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Resilience characteristics of the urban agriculture system in Lansing, Michigan: Importance of support actors in local food systems

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Abstract

Urban agriculture is a growing movement in cities across the United States, including the post-industrial Midwest. Maintaining a resilient local food system is a challenge given the environmental, resource, and institutional barriers facing urban farmers. In this descriptive correlational study, we take an in-depth look at the demographics, farm characteristics, motivations, barriers, and resilience indicators of individuals in the urban agriculture system in Lansing, Michigan, a city of the US Midwest with a growing urban agriculture system. Survey responses ($n = 92$) revealed that support actors, community gardeners, and farmers have descriptive differences in their motivations, with support actors (e.g. non-profits, university extension, or municipalities) being most strongly motivated by social and environmental justice. Community gardeners reported the lowest barriers to engaging in urban agriculture. Individuals who reported stronger motivations for building community and social and environmental justice showed significant correlations to several resilience indicators, indicating that those motivations may be important to system resilience. Urban agriculture support agencies report high barriers and are most often consulted for informational and social support. These results can inform recommendations for organizations, local governments, and researchers working in midwestern urban agriculture initiatives to better assess and promote a thriving system into the future.

1 | INTRODUCTION

The growth of urban agriculture has contributed an array of positive social, ecological, and economic impacts to its participants and their communities (Golden, 2013; Hynes, 1996; McMillan, 2008; McVey, Nash, & Stansbie, 2018; Mendes, Balmer, Kaethler, & Rhoads, 2008). Participation in urban agriculture increases access to healthy food, food security and sovereignty, education, and physical activity (Audate, Fernandez, Cloutier, & Lebel, 2019; Calvet-Mir, March, Nordh, Pourias, & Čakovská, 2016; Eriksen-Hamel

Abbreviations: GLFBGP, Greater Lansing Food Bank Garden Project; ICLB, Ingham County Land Bank; SES, Social-ecological system.

& Danso, 2010; Lieberherr-Gardiol, 2008; Litt et al., 2011; Mason & Knowd, 2010). Individuals' motivations for engaging in urban agriculture often include multiple benefits, rather than a single primary reason for participation (Kirkpatrick & Davison, 2018; Pourias, Aubry, & Duchemin, 2016). Many urban agriculture benefits are particularly important for women, immigrants, low-income households, and minorities (Audate et al., 2019; Buckingham, 2005; Clarke & Jenerette, 2015; Graham & Connell, 2006).

In addition to benefits to individuals and households, researchers have cataloged benefits of urban agriculture to the environment and communities. The planting of previously blighted urban spaces helps restore landscapes and leads to greater composting and waste recycling; together these activities reduce nutrient loss and greenhouse gas emissions (Forkes, 2007; Kulak, Graves, & Chatterton, 2013) and improve storm and wastewater management (Lydecker & Drechsel, 2010). Urban agriculture can also lead to job creation and a strengthened local economy (Chang & Morel, 2018; Karanja, Njenga, Gathuru, Karanja, & Munyao, 2010). Additionally, the shared activity of work in a community garden can create and deepen community relationships that contribute to self-governance and institutions (Mount, 2012). Across the US, urban agriculture contributes significantly to local food needs and individual and community resilience, i.e., the ability of local systems to flourish in the face of change and challenges (Barthel & Isendahl, 2013; Ernstson et al., 2010).

Simultaneously, barriers to engagement in urban agriculture limit the resilience of the urban agriculture system. Individuals might lack financial resources to purchase start-up supplies, access to safe and sufficient soil, or affordable access to water (Fox-Kämper et al., 2017; Lovell, 2010; Specht et al., 2015; Weidner, Yang, & Hamm, 2019). Urban residents may also lack knowledge about how to grow crops, raise animals, or operate technological urban agriculture systems like rooftop gardens or climate-controlled greenhouses (Specht et al., 2015). Negative perceptions about pests and unpleasant odors may discourage participation (Specht et al., 2015; Vaage, 2015). Finally, formal and informal governance might impede the growth of urban agriculture due to land use patterns or restrictive regulations (Fox-Kämper et al., 2017). Research suggests that urban agriculture commonly "emerges on land that is designated within official planning documents for land use other than food production" (Koopmans, Keech, Sovová, & Reed, 2017, p. 155), thus often existing in marginal spaces or as a temporary development strategy until the land can be repurposed for other uses (Castillo et al., 2013). Food systems, including urban agriculture, are also challenged by the changing climate, which occurs on top of an already degraded resource base, as well as vulnerabilities introduced by the rapid pace of industrialization in food systems (Hodbod & Eakin, 2015). These institutional, resource, and climate hurdles can present challenges to the resilience of urban agriculture in place.

Core Ideas

- Community gardeners most plentiful actors in the urban food system at Lansing, MI
- Community gardeners report the least strong motivations, with lowest barriers
- Community building and justice motives correlate with resilience indicators
- Networking analysis shows heavy burden on support organizations

To better understand the motivations for participation, benefits, and challenges of urban agriculture in the post-industrial Rust Belt Midwest, we conducted a descriptive correlational study of urban agriculture actors in Lansing, Michigan, including farmers, community gardeners, and support agencies ($n = 92$). Specifically, our research explores the question: *What are the demographics, motivations, barriers, and resilience indicators of the Lansing urban agriculture system among farmers, community gardeners, and support organizations, and how do those characteristics relate to each other?* Resilience in this context describes the ability of actors to respond to change through adaptation or transformation within the system in place, e.g. rather than mobility as an expression of resilience. Toward this end, we investigated indicators related to social networks, adaptive and transformative capacity, perceptions of risk, and self-efficacy (Folke et al., 2010). While we understand that arriving at a robust resilience assessment of the system would require mixed methods and longitudinal relationships (Berkes & Folke, 1998), the data presented here uses indicators to provide important insight into resilience that is both relevant for other Rust Belt urban agriculture initiatives and will facilitate the future development of participatory interventions in place to promote a more resilient urban agriculture system. We also build on the growing literature in urban agriculture motivations and barriers, which is primarily qualitative (Audate et al., 2019; Fox-Kämper et al., 2017; McVey et al., 2018; Pourias et al., 2016), by presenting a validated survey instrument for quantitative analysis of urban agriculture characteristics, and by integrating resilience indicators with motivations and barriers.

1.1 | Urban agriculture in Lansing

Lansing, MI, like cities across the Rust Belt Midwest, has witnessed a growth in urban agriculture in abandoned lots vacated by declining industries and a shrinking workforce (Colasanti, Hamm, & Litjens, 2012; Masson-Minock & Stockmann, 2010). A capital city of roughly 115,000 residents with a growing urban agriculture presence (Piso, Goralnik, Libarkin, & Lopez, 2019), Lansing's urban agriculture system includes farms and an extensive community gardening network, as well as 10 farmer's markets across Ingham County. In addition to the activities of independent farmers, urban agriculture initiatives in Lansing are underlain by an array of support actors, including local non-profits (e.g. the Greater Lansing Food Bank Garden Project [GLFBGP], the Allen Neighborhood Center, the Michigan Farmer's Market Association, and the Lansing Urban Farm Project) and municipal programs (e.g. the Ingham County Land Bank [ICLB]). Local informational support is also available through university-affiliated programs like the Center for Regional Food Systems and Michigan State University Extension.

The GLFBGP supports the predominant network of Lansing community gardeners, a large component (~3,000 participants, GLFBGP, personal communication) of urban agriculture in Lansing, by providing land access, workshops, seeds and tools, and networking among participants. Twenty percent of the gardeners in the GLFBGP network are refugees or immigrants (GLFBGP, personal communication), reflecting the diverse demographics of Lansing, as well as the role of food production for community building, place relationships, and food security for communities living at the margins (Harris, Minniss, & Somerset, 2014). Land for a number of GLFBGP gardens has been provided by the ICLB, a local governmental authority that receives property from the county treasurer's annual tax foreclosure process "[t]o put [land back] into productive use in neighborhoods" (ICLB, 2019). Investing in spaces for urban agriculture has been an important component of the ICLB's neighborhood revitalization process (ICLB, 2019).

Prior research with key urban agriculture stakeholders in Lansing indicates that participants hold multiple and sometimes competing values about the benefits, challenges, and contributions of urban agriculture in their communities (Piso et al., 2019). These competing values contribute to varied governance priorities. For example, participants who prioritized food sovereignty, community building, and environmental sustainability expressed a desire to participate in the development of good governance, which they described as attentive to context, collaboratively created, and reflective of community vision. Alternatively, participants who prioritized food safety, education, and health instead preferred clear and defined policies developed through transparent processes mediated by the state (Piso et al., 2019). These different priorities lend insight into how best to develop resilient governance structures to support a sustainable system. We build on this prior research to explore the resilience characteristics of additional stakeholder groups to better understand the larger urban agriculture system in greater Lansing.

1.2 | Resilience

Social-ecological resilience is useful framing for addressing the role of urban agriculture within a community, as it frames urban agriculture as a practice within a city-scale, food-based social-ecological system (SES) (Egerer, Fouch, Anderson, & Clarke, 2020; Ericksen, 2008; Hodbod & Eakin, 2015). SESs are complex, integrated systems that include humans and nature (Berkes & Folke, 1998). Applying an SES framing to food systems recognizes that ecological and social processes are fundamental to food generation and distribution. The integrated framing is essential to understanding the environmental and social drivers of change on urban agriculture systems, as well as how the social and ecological components of these systems then react to change (Davies & Evans, 2018; Ericksen, 2008; Hodbod & Eakin, 2015; Lengnick, 2015).

The response of a system to change is the crux of resilience thinking, where adaptability and transformability are used to understand the dynamics of social-ecological resilience across scales (Folke et al., 2010). Resilience, in this context, is the capacity of an SES to continually change and adapt yet remain within critical thresholds that ensure the system's function and identity remain the same (i.e., that it produces food). Such thresholds could include farm profitability, sufficient volunteer labor for community gardens, or land availability. Both adaptability and transformability support resilience (Folke et al., 2010), but are distinguished by the temporal, spatial, and social scales at which they occur (Moser & Ekstrom, 2010), i.e., they exist along a spectrum.

Adaptive capacity represents the capacity of an SES to combine experience and knowledge to adjust its responses to changing external drivers and internal processes maintaining function and identity (Folke et al., 2010). Transformative capacity is the capacity of an SES to become a fundamentally new system to maintain function or identity, when ecological, economic, or social structures make the existing system untenable (Folke et al., 2010). Society must consider ways to foster resilience of smaller, more manageable SES that contribute to Earth System resilience, such as urban agriculture (Folke et al., 2010). As such, we use

the spectrum of adaptive-transformative capacity to understand the resilience of the Lansing urban agriculture SES.

2 | MATERIALS AND METHODS

To characterize the resilience of the urban agriculture system in Lansing, we conducted a survey of urban agriculture stakeholders (community gardeners, farmers, and support agency staff). These surveys captured three types of information: personal demographics and urban agriculture characteristics, motivations and barriers to engagement in urban agriculture, and resilience indicators.

2.1 | Instrument development

2.1.1 | Urban agriculture characteristics and demographics

Participants were asked about their role in urban agriculture, the contribution of urban agriculture to their income and household food needs, the time spent on urban agriculture, and food distribution. Demographics questions included ethnicity, gender, age, and household income.

2.1.2 | Motivations and barriers

Motivations and barriers items were developed from prior studies of urban agriculture participants (McClintock & Simpson, 2018; Piso et al., 2019). Hypothesized categories of motivations informed by these studies included community building, social justice, environmental protection, economic, and personal health – i.e., outcomes we would expect to build in a resilient urban agriculture system. Motivations items were on a five-point Likert scale from strongly disagree (1) to strongly agree (5). Barriers to achieving resilience were developed across multiple categories: environmental (e.g. adjusting to climate changes), resource (e.g. funding and income), and institutional (e.g. following zoning laws). Barriers were on a five-point Likert scale from not at all difficult (1) to very difficult (5).

2.1.3 | Resilience indicators

Resilience indicators were based on extended adaptive capacity measures, ensuring that we were capturing the long-term perspectives required for transformative capacity. The literature demonstrates four attributes of individual adaptive capacity: skills, circumstances, perceptions, and willingness to change (Marshall & Marshall, 2007; Marshall, Park, Adger, Brown, & Howden, 2012; Nelson, Adger, & Brown, 2007). We measured skill by asking participants to evaluate their knowledge on urban agriculture using items developed by the survey team and from (Marshall, Gordon, & Ash, 2011; Marshall, Marshall, Abdulla, & Rouphael, 2010). To understand circumstances we asked questions related to social networks and alliances, a critical part of adaptive capacity (Moore & Westley, 2011). We used multiple survey questions developed from previous work (Hodbod, Tomei, & Blaber-Wegg, 2015) to capture the breadth and strength of individuals' networks in urban agriculture. Individuals listed the three most important sources of informational, financial, and social/emotional support in urban agriculture, with the option to name specific organizations or sources of support. Participants also reported how frequently they received each type of support from a variety of sources, such as friends, non-profit organizations, and the internet. To understand perceptions and willingness to change, we adapted previously published questions from Marshall et al. (2012) measuring capacity for change and perceptions of risk with transformational change. Additionally we included the General Self-Efficacy Scale (Schwarzer & Jerusalem, 1995) as an indicator of willingness to change.

2.2 | Data collection

Pilot surveys ($n = 7$) were collected with individuals involved in urban agriculture in other urban areas, with pilot respondents suggesting no changes to the survey. Pilot responses were not included in further analysis. We surveyed Lansing stakeholders from late June through mid-October 2018. Study boundaries were described by the interstate highways around Lansing (I-69 to the west and north, I-96 to the south, and Meridian, Shoeman, and Woodbury roads to the east). We contacted individuals through farmer's markets, community gardens, and support organizations. First, the research team attended all farmer's markets within the study region to distribute the survey; depending on preference, participants were provided a paper survey and return envelope or gave their email address to receive a survey link. Second, the GLFBGP shared the survey link with their garden leaders and summer workshop attendees and distributed the survey in nine community gardens based on a convenience sample. Third, urban agriculture support organizations in the area were identified through prior interviews (Piso et al., 2019) and contacted via email with a survey link to share with their networks. Additionally, all contacts were asked to share the survey with any other relevant individuals or organizations to snowball responses. We invited 13 farmers and 36 community gardeners to participate in-person at

farmer's markets and workshops. Our survey was sent out to approximately an additional 2,450 individuals based on the number of community garden plots in contacted gardens (500) and the number of individuals on Listservs at six agriculture organizations that shared the survey link. Some of these organizations were statewide or focused on all forms of agriculture. Participants were provided with the study area map to self-determine eligibility.

2.3 | Quantitative data analysis

We received 92 completed surveys (data in Supplementary Materials). Twenty-four additional surveys with <20% completion (e.g. only urban agriculture characteristics) were removed from analysis. One individual completed the online survey twice; their second response was used in our analysis. We explored descriptive statistics and trends for urban agriculture characteristics and demographics. For motivations, barriers, and resilience indicators, we performed statistical analyses to examine the validity and reliability of our measures. All quantitative analysis was performed using STATA version 15 (StataCorp LLC, College Station, TX, USA). Unidimensionality of constructs for the sample population was established via exploratory factor analysis for barriers and motivations. Simple confirmatory analysis was used to confirm unidimensionality for the previously developed resilience indicators scales. Kaiser-Meyer-Olkin value and the significance of Bartlett's test of sphericity were used to determine the factorability of the data (Bandalos & Finney, 2018). Factors were extracted using principal axis factoring and varimax rotation based on eigenvalues greater than one and scree plot analysis. Items were removed iteratively based on factor loadings – low loadings were removed first, followed by split loadings. In each theme below, we present which survey questions were retained that measured each of our measured themes and sub-themes. Survey questions that factored together were averaged to create a single measure for each scale. Finally, reliability was evaluated via internal consistency as documented by Cronbach's alpha.

2.3.1 | Urban agriculture characteristics and demographics

For our analysis, we separated actors into three groups: farmers ($n = 10$), community gardeners ($n = 62$), and support actors ($n = 20$). Farmers included respondents working on for-profit farms. Community gardeners included participants with community garden plots or working on non-profit or educational farms. Support actors included farmer's market managers, community garden organizers, or participants who work for an urban agriculture support organization. Support agency staff who also self-identified as either a farmer ($n = 5$) or a community gardener ($n = 7$) were sorted into the single category of "support actors" on the assumption that their primary relationship to the food system and their food system network was most influenced in their professional capacity as support agency staff. In other words, we assume that the relationships they maintain as support agency staff are most influential to their motivations, values, and perceptions of barriers. Support actors who did not also engage in farming or gardening ($n = 8$) were redirected so they did not respond to questions about their farm or garden characteristics. Basic descriptive statistics were used to analyze urban agriculture characteristics and demographic data.

2.3.2 | Motivations and barriers

Four factors emerged from exploratory factor analysis of the motivations data (Table 1). **Community building motivations** ($\alpha = 0.72$) were related to contributing to the local community and interacting with others socially. **Social and environmental justice motivations** ($\alpha = 0.87$) centered around providing equitable resources to community members and improving environmental conditions. **Economic motivations** ($\alpha = 0.89$) involved participating in the economy through income and job generation and being a produce supplier. **Health motivations** ($\alpha = 0.81$) were related to creating safe and nutritious foods.

Barriers items were hypothesized to include environmental, institutional, and resource barriers. Environmental barriers were those resulting from natural resources such as soil and water. Institutional barriers related to policies, laws, and relationships. Resource barriers involved information, funding, time, and space. Despite hypothetical differences in barriers, all barriers items factored together ($\alpha = 0.94$). This could indicate that respondents tend to experience all types of barriers equally, or indicate a need to survey a greater variety of barriers to develop stronger distinctions. For our analysis, we separated barriers into their listed categories when the separated categories showed differences in their correlations to other measures.

2.3.3 | Resilience indicators

We conducted confirmatory factor analyses on scales intended to measure skills, perceptions and willingness to change, and self-efficacy. Four scales were confirmed (Table 2): **perceived knowledge** of urban agriculture practices (i.e. skills) ($\alpha = 0.859$), **perceptions of risk with**

TABLE 1 Factor loadings of survey items for motivations for and barriers to engaging in urban agriculture in a study of urban community gardeners, farmers, and support actors in Lansing, MI. Loadings demonstrate four factors for motivations and one for barriers. Survey items are presented in their factor groupings, with factor loadings >0.35 indicating that items scale together. Items with loadings <0.35 are not shown and were not included in subsequent scales

	Factors	Survey Items	Factor Loading
Motivation Category	Community building	Make and support friends	0.546
		Produce food locally	0.684
		Cultivate green space throughout the city	0.837
	Social and environmental justice	Produce affordable food for the local community	0.674
		Redistribute resources and opportunities to underserved members of society	0.800
		Promote equity, access, and sustainability through structural changes in the food system	0.777
		Involve the local community in food production and distribution decisions	0.775
		Improve the urban environmental by providing habitat or improving soil	0.520
		To work in concert with natural processes	0.422
	Economic	Meet market demands for produce	0.838
		Create job opportunities for others	0.847
		Generate income	0.834
	Health	Promote food that is safer than store bought food	0.935
		Promote healthier and more nutritious food	0.734
		Survey Items	**Factor Loading**
Barriers Category	Environmental	Adapting to rapid environmental changes	0.613
		Accessing affordable, sufficient, and safe water	0.577
		Achieving adequate soil fertility	0.530
		Accessing soil that is free of contamination	0.752
	Institutional	Attaining ownership of land for farming	0.793
		Following the zoning laws where I farm	0.836
		Understanding current policies regulating farm activities	0.878
		Adapting to new policies related to farming	0.871
		Living alongside neighbors who feel that urban agriculture is a nuisance	0.832
		Building trust with others working in urban agriculture	0.716
	Resource	Finding relevant and accessible information about recommended farming practices	0.774
		Generating sufficient income at current market prices	0.664
		Attaining funding to invest in farm operations	0.728
		Having sufficient time to engage in necessary farm activities	0.600
		Having sufficient space to engage in necessary farm activities	0.726

TABLE 2 Factor analysis of responses from urban community gardeners, farmers, and support actors in Lansing, MI confirmed four scales to measure components of adaptive capacity. Survey items are presented in their factor groupings, with factor loadings >0.35 indicating that items scale together. Items with loadings <0.35 are not shown and were not included in subsequent scales

Individual Resilience Category	Survey Items	Factor Loading
Perceived Knowledge	I know a great deal about crop varieties	0.565
	I know a great deal about animal production	0.512
	I know a great deal about soil health techniques	0.726
	I know enough to be prepared for changes in the climate	0.467
	I know a great deal about existing rules and regulations for urban agriculture	0.845
	I know a great deal about rules and regulations that may pass in the near future	0.798
	I know a great deal about how to market and sell my products	0.673
	I know a great deal about where to market and sell my products	0.667
Capacity for Change	I do not think that the local climate will change much	0.392
	I do not think local policies will change much	0.556
	There is too much risk in changing for better seasons	0.598
	My family would not be supportive of change	0.649
	Any change would limit me in other areas	0.698
	It is too hard for me to change	0.585
	I am not convinced that changing will be more profitable	0.634
Self-Efficacy	It is difficult for me to stick to my aims and accomplish my goals	0.622
	I am not confident that I could deal efficiently with unexpected events	0.728
	If I am in trouble, I can usually not think of a solution	0.692
	I cannot usually handle whatever comes my way	0.630
Perceptions of Risk with Transformational Change	If the climate changes, there is not much I can do to respond to the opportunities	−0.537
	If agricultural policies change, there is not much I can do to respond to the opportunities	−0.635
	If new regulations pass, I just hope for the best	−0.353
	Current approaches for dealing with present policies will not be sufficient for dealing with future policy changes	0.448
	I do not really believe in long-term planning; things are too uncertain	−0.508
	I am less likely to endure drought compared to other growers I know	0.407
	I am less likely to endure policy changes compared to other growers that I know	−0.368
	I am interested in learning about climate and its impacts on urban agriculture	0.712
	I am interested in learning about agricultural policies and their impacts on urban agriculture	0.622
	I am interested in learning new skills	0.620
	Being a grower is a lifestyle; it is not just my job	0.409

transformational change ($\alpha = 0.691$), **willingness to change** ($\alpha = 0.781$), and **self-efficacy** ($\alpha = 0.766$). Participants' scores on each item for each scale were averaged to create scale scores. Items on the capacity for change and self-efficacy scales were all negatively worded, so the coding of these items was reversed prior to calculating a scale score.

Self-efficacy items created two factors initially, one with positively worded items and another with negatively worded items - we used the second factor with the negatively worded items due to its higher factor loadings when factored with the other resilience indicators. Perceptions of risk with transformational change items resulted in three factors with eigenvalues of >1. However, items that loaded on the second factor all had duplicate loadings on factors one or three. In addition, there was no thematic difference of items between factors one and three. Therefore, we elected to keep only items which loaded onto the

TABLE 3 Factoring of three resilience indicators among urban agriculture participants in Lansing, MI. Items load onto one factor, supporting the assumption that these scales represent the larger construct of resilience

Resilience Indicator Scale	Factor Loading
Capacity for Change	0.636
Self-Efficacy	0.512
Perceptions of Risk with Transformational Change	−0.670

first factor to create a capacity for transformational change scale. Items that had positive factor loadings were reverse coded for the perception of the risk with transformational change scale to create a measure of risk perception rather than capacity.

Following the development of the resilience indicator scales, we performed a confirmatory factor analysis on the four scales of perceived knowledge, capacity for change, self-efficacy, and perceptions of risk with transformational change. This factor analysis on individuals' scale scores was designed to confirm that these separate scales are measuring a similar construct. We found that perceived knowledge did not factor with the other scales, which may be due to it being a representation of a skill rather than perceptions and willingness to change, as the other items are. The resulting factor loadings of the resilience indicator scales ($\alpha = 0.653$) are shown in Table 3.

An analysis of networks as a representation of circumstances was our final resilience indicator. We totaled the number of categories from which individuals sought support at least annually as a measure of their support network. The strength of each network was determined by multiplying that total by the frequency with which they received support from each source.

2.4 | Open-ended question analysis

Respondents named specific organizations as sources of social and emotional, financial, and informational support. Responses were coded by individual agency name, then condensed into like groups and assigned categories. We conducted this analysis of the limited qualitative data to provide richness to the abstract reporting about support networks in the quantitative questions.

3 | RESULTS

For this descriptive correlational study, we report on trends and correlations between urban agriculture actors, urban agriculture characteristics, demographics, motivations and barriers, and resilience indicators.

3.1 | Demographics

We solicited demographics from our respondents to compare our sample to the general population of Lansing and explore any correlations between demographics and resilience. Table 4 shows our sample of urban agriculture actors was more female, educated, and likely to be white or Asian than the average Lansing city resident, with a higher median income. Demographics were not correlated with any particular actor group.

3.2 | Urban agriculture characteristics

To characterize the types of urban agriculture projects in Lansing, MI, we explored the farm products and their destinations, time invested, income generated, and food production. Survey skip logic excluded support actors who did not report also engaging in farming or gardening from these questions, so the resulting sample size for support actors in this section is reduced ($n = 12$). Across the system, actors reported growing primarily fruits (52%) and vegetables (97%) with some value-added products, both food (27%), for example honey, and non-food (21%) such as medicinal products. Most participants (85%) utilized produce for personal use. Most farmers also sent produce to farmers markets (80%) and CSAs (50%), but so did support actors (73% and 36% respectively). All three groups donated food to friends and family (72% community gardeners, 60% farmers, 46% support) and non-profits (34% community gardeners, 10% farmers, 37% support). Support actors had a more diverse range of destinations for their produce with over 45% also reporting that they sold it to friends/family and restaurants/businesses (higher than farmers, 20% and 10% respectively).

Overall, the average length of involvement in urban agriculture was 8 years (SD 10.6). Community gardeners had the shortest average involvement (mean = 7, SD 8.7), whereas farmers averaged the longest time at 17 years (SD 15.7). On average, participants spent 13 hours per week working in urban agriculture, again with the shortest commitment by the community gardeners (8 hours per week) and the longest for the farmers (28 hours per week).

TABLE 4 Demographic details of urban agriculture respondents ($n = 92$) and the population of Lansing, MI show respondents from our sample were more likely to be female, have a higher education level, and be white or Asian than the general Lansing population. Information for the Lansing population is sourced from the U.S. Census Bureau (2009)

Demographic	Sample (%)	Lansing (%)
Age		
18-64	81	66
65+	18	11
Gender		
Male	34	48
Female	65	52
Non-binary	1	No data
Education		
High School or greater	96	89
Bachelor's or higher	76	26
Ethnicity		
American Indian or Alaska Native	1	1
Asian	13	4
Black or African American	7	22
Caucasian (non-Hispanic)	67	55
Latinx/Latino/Latina or Hispanic	1	12
Multi-racial	4	No data
Native Hawaiian or Other Pacific Islander	0	0
Other	5	
Median Annual Income	$40,000–59,999	$38,642

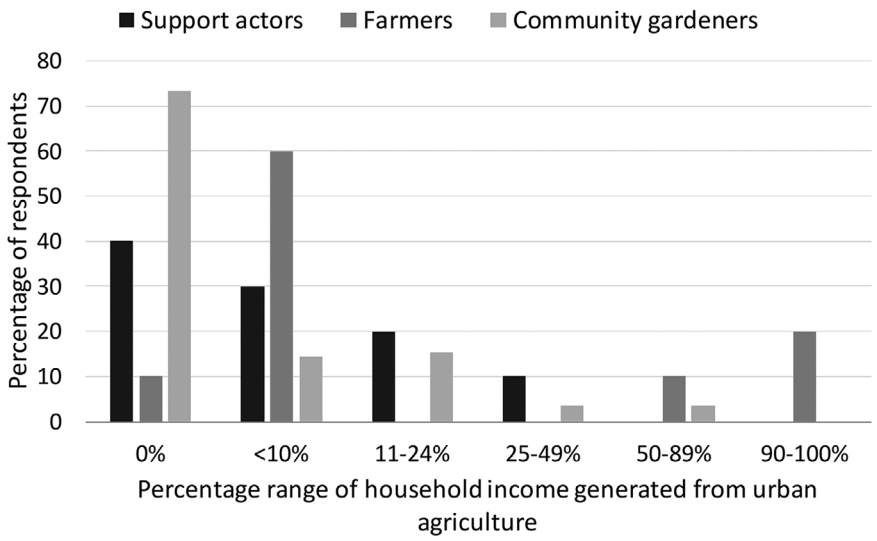

FIGURE 1 Reported percentages of household income generated from urban agriculture in each actor group are low. Support actors who also engaged in farming or gardening ($n = 12$), farmers ($n = 10$), and community gardeners ($n = 62$) in Lansing, MI self-reported these measures. The majority of respondents receive <10% of household income from urban agriculture, with farmers more likely to report higher household income than support actors and community gardeners

The percentage of income that actors receive from urban agriculture produce was small among community gardeners and support actors; Figure 1 indicates that the majority reported up to 10% of their income produced via urban agriculture. Farmers demonstrate a bi-modal distribution, with most only receiving 10% or less of their income from urban agriculture, while some receive most or all of their income from urban agriculture.

Figure 2 shows that most actors in the system provided some percentage of their household's food through urban agriculture. Community gardeners and support actors were less likely than farmers to generate a significant percentage of household food from urban agriculture.

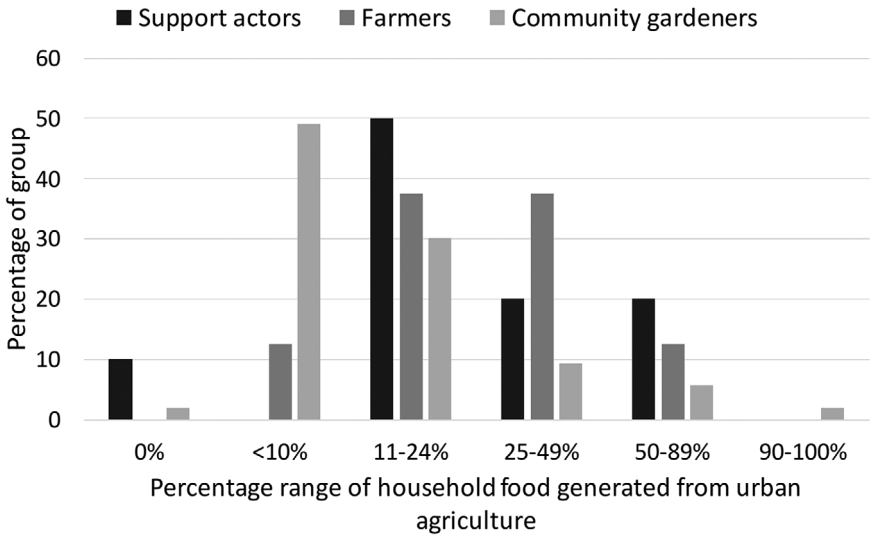

FIGURE 2 Percentages of household food generated from urban agriculture were reported to be up to 50% of household food. Support actors who also engaged in farming or gardening ($n = 12$), farmers ($n = 10$), and community gardeners ($n = 62$) in Lansing, MI self-reported these measures. Support actors and farmers are more likely to report a higher percentage of household food generation from urban agriculture than community gardeners

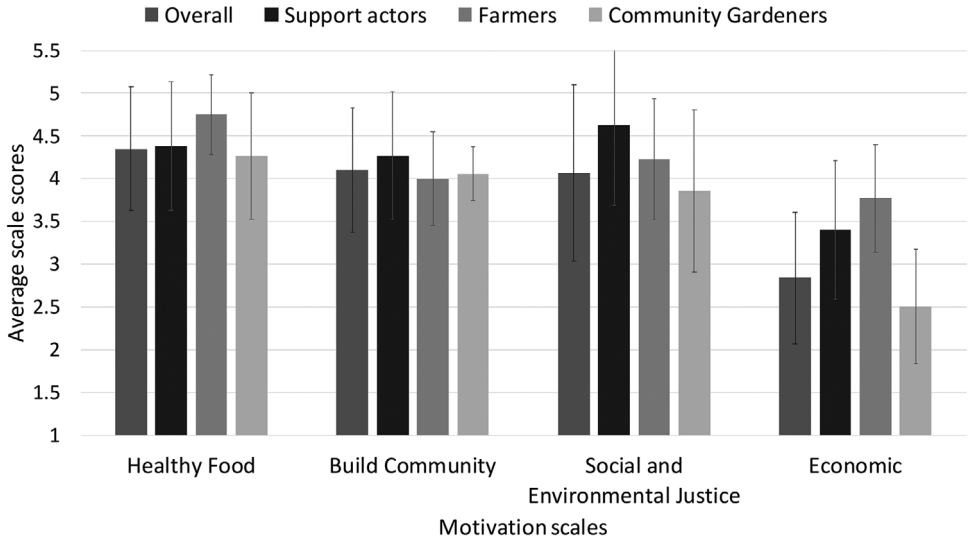

FIGURE 3 Lansing, MI respondents reported different priorities in engaging in urban agriculture on the motivation scales by actor group. Overall, motivations were highest for healthy food and lowest for economic motivations. Support actors and farmers reported stronger motivations than community gardeners. Scores are on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). Error bars represent the standard deviation

3.3 | Motivations and barriers

All groups reported agreement (i.e. a score at 3 or above) to motivations related to building community, healthy food, and social and environmental justice (Figure 3). Economic motivations were more ambivalent across the sample, with the overall mean of 2.8 reflecting 'neither disagree or agree'.

Farmers had stronger economic motivations than the other groups, while Table 5 shows community gardeners' responses were negatively correlated with economic motivations. There was also significant correlation between economic motivations and years spent engaged in urban agriculture, which could be a result of our designation of farmers as for-profit actors only, and farmers reporting the longest time engaged in urban agriculture. Table 5 also shows that the community gardener group displayed a negative correlation with justice motivations; community gardeners showed high agreement with statements related to social and environmental justice, but the negative correlation indicates weaker motivations than other actor groups. Support actors displayed positive and strong correlations with social and environmental justice motivations. There were no significant correlations between motivations and demographic variables such as education or income.

Overall average perception of barriers was 2.33 (SD 0.99), between slightly and somewhat difficult on the 1

TABLE 5 Correlations between actor groups, motivations, barriers, and resilience indicators for urban agriculture participants in Lansing, MI. Correlations demonstrated lower barriers and motivations for community gardeners, higher barriers for support actors, and other relationships with respect to motives, barriers, and resilience indicators

		Group			Motives				Barriers			Resilience Indicators			
		Comm Garden	Farms	Support	Health	Econ	Build Comm	Justice	Environment	Institution	Resource	Knowledge	Efficacy	Change Cap	Risk
Group	Comm	–													
	Farms	−0.557[c]	–												
	Support	−0.709[c]	−0.625[c]	–											
Motives	Health	−0.239	0.233	0.072	–										
	Econ	−0.447[c]	0.373[b]	0.199	0.264[a]	–									
	Build Comm	−0.132	−0.054	0.231	0.406[c]	0.221	–								
	Justice	−0.356[c]	0.128	0.337[c]	0.336[b]	0.389[b]	0.594[c]	–							
Barriers	Environment	−0.290[a]	0.098	0.281[a]	0.208	0.110	0.087	0.187	–						
	Institution	−0.335[b]	0.147	0.289[a]	0.154	0.115	0.250[a]	0.254[a]	0.806[c]	–					
	Resource	−0.277[a]	0.210	0.146	0.275[a]	0.214	0.133	0.306[a]	0.726[c]	0.872[c]	–				
Resilience Indicators	Knowledge	−0.414[c]	0.141	0.424[b]	0.069	0.406[c]	0.277[a]	0.336[b]	0.282[a]	0.434[c]	0.184	–			
	Efficacy	−0.264[a]	0.089	0.237	0.186	0.076	0.219	0.409[c]	−0.043	0.133	0.107	0.123	–		
	Change Cap	−0.106	−0.022	0.177	0.106	−0.004	0.230	0.277[a]	0.121	0.098	0.075	0.131	0.204	–	
	Risk	0.309[a]	−0.173	−0.240	−0.134	−0.112	−0.320[b]	−0.336[b]	0.028	0.080	0.085	−0.178	−0.232	−0.517	–

[a] $p < .05$.
[b] $p < .01$.
[c] $p < .001$.

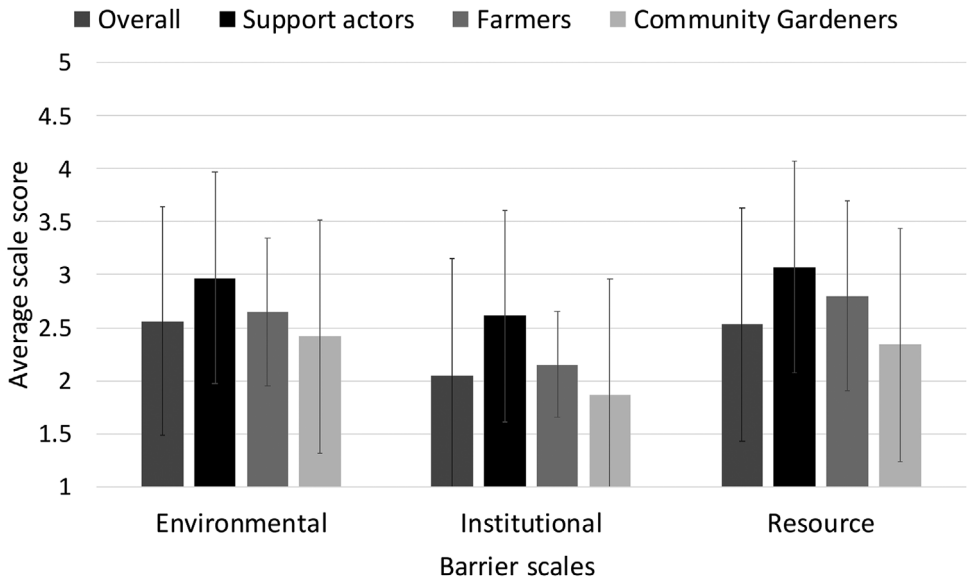

FIGURE 4 Scale scores for different types of barriers experienced by urban agriculture participants from Lansing, MI reveal that institutional barriers presented the least difficulty overall. Support actors reported the greatest difficulty in all barriers, while community gardeners reported experiencing the least difficulty with all barriers, and farmers were in between the two groups. Averages are reported on a Likert scale from 1 (not at all difficult) to 5 (very difficult), with a 3 representing somewhat difficult. Error bars represent the standard deviation

(not at all difficult) to 5 (very difficult) Likert scale. Figure 4 shows environmental and resource barriers were perceived as more difficult to overcome than institutional barriers. Community gardeners had negative correlations with all barriers, displaying the lowest perceptions of difficulty. Support groups had the highest perception of difficulty, with a weak positive correlation with institutional and environmental barriers. Some demographic variables also correlated significantly with barriers: white respondents reported lower institutional (−0.298, $p < 0.05$) and resource (−0.252, $p < .05$) barriers, and higher levels of education and income negatively correlated with all types of barriers with correlation coefficients all greater in magnitude than 0.37 and $p < .001$.

3.4 | Resilience indicators

We considered individuals' perceived farming knowledge, perceptions of risk associated with transformational change, capacity for change, and self-efficacy as important indicators of their adaptive and transformative capacity and thus resilience within the urban agriculture system.

3.4.1 | Perceived knowledge

Community gardeners reported the lowest perceived knowledge (mean = 2.69, SD 0.68) with a strong negative correlation. Support actors had the highest score (mean = 4.01, SD 0.58), and a positive correlation with perceived knowledge. Farmers fell in between the two (mean = 3.13, SD 0.60).

3.4.2 | Perceptions of risk associated with transformational change

Average risk perceptions of transformational change were generally low at 2.00 (SD 0.48). Community gardeners had the highest risk perceptions (mean = 2.05, SD 0.48) and support actors had the lowest risk perceptions (mean = 1.94, SD 0.56). Greater risk perceptions were negatively correlated with change capacity, community building motivations, and social and environmental justice motivations (Table 5).

3.4.3 | Capacity for change

All three groups were very close to overall mean of 3.29 (SD 0.49) representing neither agree/disagree on individual capacities to deal with change in the future. No significant correlations existed for actor groups or reported level of knowledge. However, change capacity was significantly positively correlated with justice motivations.

3.4.4 | Self-efficacy

The measure of self-efficacy had an average of 'agree' for each group (mean = 3.67, SD 0.72), and was highest for the

TABLE 6 The most commonly reported sources of each type of networking support among urban agriculture participants (community gardeners, farmers, and support actors) in Lansing, MI. Each source is reported along with the percentage of respondents who ranked it in their top three for that type of support and the median frequency of respondents utilizing that source

Support Type	Source	Percentage of Respondents	Median Frequency
Informational	Internet	50%	Weekly
	Non-profits	46%	Monthly
	University/extension	45%	Twice a year
Financial	Non-profits	32%	Not reported
	Family	29%	Never
	Friends and neighbors	24%	Never
Social and Emotional	Friends and neighbors	66%	Weekly
	Family	65%	Weekly
	Gardeners in my community garden	35%	Weekly

support actors (mean = 4.02, SD 0.31). Efficacy was negatively correlated with community garden respondents and positively correlated with justice motivations. It was not correlated with knowledge or barriers.

3.4.5 | Networks

Table 6 reports the top three most important sources of support for each category and the median frequency of how often they seek support for informational, financial, and social/emotional support networks.

Participants rely regularly on their immediate networks for social and emotional support, but not for information, where more formal sources of information are used. While friends and family were listed in the top financial sources of support, they were not contacted frequently. We constructed a measure of network strength for our respondents by multiplying the total number of groups that respondents received support from by how frequently they contacted those groups. No significant correlations resulted across actor groups. The strength of financial networks was not correlated with any other variables. However, the strength of informational networks was positively correlated with knowledge. The strength of social and emotional networks was correlated with change capacity, economic motivations, and justice motivations.

3.4.6 | Qualitative analysis

We coded open-ended textual responses of specific support sources to identify particular actors that operate as network nodes. It is important to assess where the system might be burdened and where greater connectivity might increase resilience through more redundancy and diversity. While participants identified a range of support organizations and resources across financial, informational, and social and emotional networks, all three support systems rely by and large on the participation and resources of the GLFBGP and their network of community gardeners. Participants named 12 different categories of financial support ($n = 67$) and identified the GLFBGP in 34% of the total responses; remaining categories were each responsible for ≤10% of the responses. Social and emotional support sources ($n = 42$) demonstrated a similar trend: 13 categories were named and the GLFBGP comprised 55% of the responses. The remaining categories each totaled no more than 10% of responses. Finally, two different categories of information support ($n = 7$) were listed: the GLFBGP (57%) and farm supply stores (43%).

3.5 | Limitations

Our results are limited by the demographics of our respondents, who were more likely to be white or Asian and were more educated and reported higher incomes than the Lansing population in general. We cannot say whether these demographics reflect the entire Lansing urban agriculture community or only those who were able to respond to our survey. We had difficulty providing survey access to immigrant and refugee gardeners who were not proficient in English because of a lack of funding for translation services and the variety of languages spoken across the community gardening network. Only four immigrant or refugee community gardeners participated in the survey, representing 6.5% of our sample of community gardeners; this is lower than the 20% of immigrant and refugee gardeners represented in the GLFBGP network, though that network does not represent all community gardeners in Lansing. We are working with the GLFGP to ensure

better representation of immigrants and refugees in future research to gain a broader understanding of urban agriculture in Lansing. As such, we have been conducting biocultural mapping with immigrant and refugee gardeners at three of the nine network gardens with high refugee and immigrant enrollment. This mapping project explores the biological and cultural diversity of the GLFGP gardens through immigrant and refugee gardeners' completion of ethnographic interviews, drawings of their garden plots, and a botanical survey. It also investigates the role of community gardening in the refugee and immigrant experience in place, with particular attention to the ways community gardens can facilitate equity and inclusion. Such methods appear to be more successful in engaging minority voices.

It should be noted that we largely utilized the GLFBGP network in soliciting responses to our survey because of their reach in the community and our ongoing collaborative work with them; we also reached out to and relied upon a number of other local support agencies for dissemination support. Although the GLFBGP is certainly a key player in the Lansing urban agriculture network, our results may suggest a slightly inflated role as a result. Because of our interest in the more formal urban agriculture system in Lansing, we did not survey home gardeners. Home gardens make up a significant portion of urban agriculture activities in other Midwestern cities such as Chicago (Taylor & Lovell, 2012), and we cannot conclude from our study their role in the urban agriculture system in Lansing, MI. A final limitation of our study was the overall sample size and a difference in sample sizes across the actor groups, which prevented us from conducting more robust statistical analyses among our sample. Nonetheless, we feel that our results have clear findings and implications for how to improve the resilience of the urban agriculture system.

4 | DISCUSSION

In examining the resilience indicators of the urban agriculture system in Lansing, Michigan, we found results that align with current literature on urban agriculture motivations and barriers (Castillo et al., 2013; Colasanti et al., 2012; McClintock & Simpson, 2018) and provide future avenues for exploration to promote the resilience of urban agriculture as a contributor to the local food system. Across our sample, urban agriculture generated a significantly higher percentage of a household's food than income, even among those who were farming for profit; it should be noted again that our sample did not include a representative sample of refugee and immigrant gardeners within the system. Most actors appear to have multiple motivations, but in the context of resilience, social and environmental justice may be particularly important for individuals to remain in the system in the longer term, at least in small urban areas like Lansing, MI. Individuals working in urban agriculture support organizations reported the strongest justice motivations, while community gardeners reported the weakest. Therefore, to promote a system that prioritizes social and environmental justice, developing robust support organizations may play an important role (Olivier, 2019).

Community gardeners are the most plentiful type of actor represented in our survey, which aligns with our expectations given the Lansing context. Community gardeners report the least strong motivations across all categories. They also reported experiencing the least restrictive barriers, which suggests three potential implications for strengthening the urban agriculture system. First, this perceived lack of barriers may be due to community gardeners in our sample having sufficient access to resources that mitigate barriers, perhaps due to their relatively high socioeconomic status compared to the Lansing population as a whole. Second, this finding could indicate that community gardeners are not likely to participate in urban agriculture if they experience high barriers. These high barriers could deter prospective community gardeners from participating in urban agriculture, or could push community gardeners out of the system once they experience more difficult barriers. Alternatively, the perception of low barriers from community gardeners could indicate that community gardening is an effective low-barrier point of entry for involving new participants in the urban agriculture system. In that case, better understanding what kinds of motivations and incentives might support longer term engagement would be useful. In any case, this result highlights the importance of maintaining low barriers for new community gardeners, as well as the value of maintaining an involved network of community of garden leaders and other support actors to retain community gardeners in the urban agriculture system (Drake & Lawson, 2015; Ghose & Pettygrove, 2014). The relatively high turnover of community gardeners compared to other actors likely also necessitates regular interaction between new community gardeners and more experienced gardeners or other support actors to continually retain knowledge in the urban agriculture system (Birky, 2009; Drake & Lawson, 2015).

The correlations between actor groups, motivations, barriers, and resilience indicators suggests that there are at least two primary types of urban agriculture participants in our system: 1) individuals who engage in urban agriculture for personal reasons, e.g. those motivated by increased access to healthy foods, and 2) individuals who engage in urban agriculture to support a local food system, e.g. those who are motivated by community building and justice.

These two frames of motivations align with the lenses of "food" and "people" as discussed by Neilson and Rickards (2017) with regard to urban agriculture. Sonti and Svendsen (2018) also showed that healthy food has grown as an urban agriculture motivation since the early 2000s, while community improvement motivations have lessened over that time period. In our study, stakeholders interested in community and justice appear to be more involved in the system as a whole than those who are motivated primarily by personal health and economics, as shown by their higher knowledge, stronger emotional networks, and higher change capacity. For example, actors motivated by community impacts report stronger indicators of adaptive capacity, indicating stronger resilience and likelihood to remain in the urban agriculture system. However, they also report higher institutional and resource barriers, which potentially indicates a lack of transformative capacity, i.e., the capacity to overcome such barriers by changing the system. Investing in changes to institutional and financial structures that support urban agriculture may improve the broader resilience of urban agriculture and local food systems, as discussed more generally for social-ecological systems in Adger (2000) and specifically for food systems in Hodbod and Eakin (2015) and Campbell (2016).

These results, reinforced by the qualitative findings that demonstrate the particular burden on key support agencies, suggest a need for increased connections among the institutional and financial network to build resilience in the urban agriculture system. This foundation should be targeted specifically for urban agriculture support organizations, which can in turn then support local farmers and community gardeners. Based on prior literature, we propose some institutional and financial means of support toward this end. First, local governments interested in investing in urban agriculture can follow several best practices, including consulting directly with urban agriculture support organizations to develop city policies (Campbell, 2016). Transparency and clarity in local urban agriculture governance can also help foster urban agriculture participation, thus increasing the diversity of capacity and innovation within the system (Biggs, Schlüter, & Schoon, 2015). Second, when developing urban agriculture policy, cities should couple policy with funding support, particularly given that urban agriculture is often most impactful for and potentially inaccessible to low-income households (Campbell, 2016; Frayne, McCordic, & Shilomboleni, 2014; Zezza & Tasciotti, 2010). Third, city governments should collect and distribute resources, potentially through an urban agriculture liaison who can explain policies and locate sources of financial support. The open-ended financial networking questions on our survey revealed a number of responses that expressed a desire for more information about funding opportunities, specifically those related to funding for disabled participants. At the same time, other individual participants shared quite a few opportunities they had discovered, though many of these were only referenced by a single participant. This disconnect between funding knowledge and funding interest suggests that little information is shared across actors about funding support, which would explain the lack of financial support reported in the survey. Sharing resources across network actors might provide greater opportunity for external support, while hosting programming about funding—or partnering with university resources to do so, for example with grant-writing or community engagement classes—would increase capacity to receive this funding.

Findings from our study suggest that the different actors in the urban agriculture system in Lansing—farmers, community gardeners, and support actors—do not necessarily have diverse networks. Diverse urban agriculture networks that consist of multiple actor groups, including universities, non-profits, and community gardeners, are best able to implement successful urban agriculture policies (Campbell, 2016). Diversity is another principle of resilient systems—it provides functional redundancy i.e. 'insurance' that allows some components to compensate for loss of others (Biggs et al., 2015). Creating opportunities to foster connections across actor groups may improve network diversity in Lansing, reducing the pressure on the GLFBGP, the central support agency. Increasing the number of actors who can share the support role means the network will be more resilient to change. Respondents reported interacting with non-profits monthly and universities twice a year for informational support. Non-profits or university extension agencies could integrate networking information and connectivity events into their initiatives to broaden their reach and impact, supplementing the efforts of the GLFBGP.

5 | CONCLUSION

Urban agriculture in Lansing provides food, income, and value-added products to participants and neighborhoods through markets, CSAs, and donations. Community gardeners are more plentiful than farmers or support actors, and our sample of urban agriculture actors differed from the demographics of the city of Lansing overall. In the Lansing area, community gardeners appear the least committed and integrated into the urban agriculture system, while farmers and support actors spend more time and have stronger motivations across all categories. Stakeholders who are more integrated into the system as demonstrated by these stronger motivations also show stronger resilience indicators, including higher knowledge and skills, lower risk perceptions, stronger emotional

networks, and higher capacity for change. However, they also showed higher perceptions of institutional and resource barriers. These results offer potential avenues for local governments and urban agriculture actors to contribute to the resilience of the system through breaking down institutional and resource barriers by prioritizing urban agriculture in local governance and fostering strong networks across the urban agriculture system. A resilient urban agriculture system is an important facet of a healthy urban system and can provide myriad social, environmental, and economic benefits.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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