioned that their high tunnel was damaged from high winds, and it had not been replaced yet. While USDA provides funding for sustainable agriculture, additional funding sources could support farmers in purchasing or replacing equipment.

Next, considering amendments, impacts on soil health and plant quality were mixed. While some studies found that plant quality was improved (e.g., through biochar or a combination of pine bark and coffee grounds), overall environmental impacts are unknown, and more research on combinations of amendments is needed. As well, multiple studies examined impacts of production practices on soil health and found mixed results. Soil health was measured through various methods including chemical, biological, and physical properties. Because of mixed findings identified in the scoping review, tools and technology that allow producers to measure soil health at scale and in real time are recommended for future studies. These tools should be affordable and adaptable to differing types of specialty crop production in diverse geographical regions. Existing research has found that healthy soils can mitigate climate change through carbon sequestration, increasing water retention and filtration, and improving water and air quality.⁶⁷ Healthy soils also improve plant health and yield, leading to an increase in producers' profit.⁶⁷ Thus, examining the impact of promising practices on soil health is recommended.

Reducing food waste is a promising practice that was only examined in one study.³⁶ Given that food loss and waste is a major contributor to greenhouse gas emissions (primarily the generation of methane, a more harmful GHG than carbon dioxide) when food waste ends up in landfills,⁶⁸ future research and practice could engage supply chain companies and food brands in identifying opportunities to reduce food loss and waste by diverting food waste that can be used in other ways.

The Environmental Protection Agency (EPA) provides guidance for sustainable food waste management and prioritizes a hierarchy of the most to least preferred recovery methods: reduce food loss and waste at the source (e.g., during food production); if food is still edible, use the food to feed people instead of throwing it away; if inedible, divert food to feed animals; create other methods or reusing food waste such as through industrial uses (e.g., anaerobic digestion) or composting; and lastly, discard food at the landfill.⁶⁹ Reducing food waste and adopting food recovery practices may also have positive impacts on human health outcomes, such as diverting still-edible food to populations in need and increasing access to food that might have been thrown away instead. For example, organizations such as Upcycled Foods and Imperfect Foods work with producers across the country to develop processes to divert potential food waste (e.g., spent grains) into new products, which becomes an added distribution channel for growers to gain additional income. If food recovery methods are adopted or desired, communities should gauge the demand for “ugly produce” and upcycled products that are still perfectly edible. This may involve conducting targeted marketing approaches or social marketing campaigns to increase awareness and demand for produce or products that are recovered.

Since distribution channels vary by market and producer needs, communities should identify opportunities to recover food through local avenues. This would require funding to support research and development of secondary markets and opportunities for local collaboration. These partnerships could involve local food producers, food access practitioners, food businesses interested in purchasing locally grown produce, and municipal entities that oversee regulations related to business or organic waste management. Additionally, a potential area of improvement is the idea of improving the efficiency of the food supply chain by connecting actors across the food system. Often, small producers lack processing or cold storage facilities to meet broader market opportunities. Exploring ways to support the local food supply chain may also support producers and practitioners who distribute emergency food simultaneously. Overall, more ways to use imperfect or blemished foods at the packer and processor level are needed.

Finally, more direct measures of GHG emissions are needed across study aims. Specifically, there is a gap in practical use among specialty crop producers to measure environmental impact due to specialized food production and varying inputs that are different from traditional agricultural methods. While life cycle assessments (LCAs) can be useful to model the processes from farm to fork and food waste management and identify areas that impact the environment,⁷⁰ there is a lack of specialized LCAs created for specialty crop production. To enhance existing measures and increase practical use for formal measures of GHG emissions, literature suggests the need to “identify food-tailored methods in LCA” and a combination of LCA methods to be applied to individual farm and larger-scale food productions.^{70,71} As well, there is a need to identify standardized measures with strong correlation to GHG emissions that are feasible and acceptable for producers, e.g., GHG calculators that have been developed through LCAs tailored to specialty crop production. Researchers and policymakers could support producers by increasing research and funding to conduct context-specific LCAs and identifying practical ways to measure environmental impact and GHG emissions.^{70,71}

Health and nutrition outcomes of food access interventions

Overall, as for the health and nutrition impacts of food access interventions, fruit and vegetable intake (FVI) and food security were the most common outcomes measured and improved through local food access interventions. More studies assessed FVI than food security, perhaps because food security is more difficult to improve, as it also relates to access and availability. For example, community members dealing with food insecurity may not have access to high quality food access points because of transportation challenges. Recently, the USDA incorporated nutrition security in its strategic plan to ensure that nutrition-related outcomes, which also include health equity, should be prioritized alongside food security efforts.⁷² Future studies should assess nutrition security to ensure that interventions increase access to food while also providing sufficient nutrition.

Better measures of nutrition security are needed, though, as are more robust study designs (beyond cross-sectional or post-test only). There are a number of validated surveys and dietary assessment methods that practitioners and evaluators can use to measure food insecurity and other diet and health outcomes.

This includes measures that are pragmatic and feasible for practitioners without research or evaluation expertise. For example, food access practitioners could take advantage of the publicly available **USDA National Institute of Food and Agriculture** Gus Schumacher Nutrition Incentive Program (GusNIP) Training, Technical Assistance, Evaluation, and Information Center (NTAE) shared measures on the **Nutrition Incentive Hub website** (<https://www.nutritionincentivehub.org/>).⁷³ Related, technical assistance specific to evaluation and dissemination of results could aid practitioners with using standardized measures across programs to better determine impacts of food access interventions.

Adoption Specialty crop production

Data detailing reasons for adopting specialty crop production was limited in the scoping review. Through the expert interviews, producers described genuine care for the populations and clients they served and wanted to make a difference in their community through providing healthy, locally grown produce. Various reasons for growing specific specialty crops were reported, such as market/consumer demand, profitability, and practicality in terms of shelf stability and what grows well in the area. Two interviewees discussed the environmental challenges (namely, soil and nutrient degradation) of initiating the production of specialty crops on land that was formerly used for row crops. Due to the intensive practices of row crop production, existing studies have identified this as a major barrier to transitioning to specialty crop production because of additional time, labor, and improvements needed to restore soil health.^{74,75}

There are multiple organizations, including the State Growers Association, the USDA Specialty Crop Research Initiative, and The Nature Conservancy, that are dedicated to promoting the adoption of specialty crop production and providing support and education to farmers who are interested in sustainable growing practices. One challenge is that little public funding is available for the research and development of specialty crops.⁷⁶ To increase adoption of sustainable practices, funding sources from federal agencies (e.g., the USDA) to local community foundations can provide financial investments, training and resources, and motivations for producers to adopt desired changes.

For example, the USDA Climate Hubs and Sustainable Agriculture Programs offer a wide range of resources and grant opportunities related to specialty crops.^{77,78} Recently, on August 23, 2023, USDA announced funding for the 2023 Specialty Crop Block Grant Program (SCBGP) which provides grants to state departments of agriculture to fund programs that enhance the competitiveness of specialty crops.⁷⁹ With this grant, funding will be distributed to state programs across the U.S. that are investing in projects to address the needs of specialty crop producers.⁷⁹

In addition, in order to develop a deeper understanding about adoption of new practices, Kuehne, et al. created the Adoption and Diffusion Outcome Prediction Tool (ADOPT) to estimate the level and adoption rate among farmers for a wide range of agricultural practices.⁸⁰ This could be particularly valuable for those investing in agricultural research and development or those advocating for policy change, as it helps predict adoption outcomes for new and novel farming practices and identify necessary changes for implementation. Utilizing and sharing the results of assessments such as the Bruce, et al. study on high tunnel adoption, as well as increasing funding for these types of evidence-based practices, could also increase the likelihood of local adoption of practices that show promise in strengthening economic success and supporting local food systems.³²

For future studies, incorporating a wide range of operations and producer types will ensure adequate representation of different players in the food systems in the Midwest, e.g., small to mid-sized operations and beginning or socially disadvantaged farmers. Though progress has been made in enhancing diversity within the agricultural workforce in recent years, minorities are still underrepresented in farming.⁸¹ Groups such as the National Society for Minorities in Agriculture, Natural Resources, and Related Sciences (MANRRS) and the Midwest Farmers of Color Coalition are working to empower and promote minorities in farming through addressing barriers that are unique to farmers of color, such as issues procuring loans. Diversification and inclusion can help build a stronger, more innovative food system, particularly when it comes to sustainability and regeneration. A 2021 report released by the New York State Department of Agriculture and Markets'

Diversity and Racial Equity Workgroup included 21 recommendations to make agriculture more inclusive, including increasing access to education, land, and capital, as well as state agricultural department reforms.⁸²

Food access interventions

Interviews revealed that adoption of programs among food access practitioners was often related to the mission of the organization and/or passion and interests of the individuals. To increase adoption of various interventions, funders and grant-making agencies can ensure adequate funding and tailor applications and funding guidelines to balance organizational and community needs.

Implementation

Specialty crop production

Producers discussed the wide variety of specialty crops currently being grown for community members. Being in the Midwest, producers adapted to climate-related weather conditions and often used sustainable practices including hoop houses, no-till practices, and interplanting to reduce inputs (e.g., water use, chemicals, fertilizers) and increase yield while also preserving the land. Preserving soil through cover cropping, crop rotation, and using high tunnels and hoop houses to extend the growing season are strategies used to support farms during the growing season and potentially beyond.^{83,84} As identified in the scoping review and qualitative interviews, many farms have adopted a number of conservation practices, including local specialty crops and organic cropping systems. For example, compared to 2012, the practice of cover cropping in 2017 has increased by 50 percent - from planting 10.3 million acres of cover crops to 15.4 million acres. This increase is likely a direct result of additional financial incentives to support farmers' soil health management practices.⁸⁴ While many farms already have efficient practices, recent literature has promoted circular economy approaches, a strategy to minimize the influx of resources and waste by keeping materials in circulation for as long as possible, to reduce the use of inputs, agriculture-related waste, and negative impacts and increasing economic profit.^{85,86}

According to recent reports, specialty crops are more vulnerable to climate change impacts compared to traditional row crops.⁸⁷

Temperature and precipitation fluctuations, especially across the Midwest, are critical factors in the quantity and quality of specialty crop production. Reduced production yield along with changes in nutrients and visual appeal related to climatic stressors can impact consumer purchasing and willingness to pay premium prices.⁸⁷ With the Midwest climate expected to undergo changes in the future, continuing to find innovative ways to reduce challenges and seek new growth opportunities is important.⁶ Climate change is also expected to lead to increased weed, disease, and insect pest pressures, impacting crop management decisions and productivity for producers.⁸⁸ With producer practices being challenged through climate change, it is vital that production strategies continue to be expanded on and researched so local food systems can continue to grow food for and help reduce food insecurity in local communities.

Food access interventions

Many articles did not describe the use of a theory, framework, or model (TFM) in developing or evaluating food access interventions. TFMs support the successful implementation of interventions and guide the development of practice-related research questions and hypotheses to optimize efforts.^{89,90} Frameworks can support interventions at both the implementation phase and when evaluating interventions to explore outcomes.⁹¹ The lack of framework use – especially for program evaluation – was also observed through the expert interviews. Many food access practitioners discussed interest in evaluation but explained that barriers, such as finances, staff time, and capacity of the organization, did not allow for formal data collection and analysis to evaluate outcomes. Lastly, similar to many food and nutrition programs, intervention components varied and typically included multiple components ranging from nutrition education to gardening programs. Although multilevel interventions are recommended,⁹² the effectiveness of each component is not yet clear, and future studies should examine core versus adaptable components of food access interventions.⁹³

Connecting specialty crop production with food access interventions

Food access practitioners reported that they benefited from being surrounded by local food production and often distributed seasonal produce for limited income or food insecure program participants.

Partnerships were critical aspects that supported program implementation and success. These partnerships spanned most community sectors, including schools, businesses, government, Cooperative Extension, and environmental advocacy groups. To achieve food and nutrition security while supporting a sustainable food system, all stages from food production and sustainable food waste management should be supported. Specifically, specialty crop producers must have markets that ensure profit, and healthy food produced must be accessible and affordable to diverse populations, especially those with limited resources (e.g., income, transportation, healthcare).

Communities with strong local food systems bridge the gap between producers and consumers while also connecting all invested parties involved in any and all stages. Relationship building is critically important to develop cross-sectoral partnerships that are not always obvious, e.g., strong local government ties and engagement with municipal planners can better support agricultural practices, food production, and therefore, access to locally grown produce to food insecure populations. Since each community and food system is unique, we recommend place-based approaches that identify appropriate solutions to specific needs to the Midwest region. For example, food policy councils (FPCs) often engage in community-specific issues and provide opportunities to strengthen the local food system, however, one of the largest barriers is the lack of funding to accomplish long-term, sustainable goals.⁹⁷ By providing funding and technical assistance to build a food systems network through FPCs, communities can identify promising solutions to support local and sustainable food production.⁹⁷

Maintenance

Specialty crop production

Long-term individual-level maintenance and program sustainability data in the scoping review were lacking. However, our review did highlight the use of the media and organization- and community-wide educational outreach as being common methods of disseminating and scaling different production approaches. More investigations are needed on which dissemination sources and channels are most effective for producers to share and receive reliable information on production practices (e.g., how to manage specific insect and disease outbreaks or develop fruit and vegetable varieties suitable for local conditions).⁷⁶

In the interviews conducted for this study, most producers wanted to continue their work; however, several mentioned the labor-intensive needs of farming. According to the USDA's Census of Agriculture, the US farming system is changing as the agricultural labor force is becoming older and the generation of family farmers is dwindling.⁹⁸ However, there are initiatives to increase specialty crop production across beginning and BIPOC (Black, Indigenous, People of Color) farmers.^{99–101} In recent years, the USDA has provided additional funding for specialty crop grants,¹⁰² sustainable agriculture and climate-smart practices,⁷⁸ and socially disadvantaged, beginning, limited resource, and women farmers.¹⁰³ Continued resources and funding are needed to bolster sustainable food systems and specialty crop production.¹⁰⁴

Taken together, the complexities associated with specialty crop development, ranging from lack of information to drastic changes in climate, are significant barriers to the development of substantial, long-term, and coordinated production efforts. To sustain and support the growth of the specialty crop industry, there is a need for future research to include a focus on sustainable practices, robust evaluation, and increased partnerships with research institutions and Cooperative Extension efforts.

Food access interventions

The scoping review uncovered several barriers to the sustainability of food access interventions across the Midwest, with limited funding being the most recurrent. Moreover, many reports suggested that innovative approaches to dedicated funding and buy-in from the community members were needed for long-term program sustainability and expansion. According to Kim, 2016, little public funding is available for the research and development of specialty crops which is evidenced.⁷⁶ As mentioned above, the USDA recently announced funding for the 2023 Specialty Crop Block Grant Program (SCBGP) which provides grants to state departments of agriculture to fund programs that enhance the competitiveness of specialty crops.⁷⁹ With this grant, funding will be distributed to state programs across the U.S. that are investing in projects that will help address the needs of specialty crop producers.⁷⁹ In addition to funding, building evidence to show successful outcomes and developing policy-level support have been identified as facilitators to sustaining food access interventions.⁹³

Overall health and environment impacts

One remaining question is the relationship between the existence of specialty crop production and the overall impact of food access points. That is, while food access practitioners perceived that they benefitted from proximity to local food production, it is unknown if the presence of specialty crop production in a community leads to the initiation of food access sites such as farmers' markets and CSAs. And, it is unknown if food access points using local produce achieve better public health outcomes for the community members they serve versus those providing non-local produce (specialty crops shipped in from outside the local area).

Only one study included in the scoping review examined local vs. distant specialty crop production. The study compared unheated hoop house lettuce production in Michigan to a hypothetical scenario of shipping lettuce from California, and found that local production had a smaller carbon footprint.⁴² However, no health or nutrition outcomes were included. Research in this area is limited, with scant evidence that purchasing local produce is associated with improved dietary intake. Future studies should compare the public health impacts of food access interventions that use local vs. distant specialty crops. For example, there may be differences in adoption (the number of food access sites in a community), implementation (the degree to which healthy foods are provided), or maintenance (long-term institutionalization of food access interventions) in communities with greater availability of local specialty crops.

Taken together, the scoping review and in-depth interview findings confirm that specialty crop production shows promise for positively impacting the environment and potential to improve community food access, yet more research is needed to identify direct and measurable environmental and health impacts. Although there is more literature and USDA research on organic and conventional farming (e.g., USDA's Census of Agriculture), the USDA did not start publishing detailed reports on specialty crop production until authorized in the 2014 Farm Bill.⁸³ Specialty crop production falls between organic and conventional methods because producers often follow organic production practices but are not required to (unless certified USDA organic),¹⁰⁵ resulting in the difficulty to quantify impacts as inputs and practices vary by farm.

Building on existing literature, our findings indicate that more large-scale studies are needed to show stronger links between specialty crop production and environmental benefits. For example, robust studies can increase the number of specialty crop production sites across different geographic regions while comparing the same, standardized outcomes. Until large-scale studies are conducted for specialty crop production, impacts (if consistent and standardized) cannot be compared with conventional methods. Similarly, the direct impacts of specialty crop production on human health and nutrition are difficult to assess due to complexities of the food system. While studies comparing the nutritional density of organic and conventional foods exist, there is insufficient evidence to show that local foods positively impact dietary quality and food security.¹⁰⁵ Specialty crops in the Midwest are distributed primarily through farmers' markets, grocery stores, and restaurants – each of which reach different populations and have varying levels of effectiveness on improving health and nutrition. There is evidence that direct-to-consumer distribution channels (farmers' markets, CSAs, you-pick) improve dietary intake and health, but that community members with lower incomes face challenges accessing these farm-direct venues.¹¹ Therefore, connecting local growers with food access practitioners to form partnerships can strengthen the local food system and increase food access for limited resource populations (e.g., limited transportation, rural areas). As well, increasing specialty crop production through increased numbers of producers beginning production (or converting a portion of row crop production) is needed to expand this impact and overcome the challenges of an aging farming workforce.

A final question is the relationship between the existence of specialty crop production and the overall impact of food access points. That is, while food access practitioners perceived that they benefitted from proximity to local food production, it is unknown if the presence of specialty crop production in a community leads to the initiation of food access sites such as farmers' markets and CSAs. In the qualitative interviews, specialty crop growers shared that they often donated excess produce to food access organizations, and food access programs received food donations from local growers. Therefore, it is unclear whether one drives the other, but it is clear that there are mutual benefits.



Recommendations

To continue promoting agricultural practices and food systems that benefit both human health and the environment – and to better quantify these impacts – recommendations based on the landscape analysis are provided. Guided by the RE-AIM framework, the four recommendations may increase the success of specialty crop production and food access programs' **reach, effectiveness, adoption, implementation, and maintenance.**

Recommendation 1:

Expand and foster connections between specialty crop producers and food access sites.

- **Support farmers to identify distribution channels** to increase demand for specialty crops and create targeted marketing strategies to improve reach and accessibility.
- **Facilitate opportunities to connect invested parties** across the food system to collaborate and address cross-sectoral issues related to the food system through local coalitions or food policy councils.
- **Provide funding and technical assistance to support local food policy councils** and/or other coalitions connecting specialty crop producers and food access practitioners.
- Require local food policy councils/coalitions to **use community-based principles** and include community members with lived experience of food insecurity to address food access and affordability challenges.

Recommendation 2:

Engage producers, food access sites, and community members in efforts to increase food recovery.

- **Gather feasible and profitable options** for secondary markets that would increase specialty crop producers' income and divert food waste.
- **Identify local opportunities to reduce food loss and waste** from production to waste management by applying the Environmental Protection Agency's Food Recovery Hierarchy.
- **Conduct targeted marketing approaches** or social marketing campaigns to increase awareness and demand for recovered produce or products.
- **Explore ways to divert food from the landfill** by sharing infrastructure or resources across the food supply chain that increases food recovery between producers and food access providers.

Recommendation 3:

Fund promising specialty crop practices with robust evaluation.

- **Provide funding to producers** using practices with high potential to contribute to environmental health and adapt to climate change (e.g., high tunnels, hoop houses).
- Structure funding opportunities to **require better measurements of environmental impacts** (e.g., GHG calculators for diversified, small farms; better soil health measures).
- Structure funding opportunities to **prioritize large-scale, robust study designs** (e.g., natural experiments to compare conservation practices across various geographical sites)
- **Prioritize funding for diverse operations and producers** (including socially disadvantaged farmers) to strengthen food systems and meet the needs of diverse communities.
- Fund studies that **investigate the difference between local produce and conventional produce** and the impacts local produce has on the environment and local community health.

Recommendation 4:

Fund food access organizations that alleviate barriers to access.

- **Provide funding to food access organizations** that connect with local producers and serve populations experiencing health disparities.
- **Provide funding for place-based innovative solutions** that alleviate access barriers (e.g., through providing transportation in rural areas or delivering produce to communities with low access areas).
- **Require measurement through standardized FVI or nutrition security measures** and provide technical assistance to use and report on these measures.
- **Require food interventions to be evidence-based** and use a theory, model, or framework.



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Appendix

Table 2. Reach and effectiveness of scoping review sources examining environmental impacts of specialty crops in the Midwest (n=13)

Author(s), Year	Site	Distribution channel	Study objectives	Study design	Environmental outcomes	Outcome measures	Results
Bender, 2017 ³⁴	WI	Farmers' markets, co-op accounts.	To evaluate a strategy for increasing soil organic matter and soil microbial activity by adding a decomposition specialty fungus to process raw organic amendments and to suppress plant disease while cultivating a cash crop of mushrooms.	Measured changes in soil health parameters including microbial activity and soil organic matter in tomato plots with and without wine cap fungus.	Soil health, disease presence, and severity.	Soil samples were tested for pH, percentage of soil organic matter, phosphorus, potassium, magnesium, calcium, cation exchange capacity, sulfur, boron, manganese, color and microbial activity. Plants were assessed for disease presence, severity, and plant vigor.	Unable to determine if wine cap mushrooms improved soil health within a two-year timeframe. There was no significant difference in disease presence in tomato plants grown with or without wine cap fungus, but there were significant differences in plant vigor and overall health, tomato yield, and weed suppression results.
Bohner, 2015 ⁴³	MO	Restaurant, mail-order, you-pick operation	To establish a replant/reclamation protocol that will allow for the successful rebuilding of a declining blueberry field using soil amendment treatments.	Collected and compared average values recorded for the trial groups of plants treated with each soil amendment (worm inclusion, worm castings tea, ground pine bark, composted shiitake log spent coffee grounds, all amendments).	Plant quality.	Height of plant measured to its longest cane, number of viable new shoots, fall color progression, general vigor of plant.	Control plants without soil amendments had higher vigor than fully amended plants and those whose soil was amended with ground pine bark alone. Control plants without soil amendments had longer cane growth than those amended with worm tea or ground pine bark. Control plants without soil amendments showed less fall color change, (plant stress indicator) than did plants with all amendments. Plants with coffee ground amendments had significantly less color change than control plants. There was no significant symbiotic effect among the combination of amendments.

Author(s), Year	Site	Distribution channel	Study objectives	Study design	Environmental outcomes	Outcome measures	Results
Bruce, 2017 ³²	IN	Local food system venues.	To investigate the overall impact of using high tunnels in terms of crop yields and crop/soil quality, and to investigate if farmers who obtained their high tunnels with support from Environmental Quality Incentives (EQI) Program differ from those who purchased some or all of their tunnels without support from the program.	Exploratory, cross-sectional surveys.	Product diversification, production, pest and disease issues, environmental impacts.	Likert-style survey questions.	Survey respondents (n=103 farmers) responded that the high tunnel significantly increased crop yields, significantly reduced negative environmental impacts, improved disease and weed problems in crops, and improved quality of harvested products. Farmers who self-funded high tunnels (vs. obtaining through the EQI Program) were more likely to indicate that growing in high tunnels increased overall yields, allowed the harvesting of warm season crops earlier in the season, improved the quality of the harvest, and reduced pest problems. There was no significant difference in product diversification.
Jelinski, 2017 ³¹	MN	Community gardens, urban farms.	To evaluate metrics of ecosystem services provided by urban agricultural management practices.	Compared and contrasted urban agricultural management plots with a control (turfgrass and unmanaged vacant lots). Three practices were evaluated: no amendment, compost amendment, and a "Growers Choice" practice, where growers leverage data collected to explore questions on their own.	Crop yields and plant quality, soil quality, insect biodiversity.	Crop yield. Plant quality. Soil quality. Soil quality: organic carbon, pH, nitrate, ammonium, available phosphorous and exchangeable potassium, bulk density, soil texture, aggregate stability, infiltration and hydraulic conductivity. Insect biodiversity: vegetative diversity and ground cover.	Crop yield: results found that existing soil quality may be more important than deciding which, if any, amendments to apply when establishing a new food production site in an urban area. Soil quality: phosphorus concentrations under urban agriculture were higher than those under adjacent turf grass. Soil potassium concentrations declined across all treatments. Physical metrics of soil quality found that saturated hydraulic conductivity was higher in the top 30 cm under urban food production areas than under adjacent turf grass areas, which may be in part due to increased organic matter rich amendment applications and tillage practices. Insect biodiversity: the abundance and richness of key arthropods differed among all garden sites and can be related to the local and surrounding ecosystem.

Author(s), Year	Site	Distribution channel	Study objectives	Study design	Environmental outcomes	Outcome measures	Results
Mareske, 2017 ³⁷	MI	Farmers' markets, with plans to develop a you-pick operation for blueberries.	To determine whether biochar can be a useful soil amendment when growing blueberries in highly alkaline heavy clay soils.	Assessed the environmental benefits of biochar use. Used biochar on .25 acre with usual sustainable practices; on the other .25 acre, used same practice minus the biochar.	Soil health/ quality, plant health/growth (after the study is over)	Soil tests (pH).	The addition of the soil amendments (primarily the sulfur and pine bark) lowered the pH by one point.
Plawecki et al, 2014 ⁴²	MI	Campus dining halls (Michigan State University also assists in building similar hoop house across Michigan).	To assess cold-season hoop house lettuce production in the context of local food systems' relative environmental effects and compare the carbon footprints of leaf lettuce production in two climatic zones, one close to the consumer market and one distant, via environmental impact modeling.	The sustainability of outdoor and hoop house lettuce production (as components of a supply chain complete to retail outlet) were evaluated using two International Standards Organization—compliant environmental impact assessment methods.	Carbon dioxide emissions (carbon footprint).	The Greenhouse Gas protocol, which reported kilograms of carbon dioxide produced per unit of leaf lettuce, and the Eco-Indicator 99, which measured eco-factor points of production methods in three impact categories (human health, ecosystem quality, and resources).	Unheated, hoop house lettuce production has a smaller carbon footprint than outdoor, distant production. Power generation and diesel consumption emitted high levels of respiratory inorganics emissions, contributing to most human health effects. The most environmentally damaging production stage was construction of the hoop house. Producing one kilogram of leaf lettuce using an unheated greenhouse resulted in emissions of .198 kg carbon dioxide. Lettuce production, only when part of a truly localized supply chain, would incur fewer kilograms carbon dioxide per hectare.

Author(s), Year	Site	Distribution channel	Study objectives	Study design	Environmental outcomes	Outcome measures	Results
Randolph, 2020 ³³	IN	Farmers' markets, community supported agriculture, food boxes, and produce bags.	To determine which organic amendments to add to soil and test productivity to determine nutrient density in an urban farm.	Two different soil amendment mixtures were tested.	Produce growth rate, appearance, and disease resistance.	Produce observations.	Using worm casting and azomite in both the greenhouse and in garden rows resulted in increased yields, larger produce (peppers and tomatoes) and less disease. There were no notable differences when comparing a worm castings/biochar combination to traditional worm castings.
Reeves et al, 2014 ⁴⁰	OH	Community gardens and market gardens	To document the yield and soil health in urban gardens as a function of their type, history, and management.	Analyzed nematode food web and crop productivity via tomato fruit yield in community and market gardens.	Analyzed nematode food web and crop productivity via tomato fruit yield in community and market gardens.	Soil organic matter: weight loss during ignition, soil texture: modified pipette and sieving technique, soil pH: combination glass electrode, soil microbial nitrogen: chloroform fumigation extraction of soil, nematodes: Baermann funnel technique, tomato productivity: gardener self-report of harvest.	Results showed a large variation in sand, silt, and clay content, and pH. Across two years, soil moisture, soil organic matter, nematode food web combined maturity index, leaf dry weight ratio, and plant surface areas were significantly higher in market than community gardens. There were no significant differences in sand, silt, or clay content, pH, nematode abundance, or overall tomato yield.

Author(s), Year	Site	Distribution channel	Study objectives	Study design	Environmental outcomes	Outcome measures	Results
Seabrook, 2016 ³⁶	OH	Farmers' markets.	To reduce food waste by working with local farmers to use their seconds and between market produce to create a value-added shelf product to sell to the community.	Glass Rooster Cannery partnered with local producers to co-create value-added products and assess pounds of produce saved.	Climate change, air quality.	Pounds of food waste saved.	Around 12,000 lbs. of potential food waste were used to create 8,000 jars of product. One farmer donated their product to a school in a food desert.
Sundin, 2006 ³⁵	MI	Fresh sales.	To evaluate the effect of foliar copper sprays in tart cherry management on the control of key diseases and the re-reduction of soft fruit at harvest, and to assess the potential of copper-hyperaccumulating plants in removing copper from agricultural soils.	Replicated field plots were set up and various spray treatments of copper fungicides were used and compared to conventional fungicide programs. Remediation experiments were conducted using alfalfa plants, which were tested under greenhouse and field conditions for their ability to accumulate copper from soils.	Disease management, plant quality, soil health	Disease ratings: percentage of infection due to cherry leaf spot, brown rot, and powdery mildew. Soft fruit: measure not specified. Soil health: copper content in soils, copper content in alfalfa roots and shoots.	Consistent, positive results were observed for copper efficacy against cherry leaf spot. Application of copper resulted in orchards with slightly less incident of soft fruit. There was no evidence of copper accumulation into the roots or shoots of alfalfa plants. These results led to an additional study on the use of copper-resistant soil bacteria; copper levels decreased in two orchards showing bacteria are effective in binding copper in soil.
Taylor et al, 2015 ⁴¹	IL	Urban home food gardens.	To compare food crop diversity and assess chemical and physical properties of garden soils.	Mixed-methods study including analysis of chemical and physical properties of garden soils	Food crop diversity, chemical and physical properties of garden soils (texture, nutrients, pH, soil organic matter, heavy metals, rate of water infiltration).	Food crop diversity: total number of taxa, taxa per square meter of total garden area; similarity: proportion of common crops between sites/groups; chemical/physical soil properties: 30-cm soil samples.	Crop plant diversity was similar across three groups of gardens (African American, Mexican, Chinese origin). Phosphorus and potassium levels often far exceeded levels required for optimal plant growth. Infiltration rates were high, which may mitigate the environmental impact of overfertilization. Soil organic matter was high across garden sites.

Author(s), Year	Site	Distribution channel	Study objectives	Study design	Environmental outcomes	Outcome measures	Results
Ugarte, 2020 ³⁹	IL	Private home gardens, community gardens, institutional farms, and private urban farms.	To evaluate soil quality characteristics in urban sites currently used for vegetable production across an urban to peri-urban gradient.	Classified 21 urban sites currently used for vegetable production based on the scale of management as private home gardens, community gardens, institutional farms, and private urban gardens. Quantified indicators of soil fertility, nematode trophic composition, food web status, and concentrations of soil contaminants.	Soil fertility, nematode trophic composition, and indicators of the food web status.	Soil tests.	Nematode analysis suggested that communities differ across sites based on their scale of management and are likely influenced by soil organic matter and soil pH. Soil fertility was significantly increased by management, particularly in community gardens and urban farms. Community gardens had a higher proportion of bacterial feeding nematodes compared to home gardens and institutional farms, which had greater proportion of plant parasitic families, relative to community gardens. Indicators of soil fertility revealed excessive concentrations of nutrients across sampled locations. Excessive levels of phosphorus and potassium observed in community gardens and urban farms did not contribute to yield.
Welbel, 2021 ³⁸	IL	Local food pantries, regenerative farmer cooperative.	To determine the difference in survival rate and growth in trees planted with and without biochar and compare quality of biochar produced from wood waste in a retort kiln and in a "Kon-tiki" open flame-curtain kiln.	Conducted field trials in windbreak and orchard by planting equal numbers of trees in control plots of untreated soil and experimental plots with biochar application. One quarter mile of trees in the windbreak served as the test plot.	Soil management, plant health/growth.	Soil tests, plant height, and stem circumference.	Based on quantitative data, it was determined that biochar as a soil amendment did not hinder plant growth and appears to have supported it.

Table 3. Adoption, implementation, and maintenance of scoping review sources examining environmental impacts of specialty crops in the Midwest (n=13)

Author(s), Year	Number and characteristics of farms	Number and characteristics of personnel	Production type	Production practices	Crops	Implementation costs	Sustainability	Scaling
Bender, 2017 ³⁴	A 41-acre commercial farm in operation for over 30 years.	Two farmers who have been growing mushrooms commercially for over 30 years and have authored several mushroom cultivation-related publications.	Not specified	Biological inoculants, tillage, cover crops, multiple cropping, nutrient cycling, organic fertilizers, water management. Integrated pest management, biological and physical control, mulches. Integrated crop and livestock systems, permaculture. Nutrient mineralization, organic matter.	Tomatoes, wine cap mushrooms.	Funded by a \$7,500 SARE grant in 2017.	Not specified	The concept and results of this study were disseminated through lectures, workshops, farmer consultations, social media, research poster display, and a podcast episode.
Bohner, 2015 ⁴³	Nine acres of cultivated land: 7.5 acres blueberries, 1 acre blackberries, .33 acres elderberries, few rows of plums and gooseberries.	The operation has been in place since 1982 with current personnel consisting of two owners, five full-time workers, and a bookkeeper.	Not specified	Not specified	Blueberries, blackberries, gooseberries, plums, shiitake mushrooms, and elderberries.	Funded by a \$7,496 SARE grant in 2015.	Data collection will take place for several years to monitor for potential changes.	Visited by local master gardeners' program and participated in gatherings sponsored by the University of Arkansas Plant Science Department.
Bruce, 2017 ³²	2,935 specialty crop farms were operating in Indiana; 178 farmers were estimated to own high tunnels.	Historically underserved (socially disadvantaged, with fewer than ten years of experience, limited-resource) farmers. Primarily male with over 13 years of experience farming.	Not specified	Recipients of cost share funding must grow crops directly in the soil and must plan supportive conservation practices to address environmental concerns associated with the installation/use of high tunnels such as erosion, irrigation, and runoff.	General specialty crops.	Supported by the Indiana State Department of Agriculture Specialty Crops Block Grant program.	Not specified	Not specified

Author(s), Year	Number and characteristics of farms	Number and characteristics of personnel	Production type	Production practices	Crops	Implementation costs	Sustainability	Scaling
Jelinski, 2017 ³¹	For-profit grower, non-profit grower, community garden.	Not specified	Not specified	Cover crops, nutrient cycling, nutrient management, organic fertilizers, pollinator habitat, water management.	Cabbage, leafy greens, sweet corn, tomatoes, collard greens, bell peppers, bush beans, carrots.	Received \$198,529 in funding from SARE grants in 2017.	Not specified	Not specified
Mareske, 2017 ³⁷	39.5 acres. 34 acres are forest, 5 are pasture. About .5 acre will be dedicated to blueberries.	A husband and wife.	Will be applying for a cost share in organic certification in several years.	Tilling, cover crops (clover), soil enhancements/ amendments (pine bark, compost, sulfur, green sand, rock phosphate and cottonseed meal), mulch, and 3-D electric fence for deer.	Blueberries.	Funded by a \$7,500 SARE grant in 2017.	Not specified	Results were shared throughout the organization and community, and with a biochar scientist in the region. Two field days took place where local students and farmers engaged in demonstrations of moving mulch and planting blueberries on the farm.
Plawecki et al, 2014 ⁴²	The network included Michigan State University's Student Organic Farm: four 30' x 96' houses.	Not specified	Organic and conventional.	Organic hoop house - tilling, compost produced at a nearby utility.	Lettuce.	Not specified	Not specified	Not specified

Author(s), Year	Number and characteristics of farms	Number and characteristics of personnel	Production type	Production practices	Crops	Implementation costs	Sustainability	Scaling
Randolph, 2020 ³³	Two 25-acre lots, one .125-acre urban garden, and one 2.5-acre farm.	Two farmers of a family-owned urban farm in Indianapolis.	Organic.	Soil enrichment.	Strawberries, beans, broccoli, brussels sprouts, cabbages, carrots, cauliflower, cucurbits, eggplant, garlic, greens, leeks, okra, onions, peas, peppers, radishes, tomatoes, and herbs.	Funded by a \$23,648 SARE grant in 2020.	Not specified	Not specified
Reeves et al, 2014 ⁴⁰	Ten urban garden sites (4 community gardens and 6 market gardens) established on urban soil between 1906-2010.	Not specified	Not specified. Used organic seed starter.	Not specified	Tomatoes.	Not specified	Not specified	Not specified
Seabrook, 2016 ³⁶	Not specified.	Eight farmers in rural Central Ohio were involved in the project.	Not specified	Food product quality/safety.	Apples, melons, beeches, strawberries, blueberries, asparagus, beans, beets, cabbages, carrots, cucurbits, garlic, onions, peppers, and tomatoes.	Funded by a \$7,500 SARE grant in 2016.	Community relationships were strengthened through the project and will continue to grow. Additional goals are to increase the number of farmers and expand the number of products processed.	Not specified.

Author(s), Year	Number and characteristics of farms	Number and characteristics of personnel	Production type	Production practices	Crops	Implementation costs	Sustainability	Scaling
Sundin, 2006 ³⁵	Six organic tart cherry orchards in northwest Michigan.	Not specified	Organic and conventional.	Fungal disease management.	Tart cherries.	Funded by a \$145,500 SARE grant in 2006.	Copper use in northwest Michigan for cherry leaf spot control has increased by 15% in a three-year period.	Results were incorporated into Michigan State University Cooperative Extension programming for Michigan tart cherry growers. The information has spread to Wisconsin and Ontario tart cherry growers, who are now using copper in their orchards.
Taylor et al, 2015 ⁴¹	Thirty-one urban home food gardens.	Thirty-one gardeners. 32% Mexican-origin, 32% Chinese-origin, and 35% African American.	Not specified	Passive forms of nutrient cycling, including burying kitchen and garden waste in gardens.	Fruits, root vegetables, leafy vegetables, squash vegetables, cruciferous vegetables, chilies, herbs, poke sallet, tropical corn, sugarcane, pigweed, melons, lemongrass.	Not specified	Not specified	Not specified
Ugarte, 2020 ³⁹	Seven community gardens, six farms, six home gardens, and two institutional farms were sampled.	Not specified	Not specified	Establishment method (in ground with native soil vs. raised beds filled with compost-top soil mix), minimal/no tillage.	Tomatoes, summer squash, peppers, kale, and collard greens.	Not specified	Not specified	Not specified

Author(s), Year	Number and characteristics of farms	Number and characteristics of personnel	Production type	Production practices	Crops	Implementation costs	Sustainability	Scaling
Welbel, 2021 ³⁸	A total of 20 acres of land.	Two farm owners who are sixth generation farmers on the land.	Not specified	Low/no till farming, cover crops, soil amendments such as biochar and basalt, agroforestry system (including two shelterbelts), use of native and perennial species in our agroforestry and horticultural crops.	Apples, pears, persimmons, chestnuts, hazelnuts.	Funded by a \$7,609 SARE grant in 2017.	Not specified	Shared findings through website and social media, research presentations, and educational outreach.

Table 4. Reach and effectiveness of scoping review sources examining health and nutrition impacts of specialty crops in the Midwest (n=15)

Author(s), Year	Site	Distribution channel	Study objectives	Study design	Health outcomes	Outcome measures	Results
Baker et al, 2013 ⁴⁷	MO	Rural community gardens.	To work with local coalitions in rural communities within the United States to complement existing programs (focused primarily on increasing knowledge, skills, and social support) by increasing access to produce through the development of community gardens.	Used a mixed methods design to assess intervention impact.	Fruit and vegetable consumption and food security.	Post-test quantitative and qualitative data (which included USDA's food security questionnaire and Behavior Risk Factor Surveillance System), face-to-face community garden surveys, and focus groups.	Survey respondents (n=50) noted that they ate more vegetables and fruit (88%), ate less fast food (72%), and spent less money on food (76%). Almost 50% of those who self-identified as being food insecure indicated that they were better able to provide food for themselves and their families (86%) as well as donate food to others (81%) because of taking part in the garden. A key theme identified in the qualitative data was related to the benefits of community gardens. Respondents stated that the community benefitted by increased access and spending less money on food.
Barnidge et al, 2013 ⁴⁵	MO	Community gardens.	To explore the association of community garden participation and fruit and vegetable consumption in rural communities.	Conducted two complementary studies. One was a quantitative, self-administered, post-intervention intercept survey with a convenience sample of community gardeners from the 12 intervention gardens. The other was a cross-sectional, population-based survey with a random sample of 1,000 residents within the intervention catchment area.	Fruit and vegetable consumption.	A population survey that measured fruit and vegetable consumption via six items from the 2009 Behavioral Risk Factor Surveillance System, and a community survey that included one item asking about consumption of fruits and vegetables.	Participation in a community garden was associated with higher fruit and vegetable consumption by survey respondents (n=1,000). Individuals who worked in a community garden at least once a week were more likely to report eating fruits and vegetables. Adult community gardeners (n=141) who responded to the community garden intercept survey reported community garden participation were more likely to report eating fruits two or more times per day and vegetables three or more times per day than those who did not report community garden participation.

Author(s), Year	Site	Distribution channel	Study objectives	Study design	Health outcomes	Outcome measures	Results
Barnidge et al, 2015 ⁵⁶	MO	Community gardens.	To present the mid-intervention results of Men on the Move Growing Communities, a nutrition education and food intervention for African Americans.	Conducted a quasi-experimental study with a comparison group.	Blood pressure and body mass index.	Blood pressure measurement and cross-sectional surveys including self-reported blood pressure and body mass index.	In the intervention county, 61% of all participants (n=389) were hypertensive at baseline compared with 45% at mid-intervention. In the comparison county (n=303), there was no change from baseline to mid-intervention. The prevalence of overweight and obese survey participants declined from 70% to 61% in the intervention county, with no change in the comparison county.
Castellanos et al, 2016 ⁵⁴	OH	Farmers' markets, community gardens, and community supported agriculture.	To explore Community Food Security Initiatives (CFSI) in low-income areas and examine the effects of the initiatives along with the other social-cognitive factors on fruit and vegetable consumption in participants.	Mixed methods including survey of both Community Food Security Initiatives (CFSI) participants and non-participants assessing fruit and vegetable intake, dietary-related social cognitive behavior, and socio-demographics.	Fruit and vegetable consumption.	The Eating at America's Table Quick Food Scan developed by the National Institute of Health used to estimate daily fruit and vegetable intake.	Surveys from targeted zip codes were completed (n=128). Dietary-related social-cognitive factors, not CFSI participation, were independent predictors of fruit and vegetable intake. Food initiative participation was not significantly related to fruit and vegetable intake.
Freedman et al, 2021 ⁵⁹	OH	Food hub, which included a local produce market and a healthy food café.	To externally evaluate food hub implementation and its impact on changes to the built and social environment and dietary patterns among residents living in the intervention neighborhood versus those in a comparison neighborhood.	Quasi-experimental, longitudinal design with data collection at baseline, 12 months, and 24 months. Implemented a food hub in the intervention neighborhood in Cleveland, Ohio. A comparison neighborhood with similar racial and economic composition and access to healthy food retailers was selected in Columbus, Ohio.	Diet quality scores, total caloric intake, and fruit and vegetable consumption.	24-hour dietary recalls at baseline, 12 months, and 24 months. Diet quality scores were assessed using the Healthy Eating Index score.	Data collected from study participants (n=329) indicated that there were no changes over time in diet quality scores, total caloric intake, or fruit and vegetable intake in the intervention neighborhood (n=179). Many of the food hub components were not implemented fully, and the dose and reach of the executed food hub components was low. There were statistically significant improvements in observed availability of healthy foods in the intervention neighborhood (n=179) versus the comparison neighborhood (n=150).

Author(s), Year	Site	Distribution channel	Study objectives	Study design	Health outcomes	Outcome measures	Results
Hartwig et al, 2016 ⁴⁹	MN	Community gardens.	To evaluate a church-based community garden initiative for refugee gardeners.	Surveys were distributed during pre- and post-season gardening.	Fruit and vegetable consumption and food security.	A preexisting food behavior checklist was used to assess fruit and vegetable intake; an internationally validated set of food security questions developed by the Food and Agriculture Organization of the United Nations was used to assess hunger and food security.	Gardeners completed pre-season (n=94) and post-season (n=97) surveys. 64% completed both surveys; responses were not matched. At the start of the season, 64% of respondents said that they ate fruits and vegetables throughout the day “everyday” compared to 78% at the end of the season. Consumption of more than one vegetable type per day “everyday” was reported among 59% of participants at the start of the season and 67% at the end of the season.
Hopkins et al, 2018 ⁵⁵	OH	Community gardens.	To examine relationships among food security, produce intake, and behaviors related to fruit and vegetable intake in community gardeners.	Surveyed all individuals with community garden plots in Athens, Ohio using a cross-sectional study design.	Fruit and vegetable consumption and food security.	Used the Intake in Low Income Communities questionnaire, Food Behavior Checklist for a Limited Resource Audience, and the United States Household Food Security Survey Module.	Participants (n=50) reported that the community gardens contributed to eating more produce (76%). Compared to the food secure gardeners, food insecure gardeners more strongly agreed that they ate more fruits and vegetables and spent less money on food due to participating in community gardening and harvesting the produce from the garden.
Krokowski, 2014 ⁵¹	WI	Farmers' markets.	To measure the value of the farmers' market Electronic Benefit Transfer (EBT) programs to SNAP participants.	Surveyed SNAP participants using a cross-sectional evaluation to collect information on fruit and vegetable consumption with the addition of EBT as a payment option.	Fruit and vegetable consumption.	SNAP beneficiary survey.	Of SNAP participants surveyed in 2011 (n=607), 87% indicated that their fruit and vegetable consumption increased with the addition of EBT as a payment option. In 2012, 99% of 1,320 individuals surveyed increased their fruit and vegetable intake by shopping at the farmers' market.

Author(s), Year	Site	Distribution channel	Study objectives	Study design	Health outcomes	Outcome measures	Results
Neff, 2021 ⁴⁶	MO	Sliding scale cooperative grocery store.	To develop a large neighborhood lot into a market garden to be farmed by paid worker-owners that would supply food through the cooperative grocery store at sliding scale prices to members of the co-op and the broader community.	Converted a grassy lot into a productive vegetable plot and explored the benefits and limitations of a worker-owned cooperative model for urban food production through qualitative methods.	Food security.	Informal discussions with farm workers.	All participating farmers and community members (n=10) reported decreased food insecurity and a sense of improved health.
Norman et al, 2018 ⁵⁰	MN	Farmers' markets.	To determine the impact of the Power of Produce Club (incentive program for children aged 5–12) on improving child fruit and vegetable consumption at a Minnesota farmers' market.	Administered a self-reported retrospective survey.	Fruit and vegetable consumption by children at home.	Survey item: "My children eat more fruits and or vegetables at home" on a five-point scale.	41% of surveyed parents/guardians (n=96) agreed or strongly agreed that their children eat more fruits and vegetables at home after participating in PoP Club as compared to before participation.
Ohri-Va-chaspati et al, 2009 ⁶⁰	OH	"Fresh Stops" (similar to farmers' markets) hosted by community-based organizations	To create a local, self-sustaining food system connecting rural and urban growers with new markets and existing programs to help improve access to fresh, locally grown produce in low-income neighborhoods via "Fresh Stops".	Evaluated three components of the City Fresh program, which provides food at "Fresh Stops," using qualitative and quantitative methods, including a pre- and post-program survey assessing access, availability, and consumption of fruits and vegetables.	Fruit and vegetable consumption.	Pre- and post-intervention surveys using questions developed from other tested instruments, collecting information on participant consumption, access, and affordability of fruits and vegetables.	Participants (n=272) completed surveys over 3 years. The overall percentage of participants eating five or more servings of fruits and vegetables increased from 36% to 56%, with the increase being of greater magnitude for low-income groups. There was no significant difference in the number of participants reporting that they were able to afford fruits and vegetables after the intervention.

Author(s), Year	Site	Distribution channel	Study objectives	Study design	Health outcomes	Outcome measures	Results
Saxe-Custack et al, 2020 ⁵²	MI	Farmers' markets.	To investigate the association between participation in a farmers' market fruit and vegetable prescription program for pediatric patients and household food security.	Conducted a survey-based cross-sectional study with a convenience sample of caregivers of children presenting for care at the Hurley Children's Center.	Food security.	Study participants completed a 42-item survey. Survey items included questions from the USDA Household Food Security Module and the Michigan Behavioral Risk Factor Surveillance Survey.	45% of caregivers who completed the survey (n=157) indicated low or very low levels of household food security. Food security scores among caregivers who reported that their child had received a prescription were not significantly different from those who reported that their child had not received a prescription.
Singleton et al, 2018 ⁴⁸	IL	Farmers' markets.	To identify barriers to fruit and vegetable consumption that exist among users of the LINK Up Illinois program and determine how these barriers are associated with fruit and vegetable consumption frequency.	Conducted a cross-sectional, self-administered survey at participating farmers' markets.	Fruit and vegetable consumption.	Fruit and vegetable consumption measures were adapted from the Behavioral Risk Factor Surveillance System.	Approximately 23% of survey participants (n=140) reported consuming fruit and vegetables greater than or equal to three times per day. Reporting one or more barriers was associated with reduced odds of consuming vegetables greater than or equal to three times a day, but not fruits.
Trapl et al, 2018 ⁵⁸	OH	Farmers' markets.	To evaluate the effectiveness of produce prescriptions within the context of hypertension visits at safety clinics on patient usage at farmers' markets and dietary change related to fruit and vegetable consumption.	Conducted a comprehensive pre-post evaluation of the produce prescription program (PRxHTN), which represents a clinical-community linkage intervention.	Fruit and vegetable consumption.	A pre- and post-program survey was used to assess demographic characteristics, food-related shopping barriers and fruit and vegetable consumption, which was assessed using the validated Fruit and Vegetable Checklist.	Among the subsample with intake and post-program survey data (n=137), there was a significant improvement in fruit and vegetable consumption.

Author(s), Year	Site	Distribution channel	Study objectives	Study design	Health outcomes	Outcome measures	Results
Weltin et al, 2012 ⁵³	Mid-west	Community gardens.	To learn whether a community garden could provide improved diabetes control for members of a Midwest community of immigrants from the Marshall Islands.	Conducted a mixed-convergent parallel designed intervention.	Hemoglobin A1c.	Data was collected at baseline and after six months during clinic appointments.	Of the participants who completed baseline and follow up data collection (n=13), individuals who participated in the community garden had significant reduction in their Hemoglobin A1c post-intervention, compared to persons who did not participate actively.

Table 5. Reach, implementation, and maintenance of scoping review sources examining health and nutrition impacts of specialty crops in the Midwest (n=15)

Author(s), Year	Number and Proportion	Representativeness	Crops	Implementation Costs	Sustainability
Baker et al, 2013 ⁴⁷	Not specified	Participants who responded to a survey were predominantly female (74%) and 45 years or older (74%). Most respondents identified themselves as black/ African American (86%), and 62% indicated that they had some level of food insecurity.	Not specified	Not specified	Not specified
Barnidge et al, 2013 ⁴⁵	5% of rural residents participated in the community garden.	Participants who completed the survey were mostly women (73%) and non-Hispanic whites (88%). Most were 45 years of age or older (81%) and less than half had more than a high school education (44%).	Not specified	Not specified	Not specified
Barnidge et al, 2015 ⁵⁶	Number served unknown. A total of 18,111 residents live in Pemiscot County.	Approximately 27% of Pemiscot County residents are African American, 30% are below the poverty level, 18% have less than a high school education. The unemployment rate is 10%.	Fruits and vegetables including green beans, carrots, collard greens, corn, cucumbers, mustard greens, onions, okra, various peppers, sweet potatoes, tomatoes, squash, pumpkins, and watermelon.	Not specified	Not specified
Castellanos et al, 2016 ⁵⁴	Not specified	Low-income individuals.	Fruits and vegetables.	Not specified	There are many challenges that confront local CFSI interventions including lack of nutrition education and motivation to participate long-term within priority communities, and lack of targeting factors beyond food access.

Author(s), Year	Number and Proportion	Representativeness	Crops	Implementation Costs	Sustainability
Freedman et al, 2021 ⁵⁹	Number served unknown. Resident population of 7,088 were eligible.	The intervention and comparison neighborhoods, respectively, had a resident population of 7,088 and 11,214, 42.9% and 37% of the households received Supplemental Nutrition Assistance Program (SNAP) benefits, and 72.2% and 62.5% of the residents were African American.	Fruits and vegetables.	The United States Healthy Food Financing Initiative (HFFI) provided resources to support the development of infrastructure to improve neighborhood food environments. The HFFI grant was leveraged to secure additional funding through multiple public-private partnerships to support food hub development and implementation over a five-year timeframe.	By the end of the natural experiment timeframe, most of the components of the food hub model were not maintained.
Hartwig et al, 2016 ⁴⁹	Community gardens serving more than 1200 refugee and immigrant families (Karen, Bhutanese, Hmong, Lisu).	Out of gardeners who completed the survey, 65% were women and 67% were Karen. 18% of gardeners reported speaking English “pretty well” or “fluently”, and they were most commonly Bhutanese. The average age of all gardeners was 39 years, ranging from 16 to 80 years. While reported food insecurity was low, 86% of respondents indicated that they participated in food subsidy programs.	Not specified	Not specified	Not specified
Hopkins et al, 2018 ⁵⁵	120 gardeners with community garden plots.	Most surveyed gardeners were white (82%) and female (67%). All respondents completed at least some college, with 47% having achieved an advanced university degree. Approximately 15% of the respondents were classified as food insecure.	Fruits and vegetables.	Not specified	Not specified

Author(s), Year	Number and Proportion	Representativeness	Crops	Implementation Costs	Sustainability
Krokowski, 2014 ⁵¹	1320 participants.	Low-income individuals who receive Supplemental Nutrition Assistance Program (SNAP).	Not specified	Funded by the United States Department of Agriculture's Farmers' Market Promotion Program.	Of the 10 markets involved in the study, nine planned to seek outside funding to continue the program.
Neff, 2021 ⁴⁶	Greater community - number not specified.	Not specified	Apples, berries, melons, peaches, beans, beets, broccoli, brussels sprouts, cabbages, carrots, cauliflower, cucurbits, eggplant, greens, leeks, okra, onions, parsnips, peas, peppers, radishes, sweet corn, sweet potatoes, tomatoes, turnips.	Funded by a \$17,996 SARE grant award in 2021.	Not specified
Norman et al, 2018 ⁵⁰	609 children participated in the Power of Produce Club at least once a week.	There was an even distribution of male and female participants, and the children who participated were predominantly white. Most families had one or two children participating in the Power of Produce Club, and most families reported having at least one child who participated in the program for two or three weeks.	Fruits and vegetables.	Not specified	Not specified

Author(s), Year	Number and Proportion	Representativeness	Crops	Implementation Costs	Sustainability
Ohri-Vachaspati et al, 2009	Around 750 families and individuals participated in the first three years of the City Fresh program.	The priority population was individuals in predominantly low-income neighborhoods with low access to fresh food. Most respondents were female, 25-54 years of age, had obtained some college or higher degree, and were white, and about 65% had annual household income less than \$50,000. About 86% of respondents indicated that they participated in one or more food subsidy programs.	Not specified	Three-year grant from the Community Foods Project initiative of the USDA (began in 2005).	City Fresh is developing a business plan that projects long-term program viability. A nutrition education tool kit and a training curriculum will be developed to train Fresh Stop volunteers in basic nutrition and food safety concepts and skills.
Saxe-Custack et al, 2020 ⁵²	Approximately 700 caregivers brought children to appointments at the Hurley Children's Center within the study time frame.	The Hurley Children's Center patient population is approximately half female (51%), majority (73%) are African American, and over 85% have Medicaid as their insurance.	Fruits and vegetables.	Not specified	Not specified
Singleton et al, 2018 ⁴⁸	Not specified	The mean age of survey respondents was 43 years, 82% were female, 29% were African American and 44% were considered obese. Around 47% of respondents reported shopping at the farmers' market once weekly.	Not specified	Not specified	Not specified

Author(s), Year	Number and Proportion	Representativeness	Crops	Implementation Costs	Sustainability
Trapl et al, 2018 ⁵⁸	224 participants.	Included clinic patients involved in a produce prescription for hypertension program (PRxHTN). Most were African American/black (97%) and women (72%) and had a high school or general equivalency diploma or less (62%). The mean age was 62 years and years with hypertension was 13. 48% were receiving SNAP benefits.	Not specified	Not specified	The prescription program for patients with hypertension has relied on time-limited local foundation funding and limited federal funding. Long-term sustainability and expansion of this model requires innovative approaches to dedicated funding to offset the cost of program coordination staff and fruit and vegetable vouchers or alternative methods to securing free fresh produce.
Weltin et al, 2012	Number served unknown. A total of 800 Marshallese individuals reside in the city and were eligible.	All eligible community members were Marshallese.	Fruits and vegetables.	Not specified	Not specified

Table 6: Main Themes from Interviews with Specialty Crop Producers (n=11)

RE-AIM Dimension	Interview Question	Summary	Key Quote(s)
Reach	Where do you market your crops? How much of it stays in the local community?	Most growers sold to local communities through a variety of vendors including farmers' markets, grocery stores, and distribution channels (e.g., direct to consumer, wholesale, retail). Some mentioned that marketing was still local and was mostly word of mouth.	"We sell a lot of our crops directly at the farm and we wholesale the majority of crops and sell within a 300-400 mile radius. We emphasize a lot of sale on local... we actually emphasize a lot of our products locally. We do sell a lot of our products on the farm. A lot of people that actually like to come directly to the farm." [203]
Reach: secondary	Can you describe who you reach through this distribution channel?	Organizations mentioned that they do reach low income communities and donated excess to local organizations like pantries, when possible. Others also noted that their primary audience was high income population to buy high value added products.	"Our population is, it's through the shareholder program, it's certified organic vegetables, it's not inexpensive, so the population that we reach...the majority are household incomes over \$100,000, over 50 years old, like 60% are over 50." [207]
Effectiveness: metrics and measures	What environmental impacts do you think your specialty crops have?	Producers reported soil improvements (quality) and yield/productivity, due to changes in practices. Not many are officially measuring impact but some have formal metrics, e.g., one using formal methods of research. Some are simply observing by seeing improved soil health and increase of organic matter, e.g., health of bees to observe habit.	"We've noticed just even in the 10 years that my wife and I have been back now, that the soil in our vegetable fields, we feel like it seems better, just the top soil seems like it has more organic matter in it, seems better, more useful and more productive." [204]
Effectiveness: strategies	Have you tried diversifying your crops?	Many have diversified crops to increase profit, market to customers, and improve growing practices (e.g., cover cropping, pest control). Diversification of crops may be linked to number of distribution channels. Some simplified due to feasibility or specialization for higher profit.	"Then looking at local farmers' markets, we didn't feel like we had enough sales to really make those farmers' markets profitable and so, it was really a financial decision that pushed us towards specializing in things [fewer specialty crops than they previously were] that we're good at and that are higher value production." [206]

RE-AIM Dimension	Interview Question	Summary	Key Quote(s)
Adoption	Can you tell me how you decide to grow the chosen primary crops?	Organizations had various reasons for growing crops, e.g., feeding people, making profit, demand for produce, effort in growing. Reasons for growing certain crops were also determined/motivated by customers. Some also mentioned the desire to rotate crops and have row crops.	"I mean, they both grew up on farms [previous generation of producers], and that, I mean the farms of I mean 50 and 60 and 70, 80 years ago we were a lot more diverse in like what everybody was produced, like everybody had their own garden, and had their own that they were producing for some of their own food on the farm pretty much, and that's a lot of that is transitioned away, I mean like as people, farms have gotten bigger, and everything too. But so it was just things that they [previous generation] were interested in, and they were sort of getting more towards. That was what they sort of wanted to retire into was just taking care of some vegetables." [204]
Implementation	What are the primary crops you produce?	Collectively, organizations produced a variety of crops: vegetables including, roots and tubers, bulb, leafy, fruiting, and cucurbit; legumes; fruits including, pome, tropical and subtropical, and stone; berries.	--
Implementation	Compared to other regions of the country, have you had to make any changes to your production practices to succeed in the Midwest?	Midwest farmers experience variability in heat/dryness, wind, cold, rainfall (drought vs. massive rain), etc. and need to invest in various methods to support irrigation, weather, etc. (e.g., high tunnels, greenhouses). These methods help to extend their growing season and allow diversity of production. They also need to consider customer demands and preferences. For example, some mentioned external influences such as NY times recipes, society articles, and other forms of outreach to engage consumers.	"We have a pretty intense crop rotation in place. So all of that is because of the influences that are specific to the Midwest, and then our community in particular is extremely diverse. So we grow, I mean, outside of Chicago. Our community is like a 100,000 people. But we have probably more different types of cultures, religions, socioeconomic status, represented here outside of Chicago. So we also some of our crops are diverse, and in response to what our clientele is interested in." [200]

RE-AIM Dimension	Interview Question	Summary	Key Quote(s)
Implementation	What sustainability/regenerative practices do you use, if any?	Organizations mentioned practices that preserve soil (cover cropping), water use, high tunnel, crop rotation. Several organizations were organic but not certified organic. Producers mentioned a number of sustainability practices: promoting pollination and bee health, reducing spraying and only when necessary, beneficial insects, using solar panels and water cisterns, reducing plastic use with biodegradable materials.	"We don't use methomyl pesticides at all. We do use a couple organic pesticides as needed...if we do use a pesticide, it's very specific to a crop or an issue and it's always organic and we don't have to do it often." [202]
Maintenance	Do you think you'll continue to focus on specialty crop production?	Almost all indicated interest in continuing practices. Organizations mentioned specific challenges they would still need to overcome to continue practices, e.g., profitable models such as delivery models or focusing on retail, labor-intensive work in the long-run.	"I guess even if I didn't have any customers, I would still grow lots of vegetables because I have this connection and love for the land and I give things away to family and if it doesn't get harvest or eaten, it would go back into the ground." [201]

Table 7: Main Themes from Interviews with Representatives from Food Access Organizations (n=15)

RE-AIM Dimension	Interview Question	Summary	Key Quote(s)
Reach	Can you describe who you reach through your intervention?	Organizations primarily served food insecure, low income, marginalized, disinvested, or underserved populations to address disparities. Organizations mentioned various aspects of identifying these communities through asset mapping, geographic areas, zip codes, schools in need, and other program reach.	"So I get calls weekly, with essentially people in tears, and they've been like I've been to 5 or 6 pantries, you know. Either they're not open, or I went there last month, or you know I have WIC, so I can't access it. Um, and so, when you talk about like the tax of poverty, right like, how do you hold a job when you just spent your whole day like bouncing pantry to pantry." [106]
Reach: transportation	What type of transportation does the population you serve use to get to your site(s)?	Organizations reported clients used mixed types of transportation including private modes (e.g., cars), public, biking, and walking. Some programs offered special services to alleviate transportation barriers such as providing shuttle buses to programs, vouchers for bikes, raffles for grocery carts, or discounted programs through Lyft to get transportation to the grocery store. One organization offered online workshops. Some mentioned the limitations of public transportation that were specific to some communities like rural areas.	"I think it's really varied depending on what the community looks like. In our metro I think that they're using public transportation and I know like some of the markets here in the Des Moines metro provide free public transportation to get to and from the market on market days, there's like a free bus line running that serves the market... But in our rural locations, I think its just kind of like a more of a fend for yourself - walking or driving or riding." [101]
Effectiveness: goals and measures	What is the overall goal or desired outcome of your intervention?	Overarching goals were to reduce food insecurity and increase fruit and vegetable intake for program participants or increase access to healthy foods in communities. Other goals pertained specifically to program goals to improve health outcomes, support local economies and farmers, or provide resources to grow food and achieve food sovereignty. A couple of organizations mentioned more systems-driven approaches that would focus on larger, community-wide goals rather than program-specific changes. For example, one organization advocated for a community-driven school model to transform the school system by focusing on workforce development for students in the agricultural sector.	"This [program] is an opportunity to get more clients to farmers' markets and purchasing more of those local fruits and vegetables and again, turning more profit for them [growers], but then again, we all love local fruits and vegetables and then again we love our communities and also keeping those dollars in our communities too. So really, the economic impact would be one of our goals in addition to fruit and vegetable intake." [105]

RE-AIM Dimension	Interview Question	Summary	Key Quote(s)
Effectiveness: results	What metrics or measures do you use to determine if you are effective in meeting those goals?	Several collected standard metrics, e.g., via GusNIP. However, there are data collection challenges including need for translation and organizational capacity. Others collect metrics to measure program satisfaction and use (redemption, distribution, etc.), while some do not collect any data. Organizations that collect data do so because of grant requirements or an interest in learning more about program impact by using data, e.g., DEI-focused metrics. Sometimes, organizations partner with external evaluators to assess program impact/results.	“That [recording metrics and measures of programs] is a space where in the process of really building that out into more robust measures... Historically we have tracked usual things, the things that are required when you have a grant, what being asked of you to track...Through another grant, we are working with some of our partners on that grant to develop some equity focused metrics that will embed equity, or progressive equity throughout everything we do” [108]
Adoption	Can you walk me through how your organization decided to begin your local food access intervention/program?	Organizations started local food access programs largely due to seeing a need in their community. Programs are usually aligned with organizational mission/vision and expand from existing programs with new funding. Programs vary widely in terms of audience (schools, farmers’ markets, produce RX) and methods or approach. These programs had some connection to the food system including some mention of farming and food distribution programs.	“The motivation was... to provide a market place for Iowa producers, of everything, not just fresh produce but meats, eggs, etc... to provide a consistent or regular supply of local foods into underserved communities and not wanting local food just to be a thing for the wealthy, or those who have the privilege to purchase local food” [107]
Implementation: components	Can you describe the specific components of the intervention you’ve implemented?	Often, food distribution was dependent on the growing season. Programs were implemented at diverse outlets to expand food access through various sites such as farmers’ markets, CSAs, grocery stores, urban farms, food pantries/banks, schools, and worked with various food systems actors such as food producers/farmers and distributors that focused on the food production side, e.g., gardening and agriculture. Interventions incorporated components of program that were educational and provided food. One mentioned food insecurity screening to provide food services.	“So right now, we're in the process of forming the female farmer cooperative, so they will get together and plan out their crops for the next 12 months or so together...And our nurses are working together now to figure out what's logistically going to make sense for them. If they're going to be distributing all 50 bucks within a few short days, so we're kind of trying to make sure that from harvest to being delivered to the mom, there isn't a whole lot of time that passes, so they [moms] get the freshest stuff [produce] possible and Purdue Extension is working on surveys for the moms to find out [if] they have dietary restrictions? Do they even have kitchen equipment and utensils to process the food that they'll be getting? And cook it and prepare it and whatnot. Once that's kind of all ironed out, the nurses will do some farm tours this summer just to meet the farmers and start to build those connections so that they can also tell that story to the moms we will be distributing to.” [108]

RE-AIM Dimension	Interview Question	Summary	Key Quote(s)
Implementation: partner organizations	What partner organizations were involved?	Organizations partnered with numerous different organizations such as non-profit community partners, government institutions, healthcare institutions, Cooperative Extension Services, for-profit business, local politicians, farmer-related organizations, gardening experts, policy advocates including environmental advocates, and volunteers.	"But then to realize, like we do food really well. And this is our lane. And we can partner with other people who do, you know, the other things we're eyeing really well, and form really solid partnerships. And that's really how we move forward in our community. Just link arms, and we do what we do well and you do what you do well, and we combine those programs and support each other, moving forward. And we need much more of that in the nonprofit." [106]
Implementation: education	Is there an education component included?	Organizations offered a variety of nutrition and gardening/agriculture programs and educational resources through different types of educators, e.g., Cooperative Extension, registered dietitians, SNAP-Ed. These classes were taught at different locations to a variety of audiences such as schools, clinical settings with medical providers and residents, community organizations such as food pantries, health fairs, and farmers' markets. Some organizations offered programs in multiple languages, and one organization offered an apprenticeship program.	"...and it's always interesting for me, because, like I was almost every community meeting. I sit in our committee. They're like, oh, we need education to you know, teach the incoming immigrant population how to cook, how to garden, and I'm like, not an issue - like they do both very successfully, like better than most Americans right. Now, if your family's been in, you know, lived in the US, and poverty for multi-generations like that's where we're, seeing that need of cooking, instruction and things." [106]
Implementation: adaptation	What considerations or changes did you have to make to your programming to be effective for the community you serve?	Organizations had informal and formal ways to collect feedback from audiences. Some mentioned adjusting programs based on needs of community (e.g., providing translations, tailoring what they grow to client preferences, distributing in bulk) while others described more detailed processes for formative, process, and outcome evaluations. For growing programs, organizations mentioned how feedback impacted grow plans and growing seasons. Mentioned use of toolkits and other resources to adapt/create programs when possible. Not too many DEI efforts but one mentioned DEI hiring principles and how to reach communities of color. Another mentioned adaptations to program model based on org needs, e.g., POS system, coupons, etc.; increasing access to programs.	"We serve our client a kind of tool called Voice Your Choice, it's a tool that's in 6 different languages, that's typically at a kiosk that's at the actual pantry or place where people are getting the resources, it's a survey-based tool on an iPad... it's all visual, they see pictures of the crops that they want or that they could desire and they can complete the survey and show their preference on what things they'd like us to grow, so use that information to design our crop plan each year" [107]

RE-AIM Dimension	Interview Question	Summary	Key Quote(s)
Implementation: cost	Can you share more about how the intervention is financed?	Organizations mentioned a number of diverse funding sources through government and federal fundings, local foundations, and private donors. In addition to diverse funding sources, organizations mentioned the importance of diversifying the types and number of funding sources to ensure sustainable funds. Some mentioned the challenges in finding funding, specifically grants that required matched funds.	"Up until very very recently, we were operating on a shoestring. So we've had some pretty good success over the last couple of years with grants that will give us some stability for the next 4-5 years and that is a big goal, to try to develop some more diverse funding streams and long-term sustainability for programs and staff and everything that we're doing." [108]
Maintenance: plans	Do you expect your intervention to continue permanently?	Organizations plan on continuing programs with adaptations as needed. Programs were also dependent on stable and continued funding. Overall, most wanted to continue the programs or change aspects of the program, as necessary.	"There's support from both of our healthcare systems that are on board, but there's not a ton of dollars coming our way basically, so we do need to bring in other money, other grants, but we do have some stable funders we just need to expand on that... we're hoping to be able to keep scaling it up and scaling up sustainably, too" [105]
Maintenance: barriers	What barriers to the sustainability/maintenance of the program?	Funding was the primary barrier mentioned. Sometimes, funding restrictions also further limited the use of grant funds due to restrictions of spending ability. A few people mentioned challenges in supporting local agriculture, which included barriers such as support for growers, land conservation, and the economic benefits of local food systems/specialty crop production (due to lack of Dept. of Ag support).	"I think culturally, we have a problem in Indiana, like local food, is not what is supported by our Department of Ag. There's no agency or division in the Department of Agriculture that supports local food. It mostly supports commodity crop farming... getting them to understand the actual economic benefits of supporting local specialty crop and, like specialty, good producers, has not gone very far here." [104]

Peer-reviewed Literature – Journals and Key Search Terms

(local food systems OR short food supply chains OR specialty crops OR alternative food networks) AND (nutrition OR health OR chronic disease OR economic benefit OR rural development OR environmental impact OR biodiversity OR energy OR climate change) AND (Michigan OR Ohio OR Indiana OR Illinois OR Wisconsin OR Minnesota OR Iowa OR Missouri OR Kansas OR Nebraska OR South Dakota OR North Dakota)

CabDirect- Agriculture

PubMed- Health

Environment Complete- Environment

Academic Search Complete- Multidisciplinary

CabDirect CAB Abstracts Search- 1709 Results

All Fields

"local food system*" OR "local food system stakeholder*" OR "short food supply chain*" OR "specialty crop*" OR "alternative food network*" OR "sustainable urban system*" OR "sustainable agriculture" OR "farmers market*" OR "local food" OR "Sustainable urban system*" OR "specialty crop production" OR "food hubs" OR "community garden" OR "direct-to-consumer" OR "community supported agriculture" OR "locally grown" OR "food system sustainability" OR "alternative food network*" OR "fruit crops" OR "tree nuts" OR "dried fruit*" OR "nursery crop*" OR floriculture OR herbs OR spices OR "medicinal herb*" OR honey OR "maple syrup" OR coffee OR "beverage crops" OR "tea leaves" OR turfgrass* OR hops OR "annual bedding plant*" OR "potted flowering plant*" OR "potted herbaceous perennial*" OR "cut flower*" OR "cut cultivated green*" OR "foliage plant*" OR "Christmas tree*" OR "deciduous flowering tree*" OR "broadleaf evergreen*" OR "deciduous shade tree*" OR "landscape conifers" OR "deciduous shrubs"

AND

ALL FIELDS

nutrition OR "nutritional impact" OR health OR "health impact" OR "chronic disease" OR "social determinants of health" OR "economic benefit" OR "economic impact" OR "rural development" OR "Informal economy" OR "economic indicator*" OR "environmental impact*" OR biodiversity OR energy OR "climate change" OR "climate change impact*" OR "Environmental value*" OR "carbon footprint" OR "life cycle assessment"

AND

ALL FIELDS

Michigan OR Ohio OR Indiana OR Illinois OR Wisconsin OR Minnesota OR Iowa OR Missouri OR Kansas OR Nebraska OR "South Dakota" OR "North Dakota" OR "Midwest U.S." OR "U.S. Heartland"

PubMed- Title/Abstract Search: 50 Results

Title/Abstract

"specialty crop*" OR "agricultural crop*" OR "alternative food network*" OR "local food" OR "specialty crop production" OR "food hubs" OR "direct-to-consumer" OR "community supported agriculture" OR "locally grown" OR "fruit crops" OR "tree nuts" OR "dried fruit*" OR "nursery crop*" OR floriculture OR horticulture OR herbs OR spices OR "medicinal herb*" OR honey OR "maple syrup" OR coffee OR "beverage crops" OR hops OR "tea leaves" OR turfgrass OR "food origin*" OR "local food suppl*"

Title/Abstract

AND

nutrition OR "nutritional impact" OR "healthy diet" OR "health impact" OR "chronic disease" OR "social determinants of health" OR "economic benefit" OR "economic impact" OR "rural development" OR "Informal economy" OR "economic indicator*" OR "environmental impact*" OR biodiversity OR energy OR "climate change" OR "climate change impact*" OR "Environmental value*" OR "carbon footprint" OR "life cycle assessment"

Title/Abstract

AND

Michigan OR Ohio OR Indiana OR Illinois OR Wisconsin OR Minnesota OR Iowa OR Missouri OR Kansas OR Nebraska OR "South Dakota" OR "North Dakota" OR "Midwestern United States"

((("specialty crop*" [Title/Abstract] OR "agricultural crop*" [Title/Abstract] OR "alternative food network*" [Title/Abstract] OR "local food" [Title/Abstract] OR "specialty crop production" [Title/Abstract] OR "food hubs" [Title/Abstract] OR "direct-to-consumer" [Title/Abstract] OR "community supported agriculture" [Title/Abstract] OR "locally grown" [Title/Abstract] OR "fruit crops" [Title/Abstract] OR "tree nuts" [Title/Abstract] OR "dried fruit*" [Title/Abstract] OR "nursery crop*" [Title/Abstract] OR floriculture [Title/Abstract] OR horticulture [Title/Abstract] OR herbs [Title/Abstract] OR spices [Title/Abstract] OR "medicinal herb*" [Title/Abstract] OR honey [Title/Abstract] OR "maple syrup" [Title/Abstract] OR coffee [Title/Abstract] OR "beverage crops" [Title/Abstract] OR hops [Title/Abstract] OR "tea leaves" [Title/Abstract] OR turfgrass [Title/Abstract] OR "food origin*" [Title/Abstract] OR "local food suppl*" [Title/Abstract]) AND (nutrition [Title/Abstract] OR "nutritional impact" [Title/Abstract] OR "healthy diet" [Title/Abstract] OR "health impact" [Title/Abstract] OR "chronic disease" [Title/Abstract] OR "social determinants of health" [Title/Abstract] OR "economic benefit" [Title/Abstract] OR "economic impact" [Title/Abstract] OR "rural development" [Title/Abstract] OR "informal economy" [Title/Abstract] OR "economic indicator*" [Title/Abstract] OR "environmental impact*" [Title/Abstract] OR biodiversity [Title/Abstract] OR energy [Title/Abstract] OR "climate change" [Title/Abstract] OR "climate change impact*" [Title/Abstract] OR "Environmental value*" [Title/Abstract] OR "carbon footprint" [Title/Abstract] OR "life cycle assessment" [Title/Abstract])) AND (Michigan [Title/Abstract] OR Ohio [Title/Abstract] OR Indiana [Title/Abstract] OR Illinois [Title/Abstract] OR Wisconsin [Title/Abstract] OR Minnesota [Title/Abstract] OR Iowa [Title/Abstract] OR Missouri [Title/Abstract] OR Kansas [Title/Abstract] OR Nebraska [Title/Abstract] OR "South Dakota" [Title/Abstract] OR "North Dakota" [Title/Abstract] OR "Midwestern United States" [Title/Abstract])

Environment Complete-620 results

2004- Present

Academic Journals

TI Title

"local food system*" OR "local food system stakeholder*" OR "short food supply chain*" OR "specialty crop" OR "specialty crops" OR "alternative food network*" OR "sustainable urban system*" OR "sustainable agriculture" OR "farmers market*" OR "local food" OR "Sustainable urban system*" OR "specialty crop production" OR "food hubs" OR "direct-to-consumer" OR "community-supported agriculture" OR "locally grown" OR "food system sustainability" OR "alternative food network*" OR "sustainable food movement" OR "Agricultural productivity" OR "fruit crops" OR "tree nuts" OR "dried fruit*" OR "nursery crop*" OR herbs OR spices OR "medicinal herb*" OR honey OR "maple syrup" OR "coffee growing" OR "beverage crops" OR "tea leaves" OR turfgrass* OR hops OR "bedding plant growing" OR "foliage plant*" OR "Christmas tree*" OR "broadleaf evergreen*" OR "deciduous shade tree*" OR "deciduous shrubs" OR "edible plant*" OR "vegetable crops" OR "food system" OR "Specialty crop system*" OR "localized food systems"

AND

TX ALL TEXT

nutrition OR "nutritional impact" OR health OR "health impact" OR "chronic disease" OR "social determinants of health" OR "economic benefit" OR "economic impact" OR "rural development" OR "informal economy" OR "economic indicator*" OR "environmental impact*" OR "environmental health" OR biodiversity OR energy OR "climate change" OR "climate change impact*" OR "Environmental value*" OR "carbon footprint" OR "life cycle assessment" OR "dietary change" OR "Urban and peri-urban agriculture" OR "economic development" OR "Life cycle impacts" OR "economic development" OR "Cost effectiveness"

AND

TX ALL TEXT

Michigan OR Ohio OR Indiana OR Illinois OR Wisconsin OR Minnesota OR Iowa OR Missouri OR Kansas OR Nebraska OR "South Dakota" OR "North Dakota" OR "Midwest U.S." OR "U.S. Heartland" OR midwest USA

Academic Search Complete= 1012 results

2004-Current

Academic Journals

TX All Text

"local food system*" OR "local food system stakeholder*" OR "short food supply chain*" OR "specialty crop*" OR "alternative food network*" OR "sustainable urban system*" OR "sustainable agriculture" OR "farmers' market*" OR "local food" OR "specialty crop production" OR "community garden" OR "direct-to-consumer" OR "community-supported agriculture" OR "locally grown" OR "alternative food network*" OR "fruit crops" OR "tree nuts" OR "dried fruit*" OR "nursery crop*" OR floriculture OR herbs OR spices OR "medicinal herb*" OR honey OR "maple syrup" OR coffee OR "tea leaves" OR turfgrass* OR hops OR "cut flower*" OR "foliage plant*" OR "Christmas tree*" OR "broadleaf evergreen*" OR "deciduous shrubs" OR "LOCAL produce" OR "LOCALLY grown foods" OR "alternative crops" OR "biodynamic agriculture" OR "biodynamic farm*" OR "alternative agriculture" OR "coffee growing" OR "Urban and peri-urban agriculture" OR "agricultural productivity" OR "Alternative Specialty Crops"

AND

TX ALL TEXT

nutrition OR "nutritional impact" OR health OR "health impact" OR "chronic disease" OR "social determinants of health" OR "economic benefit" OR "economic impact" OR "rural development" OR "Informal economy" OR "economic indicator*" OR "environmental impact*" OR biodiversity OR energy OR "climate change" OR "climate change impact*" OR "Environmental value*" OR "carbon footprint" OR "life cycle assessment" OR "dietary change" OR "cost effectiveness"

AND

GE GEOGRAPHIC TERMS

Michigan OR Ohio OR Indiana OR Illinois OR Wisconsin OR Minnesota OR Iowa OR Missouri OR Kansas OR Nebraska OR "South Dakota" OR "North Dakota" OR "Midwest U.S." OR "U.S. Heartland"

almond OR apple OR apricot OR avocado OR banana OR blackberry OR blueberry OR breadfruit OR cacao OR cashew OR cherimoya OR cherry OR chestnut OR chokeberry OR citrus OR coconut OR coffee OR cranberry OR currant OR date OR "feijoa fruit" OR fig OR filbert OR hazelnut OR gooseberry OR grape OR guava OR kiwi OR litchi OR macadamia OR mango OR nectarine OR olive OR papaya OR passion fruit OR peach OR pear OR pecan OR persimmon OR pineapple OR pistachio OR plum OR prune OR pomegranate OR quince OR raspberry OR strawberry OR Suriname cherry OR walnut OR artichoke OR asparagus OR bean OR beet OR broccoli OR "broccoli raab" OR "Brussels sprouts" OR cabbage OR carrot OR cauliflower OR celeriac OR celery OR chickpeas OR chive OR collards OR kale OR cucumber OR edamame OR eggplant OR endive OR pea OR garlic OR horseradish OR kohlrabi OR leek OR lentils OR lettuce OR melon OR mushroom OR mustard and other greens OR okra OR onion OR parsley OR parsnip OR pepper OR potato OR "prickly pear" OR pumpkin OR radish OR rhubarb OR rutabaga OR salsify OR spinach OR squash OR "sweet corn" OR "sweet potato" OR "Swiss chard" OR taro OR tomato OR tomatillo OR turnip OR watermelon OR "Culinary Herbs" OR "culinary spices" OR allspice OR Angelica OR anise OR annatto OR arugula OR asafetida OR basil OR seaweed OR borage OR calendula OR caper OR caraway OR cardamom OR cinnamon OR "clary sage" OR cloves OR catnip OR chamomile OR chervil OR chicory OR cicely OR cilantro OR comfrey OR coriander OR cress OR cumin OR curry OR dill OR fennel OR fenugreek OR filé OR fingerroot OR galangal OR ginger OR hops OR horehound OR hyssop OR lavender OR "lemon balm" OR "lemon thyme" OR lovage OR mace OR mahlab OR marjoram OR mint OR mugwort OR nutmeg OR oregano OR paprika OR parsley OR pepper OR rosemary OR rue OR saffron OR sage OR savory OR sorrel OR tarragon OR thyme OR turmeric OR vanilla OR wasabi OR and watercress OR astragalus OR boldo OR comfrey OR coneflower OR fenugreek OR feverfew OR foxglove OR "ginkgo biloba" OR ginseng OR "goat's rue" OR goldenseal OR gypsywort OR horehound OR horsetail OR lavender OR liquorice OR marshmallow OR mullein OR nettle OR passionflower OR patchouli OR pennyroyal OR pokeweed OR skullcap OR sorrel OR "St. John's wort" OR senna OR "sow thistle" OR stevia OR tansy OR "witch hazel" OR "wood betony" OR wormwood OR yarrow OR "yerba buena" OR "Ylang Ylang" OR