




A Pilot Study Exploring Practices that Support the Longevity of Community Gardens Supported by Religious Organizations

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Accepted: 20 February 2023 / Published online: 12 May 2023
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Abstract

Current food production methods in the United States (US) contribute to environmental degradation as well as food insecurity. Food production by means of community gardens has the potential to reduce the deleterious effects of current production methods. However, many community gardens face challenges that hinder their longevity, thereby reducing the likelihood of the support they might provide for environmentally sustainable food production and decreased food insecurity for community members. Researchers conducted a literature review regarding best practices for community gardens, and used ethnographic research methods to inform a culturo-behavioral systems analysis using the Total Performance System and matrix (systems interdependency) analysis to better understand the cultural practices of two established community gardens in the southwest region of the US. The results of the analyses are presented in terms of recommendations to support each community garden's sustainability. Recommendations regarding future research include environmental manipulations to identify functional relations and potential outcome measures for improving the longevity of community gardens.

Keywords Culturo-Behavior Science · community gardens · environmental sustainability · food security

Food insecurity “exists whenever the availability of nutritionally adequate and safe foods or the ability to acquire acceptable food in socially acceptable ways is limited or uncertain” (Anderson, 1990, p. 21). Conversely, food security is “access by all people at all times to enough food for an active, healthy lifestyle” (Coleman-Jensen

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et al., 2018, p. 2). Food insecurity is associated with poverty and results from economic and social processes that limit access to food (Chilton & Rose, 2009), particularly healthy food. The problem of accessibility to healthy food in low socioeconomic status (SES) neighborhoods creates a multitude of issues that negatively impact not only the community members residing in these neighborhoods but also society as a whole.

Due to the lack of access to larger supermarkets that sell nutritious food at a lower cost (Andreyeva et al., 2008; Franco et al., 2008; Hatzenbuehler et al., 2012; Morland et al., 2002), the community members may resort to more accessible smaller grocery stores and convenience stores in their communities that sell processed foods that are high in sugars and fats (Gittelsohn et al., 2008; Hilmers et al., 2012; Jetter & Cassady, 2006; Larson et al., 2009; Sloane et al., 2003). This, in turn, negatively impacts the health of the community members, increasing the prevalence of birth defects (Carmichael et al., 2007), anemia (Eicher-Miller et al., 2009; Skalicky et al., 2006), depression and anxiety (Whitaker et al., 2006), oral health problems (Muirhead et al., 2009), cardiovascular disease (Morales & Berkowitz, 2016), and obesity (Franklin et al., 2012; Morales & Berkowitz). Many of these, often chronic, health problems associated with the accessibility of healthful foods result in higher healthcare costs for those individuals (Lee, 2013), which results in an estimated expenditure of 90 billion dollars annually in the US (Brown et al., 2007). Even though the relationship between the accessibility of healthy food in low SES neighborhoods and its impact on the health of the community members and on the healthcare system (Neff et al., 2009) appears to be clear, the food production system in the US continues to support the production of highly processed foods to feed its large population.¹

Community Gardens—An Overview

Community gardens (CGs) are sections “of land collectively gardened for the specific purpose of growing fruits, vegetables, and/or herbs for self-consumption” (Egli et al., 2016, p. 348), and may provide an alternative food production method that can contribute to reducing food insecurity. CGs are an economically viable alternative for producing fresh fruits and vegetables because gardeners can produce large amounts of food at a relatively low cost compared to similar food at a grocery store (Flachs, 2010). Crops harvested from CGs may be donated to local food banks and can be made available at no cost to those who face food insecurity (Furness & Gallaher, 2018), especially if housed within supportive contexts, which often include not-for-profit organizations such as K–12 schools and religious organizations. CGs are also an environmentally sustainable alternative to mechanized monoculture, a farming method in which hand labor is replaced with machines, and a single crop is grown across large tracts of land to maximize crop output. Compared to conventional methods of agriculture, sustainable agriculture relies less on fertilizers and

¹ Consumer demand for some “healthy foods” may be lacking in some cases due to a variety of current and historical environmental factors.

pesticides, which protects natural systems and can be a more economically viable way to produce healthy foods (Enger & Smith, 2016).

Agricultural techniques applied within CGs are more likely to be environmentally sustainable. For example, Cordovil et al. (2015) demonstrated how sustainable gardening practices were used among three neighborhood urban farms in Lisbon, Portugal; the land was tilled by hand, composted, and did not use commercial pesticides. Additional benefits of CGs span multiple domains and have been demonstrated through increasing the health and safety of community environments (Hite et al., 2017), improving environmental sustainability (Cordovil et al., 2015), increasing vegetable consumption (Alaimo et al., 2008; Algert et al., 2016; Carney et al., 2012; Litt et al., 2011; Morris & Zidenberg-Cherr, 2002), increasing physical activity (Twiss et al., 2003), decreasing obesity (Davis et al., 2011), increasing property value (Voicu & Been, 2008), creating safe environments (Hite et al.), and mitigating urban blight (Schukoske, 2000). Thus, CGs provide an effective method for increasing food security for the immediate community while maintaining sustainable growing practices (Carney et al., 2012; Cordovil et al., 2015).

It is important, however, to identify the practices and conditions that maintain CGs. Even though CGs are beneficial for communities and environments, they face barriers that threaten the likelihood that they will continue past one growing season. Some initial barriers include accessing land (Saldivar-Tanaka & Krasny, 2004) or water meters (Eslick & Thomas, 2010) and obtaining legal permits and certificates of occupancy (Voigt, 2011). Even after these barriers are overcome, maintenance practices such as managing volunteerism (Saldivar-Tanaka & Krasny), accessing technical knowledge (Diaz et al., 2018), and maintaining financial resources (Eslick & Thomas) can hinder a CG's success.

Behavior scientists may be able to support CGs in overcoming barriers and adopting and maintaining sustainable practices. Culturo-Behavior Science (CBS), for example, is a specialization within behavior analysis that utilizes multidisciplinary, transdisciplinary, and/or ecological approaches to analyze existing practices and develop interventions that support large-scale change within cultural and behavioral systems (Cihon & Mattaini, 2019, 2020). Culturo-behavior scientists often incorporate concepts and analytic strategies from behavior systems analysis (BSA; Brethower, 1972), and cultural analysis (e.g., the metacontingency; Glenn, 1986, 1988; Glenn et al. 2016; Glenn & Malott, 2004; Malott & Glenn, 2006) and examine individual behavior and organizational practices across multiple levels of analysis (Malott, 2003; Malott & Martinez, 2006).

Community Gardens as Organizations

Organizations such as schools, companies, and non-profit organizations are found within most human cultures (Malott & Glenn, 2006). CGs are organizations, sometimes positioned within other organizations (e.g., K–12 schools, religious organizations), and are components of behavioral systems formed when multiple individuals are working together toward a common goal (Malott, 2003). One way to describe organizational practices is in terms of the metacontingency, which consists of “a

contingent relation between 1) recurring interlocking behavioral contingencies having an aggregate product (culturant; Hunter, 2012) and 2) selecting environment or conditions” (Glenn et al., 2016, p. 13), all of which occurs in the context of a cultural/institutional milieu. The selecting environment or conditions includes those metacontingencies established by the cultural/institutional milieu (see Houmanfar, Rodrigues, et al., 2010; Houmanfar, Ardila Sánchez, et al., 2020) that further sustain the system’s interlocking behavioral contingencies. The components of the metacontingency can be exemplified by describing a process within a CG. In a CG, multiple gardeners come together to harvest tomatoes during a garden workday. Gardener 1 (G1) sees that some, but not other tomatoes are ripe, and points out the ripe ones while saying “those tomatoes” to G2. G2 picks the ripe tomatoes and hands them to G3 before going back to pick more. G3 rinses the tomatoes and then carries them over to the basket above the scale where they set them. G4 writes down the weight of the tomatoes before carrying the basket of tomatoes to a loading truck. These steps are repeated until G1 cannot find any more tomatoes to pick, or the truck is full. G5 then drives the tomatoes to the food pantry and delivers them to the food pantry volunteer. Food pantry recipients arrive and are given the tomatoes. This set of interlocking behavioral contingencies (IBCs) and aggregate products (APs) (culturant; Hunter, 2012) are repeated weekly. The gardeners as well as the food pantry volunteer engage in IBCs that produce the AP (i.e., the tomatoes that are made available for food pantry recipients). The result of each individual’s behavior occasions the response of the next. The culturant is the entire tomato harvesting process, including bringing the tomatoes to the food pantry. The selecting environment includes the cultural/institutional milieu, which could be the food pantry recipients taking the tomatoes, and for some CGs like those explored in the current manuscript, the cultural/institutional milieu may include a collaborating religious organization that provides the financial and human resources necessary to sustain the recurring IBCs and APs, and ultimately the CG itself.

CBS Tools to Analyze Organizations

CBS studies both the individual behavioral- and systems-level interactions to gain a deeper understanding of the variables that maintain or hinder the performance and adaptability of organizations. The Total Performance System (TPS; Brethower, 1972) is a tool within BSA that allows researchers to organize the components of a system to depict the organization’s three levels: Organization, Process, and Performer, which give a comprehensive analysis from the top to the bottom of the organization (Diener et al., 2009; Malott, 2003). The interventions produced by this type of analysis identify and target the areas of the system that will “have the largest positive impact on the organization” (Diener et al., p. 110).

Another way in which culturo-behavior scientists have approached large-scale change is through the matrix analysis (Biglan, 1995; Mattaini, 2013). The matrix analysis provides an analysis of concurrent interacting interdependencies among different classes of actors and sectors (Mattaini). For example, the consequences of one (class of actor) individual’s action provides a motivating context for another

organization (sector) to complete a task, which then sets the occasion for another organization to complete another task, and so forth. The matrix analysis lends well to developing an understanding of the ways in which different actors and sectors interact to create or solve different problems (e.g., Biglan, 2016; Fava & Vasconcelos, 2017; Luke & Alavosius, 2012; Mattaini, 2013; Seniuk et al., 2019). Once the relevant variables are identified, the culturo-behavior scientist can make informed decisions, leading to the actualization of interventions that will produce the most effective change.

A Pilot Study to Assess Community Gardens Supported by Religious Organizations

CGs may be one way to reduce the environmental impact caused by unsustainable food production methods as well as counter issues related to food insecurity resulting from the cost and/or unavailability of healthier food choices. However, little is known about the environmental and organizational variables that maintain different types of CGs, especially those supported by not-for-profit organizations such as religious organizations. A closer look into the factors that support the longevity of CGs in these specific contexts could support the purpose of CGs to provide fresh food options to the surrounding community. The tools of CBS can provide a starting point for conducting such an analysis.

In the current manuscript, researchers describe a pilot study conducted with two CGs housed within the cultural/institutional milieu of religious organizations. Researchers conducted a literature review regarding best practices for community gardens, and used ethnographic research methods to inform a culturo-behavioral systems analysis using the Total Performance System and matrix (systems interdependency) analysis to better understand the cultural practices of two established community gardens in the southwest region of the US.

Method

General Procedures

The overall framework for this study was based upon methods used in ethnographic research (Carvalho et al., 2017; Jones & Smith, 2017) and CBS (Diener et al., 2009; Malott, 2003; Mattaini, 2013). The first task was to gather information about CGs by reviewing the extant literature, which provided a generic set of best practices for CGs. The next step involved recruiting CGs and their essential personnel to participate in the ethnographic portion of the research. This phase included in-depth observation and structured interviews, conducted using a modified version of the Behavioral Systems Analysis Questionnaire (BSAQ; Diener et al.). Next, the information collected during observations and interviews was organized and analyzed combining several tools/frameworks from CBS including matrix analyses and Malott's (2003) Behavioral Systems Engineering Model (BSEM). These analyses provided details

regarding the practices of the participating CGs, allowing recommendations as to how the participating CGs might improve their practices and/or align them more closely with the best practices in the literature.

Phase I: Gathering Information Regarding Best Practices for CGs

The first author reviewed the literature to determine the classes of actors and the corresponding practices that support the status quo (Mattaini, 2013). The terms “best practices or barriers” and “community garden” were included in a search of Ebscohost. Those articles that included information regarding CGs and practices that support or pose a barrier for them were selected, and those that described only the practices involved in the initial startup of a CG were excluded. A total of 20 articles out of 90 were selected for inclusion in the review.

Phase II: Ethnographic Procedures

Participant Recruitment, Participants, & Setting

CGs and key personnel were recruited from a sample of CGs and coordinators who participated in a 2019 survey hosted by the Dallas Coalition for Hunger Solutions (DCHS). The DCHS coordinator sent the recruitment email to 18 CGs and corresponding coordinators who met the following criteria: the CG cultivated fruits and/or vegetables, allowed gardeners to take the food home, and had been growing for at least two seasons in 2018. Three CGs in Dallas County were selected for participation, though results for only two of the three are presented here.² Initial consent for participation was provided by the CG coordinators who agreed to: grant site permission for the CG to take part in the current study, allow audio recording during interviews, provide access to de-identified CG data, and de-identify any CG data taken during the observation period.

CG volunteers were recruited through an email sent by the CG coordinators from Gardens 1 (G1) and 3 (G3). CG volunteers had to be at least 18 years old and participate in garden activities for approximately 1 hour each week. The email included the purpose of the study, the approximate time commitment, and a consent form that potential participants could review prior to the consent process. The first author set up individual meetings over the phone with potential participants to review the consent form. After gaining verbal consent from the CG volunteer over the phone, they could go forward with the interview promptly or at a later mutually agreeable time. The information included in this study has been adapted to maintain participants' confidentiality as best as possible (e.g., each individual participant was assigned a pseudonym from an alphabetical list of botanical names [House Plants Expert,

² Research for G2 was not completed due to the immediate suspension of human research in response to COVID-19 in March 2020.

2020] in the order in which they signed the consent forms [e.g., CG coordinator for G1 was Ainsley, CG coordinator for G3 was Calendula, etc.]).

Garden 1 G1 had 1282 m² of growing space and was located on the grounds of a religious organization (RO) that supported it. G1 cultivated fruits, vegetables, and chickens that they donated to a local food pantry. G1 had tax exemption status for purchasing supplies. Additionally, G1 donated two plots to local refugee families to cultivate their own food and take it home. The G1 coordinator (Ainsley) had been the coordinator for 4 years. She had several years of experience with gardening beginning in childhood, had completed the requirements for Master Gardeners (Texas Master Gardener Association, n.d.), earned certificates as a master vegetable specialist (Tree Care Specialist Training Program, n.d.) and as a master tree specialist (Greenhouse Management Advanced Training, n.d.), and had relevant work experience as a manager. All garden plots were shared among volunteers to grow crops for donation.

Garden 3 G3 was located on the premises and directly next to a RO different from G1. The garden mainly consisted of individual gardening plots ($N = 21$; 16 at 7.62 x 1.52 m and 5 at 3.66 x 3.66 m), tended to by volunteers assigned to them, and had fewer plots assigned to crops grown for donation to the food pantry every 2 weeks ($N = 3$; 1 at 3.66 x 3.66 m and 2 at 7.62 x 1.52 m). The G3 coordinator (Calendula) had been the coordinator for approximately 2 years and had gardened since she was a child. G3 was the first CG of which she had been a member, and she considered her skills to be self-taught. Her volunteer management experience had been acquired throughout her time as a garden coordinator. The two G3 volunteers (Dahlia and Elm) had both gained agricultural experience throughout their lives. They, along with two other G3 volunteers, cared for the donation plots at G3, but also had their own individual plots. G3 volunteers cultivated fruits, vegetables, and herbs.

Observations and Interviews

The ethnographic methods used were modeled after Carvalho et al. (2017). In the current study, researchers similarly used a participant observer approach; the first author worked alongside garden volunteers and maintained regular contact with the participants. She asked questions to supplement her structured interviews and observations. She joined gardeners for garden workdays, meetings, and nonevent workdays. She also joined the CG's social media pages and was included in emails sent by the garden coordinators throughout the observation period.

The first author's first meeting with the coordinators from G1 and G3 included meeting at the garden for a tour, then immediately after, meeting at a local coffee shop to review the consent form and details regarding observations and the subsequent presentation of data and results. At that time, she also answered any questions the coordinators had. The meeting ended after the coordinator signed the consent form, a time had been set up to complete the BSAQ, and subsequent observations were scheduled.

The first author interviewed each CG coordinator using a modified version of the BSAQ (described in the section “BSAQ and Food Security Survey”). She completed this within the same week the consent form was signed; unstructured interviews were conducted following the BSAQ to clarify any information or fill in gaps for missing information. The BSAQ interviews were voice recorded using the Voice Memos app, transcribed, and then written results were formatted similarly to Diener et al. (2009).³

Observations occurred during meetings, garden workdays, and general non-event days at the gardens once or twice each week during the 4-week observation period. The first author gained permission from garden coordinators via text and/or email prior to each visit and conducted five observations for each garden. If the first author visited during a workday, she stayed for the full 2 hours; if there were no events, she stayed 5 to 10 min and collected attendance, took photos, and recorded other relevant information.

During observations, the first author also recorded the number of participants present, general conditions of gardening supplies and garden beds, the amount of produce weighed by a garden volunteer (in pounds) harvested and available for volunteers to take and/or for donation, sustainable practices (e.g., composting, rainwater collection, organic methods), and any events or information posted for volunteers. Participating garden coordinators were asked questions to clarify information exchanged during the observation periods. In addition, the first author took weekly photos of gardening beds and supplies using an iPhone 6S Plus that were later uploaded onto a password protected online document. The information collected during observations and unstructured interviews was recorded using handwritten notes and later typed into a password protected online document.

BSAQ and Food Security Survey

The first formal interview with CG coordinators was based upon the BSAQ interview (see Appendix A). The questions included were adapted from Diener et al. (2009). The first author conducted a formal interview with each of the CG coordinators from G1 and G3, and asked participants clarification and follow-up questions guided by information gathered during observations. These interviews were conducted after the first observation for G1 and after the second observation for G3.

The first author also conducted a formal interview with two CG volunteers from G3 over the phone, in response to changes the institutional review board approved following restrictions on research modalities due to COVID-19. Similar to the CG coordinator but with respect to the performer level of the BSAQ (see Appendix B), the first author asked participants clarification and follow-up questions guided by information gathered during observations. Both interviews occurred after observations at the CGs.

At the end of the interview, all participants were given the option to complete a food security survey (Economic Research Service, USDA, 2012). It is an 18-item,

³ Transcripts are available by contacting the second author.

three-stage questionnaire in which the first stage is a screener to ask the minimum number of questions necessary to assess an individual's level of food security (see Appendix C). All participants agreed to complete the survey and the results indicated a high level of food security for all participants.

Phase III: Data Summary and Analysis

Literature Review Table

The information collected from the literature review was organized in a table following the format of the table generated by Aspholm and Mattaini (2017).

Total Performance System (TPS)

A set of TPS diagrams informed by Diener et al. (2009) were made (using draw.io) for each CG based upon the information collected via observations and interviews. The organizational, process, and performer levels included information gleaned from all levels of the BSAQ and information collected from observations and unstructured interviews. For the organizational level, the information was synthesized to depict the nine key components of an organization. For the process level, information was arranged to depict the gardening process. Finally, the performer level incorporated the information obtained regarding the garden coordinator and volunteer job duties, inputs, and feedback for each CG.

Matrix (Interdependency Diagrams)

A matrix depicting the interdependencies among the various actors and sectors at the CGs was made using draw.io, incorporating all responses collected during structured and follow-up interviews along with information gathered during observations. One matrix diagram was created for each CG. First, the researchers identified all the relevant actors and sectors for each CG and created a column for each. Within each column, five distinct sections were created from top to bottom: action/practice, class of actor, motivating context, consequences, and opposing practices. For each action or practice engaged by each class of actor (actor or sector), the corresponding motivating context(s), consequence(s), and opposing practice(s) were identified and listed in the respective row. Lines with arrows were drawn to depict the contingencies between sectors (e.g., when the practices of one sector serve as the consequences for another sector's practices). For example, if the production (consequence) of one resource for Sector A served as a motivating context for Actor B, a line began from the consequence row of Sector A and connected with an arrow pointing toward the motivating context row for Actor B, illustrating the connection between the different actor and/or sector that maintained the current practices at the CGs.

Results, Analysis, and Recommendations

The results are presented as a narrative that details findings from observations and interviews. It is organized to tell the story of each CG and is supplemented with corresponding tables and figures. This section also includes information compiled from the results, analyzed using combinations of different conceptual tools such as the metacontingency including the unique features of the ROs as the cultural/institutional milieus that supported the CGs' recurring IBCs. The analysis allowed researchers to identify the potential variables maintaining processes at the CGs, and make recommendations for improved practices to address issues related to maintaining volunteerism, allocating funds, and reducing the CG coordinators' workloads.

Literature Review and Best Practices for CGs

Table 1 depicts the results of the literature review. The information is organized with respect to the five general actors/sectors necessary to maintain the longevity of CGs (garden volunteers, a garden coordinator, government [e.g., city ordinances], education sources, and funding [e.g., local companies and private donors]), the practices they engage in which support CGs, the practices that might oppose engaging in best practices, incentives and disincentives for engaging in the target practices, and the facilitating conditions.

TPS – Organizational Level

The organizational level of the TPS depicts the connections and the flow of nine critical organizational elements: mission/goal statement, inputs, processing system, processing system feedback, outputs, receiving system, receiving system feedback, environmental variables, and competitors for resources and customers. Figure 1 (top panel) and Fig. 2 (top panel) depict the Organization Level TPS for G1 and G3, respectively.

Mission/Goal Statement

A mission statement provides leaders a tool for guiding its evolution (Malott, 2003). An organization that does not have a mission may not have a clear direction, and it may not be able to adapt to changing environmental conditions. A mission that is missing components, presents information unclearly or in a manner that is too complex or too ambiguous can lead to organizational myopia, which occurs when an organization makes changes without respect to its mission, leading it “to produce without realizing its purpose” (Malott, 2003, p. 48).

Table 1 Community Garden Best Practices Literature Review

Sector	Practices Supporting Community Gardens	Practices Opposing Community Gardens	Incentives	Disincentives	Facilitating Conditions
<i>Garden Volunteers</i>	Environmentally sustainable cultivation; maintain infrastructure; pest control; cultivating culturally appropriate food ¹⁴	Plot abandonment; purchasing processed food ^{1,4,19} ; community norms and beliefs ¹⁴ ; competing priorities ²	Increased personal/community food security ^{2,9,10,11,15,17,19} ; building community relations: locally sourced food ^{1,8,11,15} ; environmental sustainability ¹⁹	Time commitment ^{2,3,5,10,12,14,15,20} ; lack of skills ^{9,14,19,20} ; cost ^{9,14} ; lack of supplies ^{6,14} ; risk of failure ⁹ ; pests; language barriers ²⁰ ; poor soil health ³ ; poor communication ^{2,3,11}	Close proximity of gardens to residences ^{8,14}
<i>Garden Coordinator</i>	Maintain volunteerism ^{7,14,17} ; set garden workdays ¹³ ; allocate resources to financially maintain garden; community outreach; volunteer recruitment ^{10,14,17} ; water management ⁷ ; open system ^{4,16,18}	Lack of participation from volunteers and surrounding community ^{6,7,12,14} ; closed system ¹⁸	Gain management skills ¹⁷ ; increase food security in the community and personally ^{2,9,10,11,15,17,19}	Time commitment; lack of skills ⁶ ; inadequate community support ^{5,6,12} ; lack of supplies and funding ^{3,4,5,6,10} ; scheduling issues; lack of compliance ⁶ ; lack of leadership ^{6,10,20}	Community with similar motivations ⁴
<i>Government</i>	Water access ^{3,4,14,20} ; access to land; cooperation with community garden members ^{13,20}	Land use certificates expensive and/or difficult to set up garden ²⁰ ; expensive to attain water ^{3,4,14,20} ; zoning restrictions ^{8,20}	Increased property value; increased neighborhood safety; increased community food security ^{14,19}	Difficulty navigating local regulations ^{6,15}	Supportive legislation ^{4,15,20} and urban regeneration strategies ^{15,20}
<i>Education Sources- Master Gardeners</i>	Garden techniques ^{4,17,20} ; sustainable agriculture practices ²⁰ ; community building ¹³		Increase growth productivity of garden ^{4,20}		
<i>Local Companies/ Private Donors/ Grants</i>	Funding and donating supplies ^{8,20}	Theft and vandalism ^{3,6,7,20}			

The superscript numbers correspond to the source from which this information was found, listed by the corresponding number in the reference section

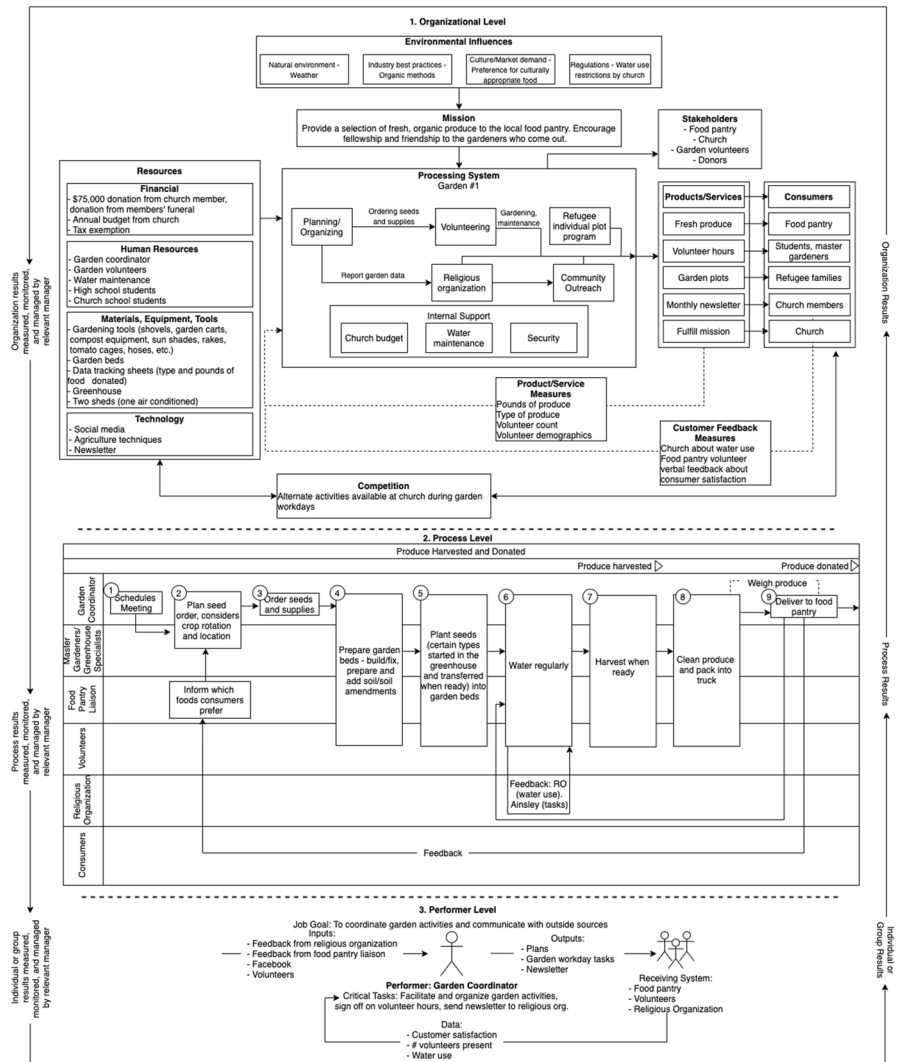


Fig. 1 TPS – Organization, Process, & Performer Levels: Garden 1

Moreover, the mission should be defined taking the macrosystem (or the system in which the organization exists) into account (Malott, 2003).

G1 did not have a formal mission statement. Based upon Malott’s (2003) recommendations, information collected from the current research (i.e., Ainsley’s response during the BSAQ), and with respect to the urban agricultural system as the macrosystem, the following mission was recommended:

The mission of [Garden 1] is to provide a selection of fresh, culturally appropriate produce to persons who experience food insecurity through

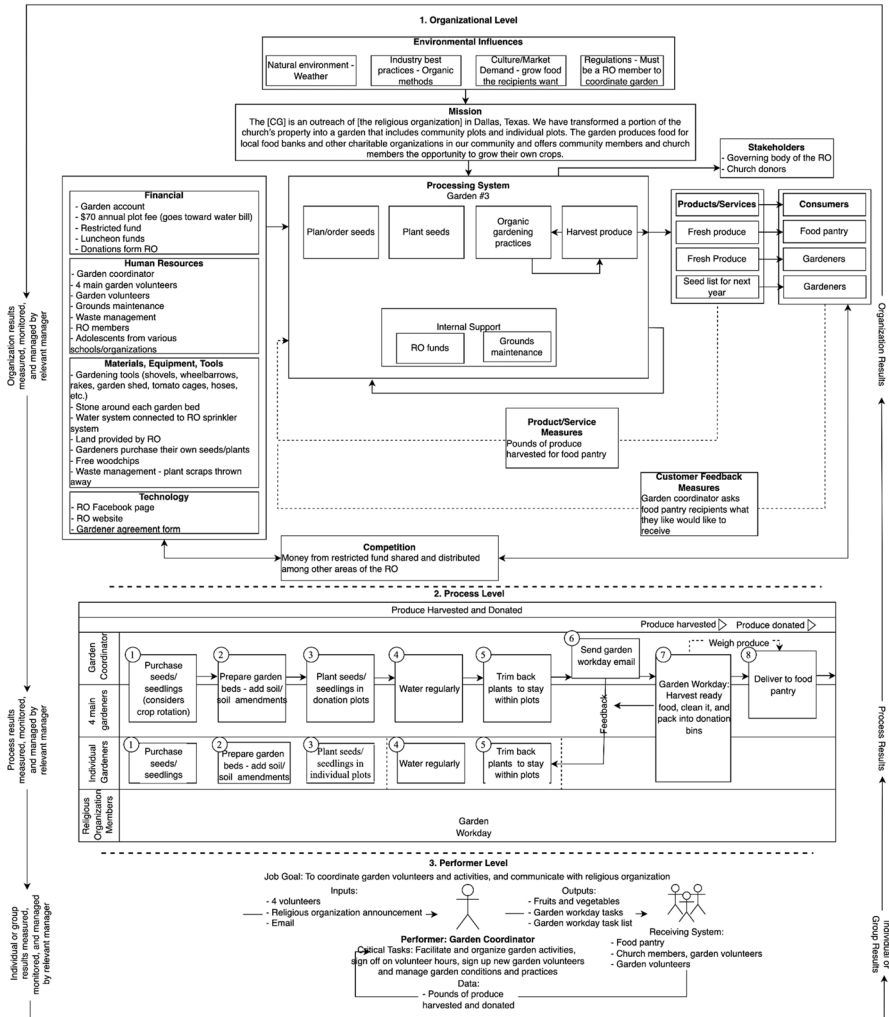


Fig. 2 TPS – Organization, Process, & Performer Levels: Garden 3

environmentally sustainable, organic cultivation while encouraging fellowship and friendship to gardeners.

G3 had a mission published on the RO’s website, as follows:

The community garden is an extension of our religious organization in Dallas, Texas. We have converted a portion of the religious organization’s

*property into a community garden that consists of both community and individual garden beds for community and religious organization members to cultivate their own food. Produce is also donated to local food banks and other related charities within the community.*⁴

However, a close look and analysis of the mission revealed that it included excess information, such as the CG's location, the RO it belonged to, and the action of it being built upon the RO's property that could potentially detract from its overall message. It was also missing three key components: feedback from the receiving system, feedback from the processing system, and the macrosystem. The mission statement could be more descriptive with respect to its products as it describes the available planting beds but is ambiguous in the use of the term "food". Thus, we recommended that G3 adopt the following mission statement:

The mission of [Garden 3] is 1) to provide individual garden beds to community and [RO] members that support the growth of their own produce in a cost effective and organic manner, and 2) to donate fresh produce favored by food pantry patrons.

Adoption of these revised, or newly crafted mission statements could further increase the CGs' longevity, assisting key personnel in behaving in ways that are in accordance with the mission, and help to ensure the CGs' adaptability to rapidly changing environment conditions.

Inputs

Inputs for CGs included resources that were categorized into four sections: financial; human resources; materials, equipment, and tools; and technology.

Financial Resources For G1, financial resources included a \$75,000 donation from a church member who had passed away; an additional unknown sum was also donated in lieu of flowers or monetary gifts from those who attended her funeral. The supporting RO also provided an annual budget for the CG to use to purchase necessary supplies; the amount of which was not disclosed.⁵ For G3, financial resources included an undisclosed amount of money in the CG's bank account, a \$70 annual fee for CG volunteers that paid for water, a restricted fund supported by a program within the RO, funds collected during luncheons, and, finally, donations given by members of the RO. For both gardens, these financial resources contributed to purchasing supplies throughout the growing season, infrastructural facilities (like sheds for G1 and concrete raised planting beds for G3), and upkeep for tools and equipment. The financial resources for both CGs appeared to be sufficient; both had access to funding from multiple sources, a practice that may be of interest to other CGs.

⁴ Reference retracted and identifying names have been omitted to maintain participant confidentiality.

⁵ Ainsley reported, "I understand that was a nice pot of money that we've been using but nobody ever tells us how much it is or anything like that."

Human Resources For G1, the human resources included six classes of actors: CG coordinator (Ainsley); CG volunteers who were church members, Master Gardeners Association-trained volunteers, and food pantry personnel; water maintenance staff who were affiliated with the RO; high school students fulfilling their community service hours; students from the church's elementary attending instructional classes supplemental to their core curriculum; and 24-hour security personnel who were provided by the RO. For G3, human resources fell into seven categories: CG coordinator (Calendula), four primary CG volunteers, other CG volunteers, grounds maintenance, waste management, members of the RO, and adolescents from various schools and organizations.

Human resources, specifically CG volunteers, engage in practices that support environmentally sustainable crop cultivation. G1 appeared to have enough volunteers who allocated sufficient time to help to maintain the plots. However, Ainsley once reported, "Yeah, like there were chores that didn't get done today, but I'll just add them to the list...there are low priority things that don't get done, but that's okay" and the first author observed this during garden workdays. G1, therefore, could benefit from additional volunteers, and a further look into volunteer dropout rates and training procedures for new CG volunteers would further benefit the analysis as it might support recommendations for recruiting new volunteers. The participants interviewed from G3, however, reported a lack of CG volunteers, particularly with respect to those needed to maintain the donation plots. Calendula noted, "I think they're (the garden volunteers) are frustrated that there's not more of us working together. I think a few people do most of the work, and that is often the case that again, I don't know what to do about that." This was confirmed during the first author's observations as she did not see a CG volunteer during any of the observation periods. The sole reliance on Calendula and the four main CG volunteers may negatively impact the CG's sustainability.

Several researchers have recommended that community outreach is necessary for maintaining appropriate volunteer help (Ghose & Pettygrove, 2014, Kingsley et al., 2019, Mikulec et al., 2013) and this may be a process that Calendula and the main volunteers for G3 want to establish. Some ways in which Calendula and the main volunteers might begin such a process would be to reach out to the Master Gardeners Association, to host more regular CG events at the RO, and to set up recruitment methods both within the RO and the surrounding community. Implementation could be further supported by tracking the baseline number of participants attending workdays or those recruited through outreach attempts to determine the practices that are most effective in that community.

The CG coordinators engage in multiple tasks as previously described and their roles are instrumental in the maintenance of the CGs. Ainsley reported that she felt there were enough human resources for G1, whereas Calendula reported that she had to give a high number of hours each week to complete the necessary tasks for G3. Time commitment is a barrier that is consistent with those described in the peer reviewed literature (Diaz et al., 2018, Mangadu et al., 2016, Wesener et al., 2020). Consistent with the previous recommendation, additional volunteers might decrease the burden on Calendula to do so many tasks. Moreover, Calendula could recruit

support from culturo-behavior scientists in designing interventions and arranging the environment in ways that might increase the efficiency of the garden coordinator and volunteers, thereby reducing the time needed to maintain the garden each week.

Both CGs had adequate access to personnel for tasks such as waste management and groundskeeping, but G3 did not have access to enough security personnel, leading to some instances of both theft and vandalism. G1, however, had access to 24-hour security personnel employed by the RO. Additional recommendations and alternatives were presented to G3 to address theft and vandalism.

Material Resources Material resources for G1 included basic gardening tools (e.g., garden carts, compost equipment, etc.), raised garden beds, pens and paper data sheets to track the amount and type of produce harvested during each workday, a greenhouse, and two air-conditioned garden sheds. There were in-ground planting beds as well as raised beds. Ainsley purchased all supplies for the CG, the land was provided by the RO, waste receptacles were available and paid for by the RO, and wood chips were dropped off by the city, at no cost, approximately once per year.

Materials, equipment, and tools for G3 included gardening tools, a storage shed to house equipment, etc. Each planting bed was raised above the ground and lined with stone pieces before it was filled with soil, compost, and dirt. There was approximately 36.6 m² of growing space for donation plots and 216.09 m² for individual plots. Eight water spigots were connected to the RO's sprinkler system and used on the CG. Land was provided on the ground of the RO. CG volunteers purchased their own seeds, seedlings, and plant growing supplies (e.g., tomato cages and trellises for individual plots). Calendula purchased those same supplies for the donation plots using funds from the CG's bank account. Wood chips that lined the rows between plots were provided by the city at no cost to the CG and were dropped off in the parking lot as needed, usually once each year. Waste receptacles were provided by the RO (i.e., a dumpster next to the CG) and were used to dispose of plant scraps and any other refuse.

The results suggest that both CGs have adequate access to materials and suggest that both CGs continually improve and update necessary materials. However, G3 did not have a tool for composting, a best practice indicated in the literature review (Mangadu et al., 2016). The lack of a tool for composting leads to food scraps that could have otherwise been composted being thrown in the trash. This practice may increase the need to purchase store-bought compost for the CG, adding additional costs to the maintenance of the CG. Investing financial resources to purchase a composting tool or human resources to build a compost bin could reduce financial expenses incurred by G3 and the environmental impact.

Technology Resources Technology inputs for G1 included a social media page that was used to report the results of CG activities as well as to share information. A second form of technology was agricultural techniques and information provided by the Master Gardeners Association-trained CG volunteers. The newsletter published by the RO was used to recruit new CG volunteers. Technology inputs for G3 included

the online resources for the CG. The RO had a social media page and periodically published posts about activities at the CG, including donations that were made to the food pantry and workdays that are organized by the RO. The RO also had a website that advertised the CG, provided resources for potential volunteers, and contained additional information for the CG, including the CG's mission statement. The CG used a CG volunteer agreement form that outlined the rules and expectations for volunteers who had to sign the agreement prior to gaining access to a plot.

Both CGs relied on emails to communicate the tasks that needed to be completed on upcoming workdays, sent weekly (G1) or monthly (G3). Ainsley also posted the activities and tasks completed on their social media page: the pounds of and types of produce donated, photos, and the agricultural techniques used after workdays. The posts could be considered an end to the harvesting process, as they provide volunteers feedback, and possibly a form of reinforcement for some. For example, one social media post included a year-to-date donation count. One recommendation building from that idea might include setting donation goals. For G3, however, one recommendation might be to apply more technology, such as a CG social media page or to send more frequent emails to CG volunteers to improve the feedback ratio. Such adaptations might increase CG activities to maintain or increase community relations, as recommended as a best practice. Doing so could facilitate increased communication between members, possibly improving attendance to workdays. Calendula might also correspond with RO personnel who manage the website and social media page to increase the CG's presence.

Processing System

An overview of the processing system is included within the organizational level of the TPS (Figs. 1 and 2). The details and recommendations for the processing systems for both community gardens are further detailed in the TPS – Process Level section.

For G1, the processing system pertaining to cultivating fruits and vegetables for the food pantry was supported by the RO, in that it provided a budget, water maintenance, and 24-hour security personnel. Generally, Master Gardeners, the CG coordinator, and the food pantry liaison met once per season to plan which seeds they would order. Once the seeds arrived, CG volunteers started them in the greenhouse and later transplanted them into plots. Over the course of the next few months, organic practices were used to maintain the produce until it was harvested, at which point it was brought to the food pantry once or twice a week. This process repeated until the end of the growing season.

For G3, the processing system—cultivating fruits and vegetables for the food pantry—was supported primarily by Calendula and the four main CG gardeners/volunteers, with additional volunteer support from individual plot members and adolescents from various organizations. Furthermore, the RO provided facilities management (e.g., cutting the grass and access to water). Calendula purchased supplies (e.g., seeds, seedlings, and communal supplies). Four CG volunteers who regularly attended CG workdays planted the seeds and seedlings in the donation beds

and any vacant beds at the beginning of each growing season. Communal supplies were available at any time. Individual CG volunteers were allowed to work in their plots at any time excluding CG workdays when attendees were expected to work in donation plots and to clear the Bermuda grass from the rows between the individual plots. Adolescents, students from local schools or various organizations such as Boy Scouts of America, and members of the RO, volunteered during CG workdays. Produce was harvested the first and third Tuesday each month; Calendula and the four main CG volunteers did most of the harvesting. The produce was cleaned, weighed, and brought to the food pantry before volunteers from the food pantry distributed it and other shelf-stable foods to individuals who attended the food pantry during its hour and a half long session.

Processing System Feedback

Feedback for G1 included a one-time comment from the RO that pertained to water use. The RO previously notified Ainsley that the CG used too much water and recommended that they try conserving. Ainsley used that information to adapt their practices and instructed CG volunteers and Master Gardeners to adjust practices to reduce water consumption, such as planting crops that required similar amounts of water together, hand watering plots, and purchasing a water meter that gave immediate feedback as to whether each plot required water. The feedback from the RO may have been sufficient for reducing water use; however, the RO did not give any further feedback. One recommendation for G1 would be to contact the RO and ask for additional feedback as it could support future adaptations made to optimize water use, including commenting on improved water usage. Additionally, more practices within the cultivation process could further improve water use, such as rainwater collection and planting cover crops.

For G3, feedback was often given by the garden coordinator and included instructions to clear long vines that stretched outside of the plots, to properly dispose of trash, or the proper use of organic methods. Because CG volunteers complied with Calendula's feedback regularly, the feedback emails appeared sufficient, especially considering the low volume of emails she had to send. The first author also noticed that feedback looked more educational than aversive, which may have been an important factor in generating compliance. However, further investigation into the cultivation process such as more frequent visits to the CG to monitor whether CG volunteers' plots are maintained properly could be advantageous.

Output, Receiving System, and Receiving System Feedback

Outputs and Receiving System For G1, outputs in the form of products and services included fresh produce, volunteer hours, plots, a monthly newsletter, and a fulfilled mission. The corresponding receiving systems included the food pantry, students and Master Gardeners, refugee families, and the RO and its members. Fresh produce was cultivated by the volunteers each week as a result of the cultivation process and was brought to the food pantry. Volunteer hours were accumulated by high school students and Master Gardeners in fulfillment of requirements set by their respective

institutions. Two plots had been made available for refugee families to cultivate their own produce. A monthly newsletter that detailed volunteer demographics and pounds of produce harvested was sent to the RO and was made available to its members. Lastly, a component of the RO's mission was to help those less fortunate and this was achieved through produce donations. G3 produced three outputs, each corresponding to its own receiving system: 1) fresh produce (output) was donated to the food pantry (receiving system), 2) fresh produce was made available for CG volunteers, and 3) four main CG volunteers made the seed list for G3.

Customer Feedback Measures Both CGs received feedback from food pantry recipients about their preferred produce. For G1, feedback for the donated produce was delivered to Ainsley in the form of a description of appreciation by its recipients via the food pantry liaison. Ainsley then passed that information onto CG volunteers. Additionally, the RO provided one-time feedback pertaining to water use by the CG. For G3, Calendula had previously received feedback from food pantry recipients about the produce they received regarding which crops they preferred.

The receiving system feedbacks were sufficient for both CGs as they each adapted what they planted each season as a result. However, contact between the food pantry personnel and the CGs was infrequent. Both CGs could benefit from more regular feedback from the donation recipients. Minimally, this should occur at the end of each growing season, providing consequences to select target APs.

Environmental Variables

CGs are subject to five environmental variables: the natural environment, industry best practices, culture and market demand, and government. For G1, the natural environment, particularly regarding the weather, had an impact on several of the practices. For example, the amount of water the crops needed as well as when to cover the produce to protect them from the frost or high heat were both affected by the weather. Second, industry best practices selected for organic practices such as composting and natural pest remedies such as companion planting as opposed to using chemical substitutes like fertilizers and pesticides. Third, the culture and market included the preference for culturally appropriate food by the food pantry recipients. Fourth, G1 qualified for a tax-exempt status which allowed the RO to be reimbursed for any CG-related purchases Ainsley made.

For G3, the natural environment also influenced which types of produce would be grown during each season, along with deadlines that were adhered to with respect to when to place certain plants in the ground (e.g., tomatoes must be planted before the beginning of June, or it will be too late, and the plant will not produce as much fruit). Additionally, certain weather events, such as an unanticipated storm or an early frost, might damage existing crops. G3 acted in accordance with the natural environment to maximize crop yield and prevent crop loss. Industry best practices supported organic cultivation as opposed to non-organic, and Calendula monitored the types of products used by volunteers to ensure they were adhering to those guidelines. Moreover, the CG volunteer agreement included a section indicating that only

organic methods were allowed. Culture and market demand influenced the types of produce grown. Calendula exemplified that food pantry recipients nearly fought over collard greens that were donated by one of the four main volunteers. She sometimes attended food pantry sessions and saw which produce the recipients took first.

Environmental variables select certain practices as opposed to others. One example is the shifts that the CGs made regarding the start and stop times of workdays during the hotter periods in the year. G1, for example, hosted workdays an hour earlier, before temperatures were uncomfortable for volunteers. However, attendance also decreased when workdays started earlier, as it might compete with sleep or work schedules. Attendance at G3 decreased during the summer months, reportedly due to heat but decreased plant production was another factor that was reported as a possible barrier imposed by environmental variables. Participation increases as the season changes and the weather becomes more temperate, which lasts through the next spring. To discover which of these variables remains most salient for attendance, a further analysis that investigates which of these barriers hinder attendance could be conducted. For example, the CGs could continue hosting workdays at the regular times and provide shade tents for CG volunteers. If volunteerism increases to a steady state appropriate for tending the CGs, it might indicate the early schedules influenced attendance most.

Unpredictable weather events also evoked immediate action at both CGs to help to avoid crop loss. Both CGs reported significant weather events for the year prior to this study. The first was an unexpected freeze and the second was a severe storm. Again, neither of these events could be controlled, but how the CG responds, and how quickly they respond could be adjusted. Appointing the garden coordinator or one or more of the CG volunteers to report or respond to severe weather warnings and watches during the stormy or high-risk for freeze seasons might improve response time and prevent crop loss due to severe weather.

Other environmental variables for the CGs included industry best practices that selected for crops to be grown organically. G1 engaged in fully organic practices; however, G3 experienced some challenges with CG volunteers using chemicals. Calendula provided feedback and instruction to the CG volunteers through educational opportunities. These actions might be further improved through increased opportunities for contact with all the volunteers at G3, like events such as bringing a Master Gardener on site to teach about organic versus inorganic, as well as with other environmentally sustainable topics (e.g., crop rotation and companion planting). These trainings could be constructed and made available through technology inputs as online modules that CG volunteers could complete. Behavioral systems scientists could further support improvements in these areas by tracking which CG volunteers attend the events, recording which plot they maintain, and working to improve training systems for volunteers.

Competitors for Resources and Customers

Ainsley reported that competition for resources for G1 included the concurrently available activities that took place on CG workdays, specifically those available through the RO; CG volunteers' time was an important resource for G1.

Additionally, fewer volunteers attended workdays by mid- to late-summer as the temperatures were hotter during the day then. One suggestion for G1 might be to offer another, shorter workday during the week, which may help alleviate these barriers. Moreover, G1 might further enhance their community outreach by advertising the CG to potential volunteers and receiving their feedback to facilitate adaptations.

For G3, the RO provided money from the restricted fund for various activities, not just for the CG. Thus, not all the money was available to support only the CG, and G3 experienced competition with other subsections of the RO. It is likely important that G3 explore additional sources of funding such as grants from local organizations with missions that support urban agriculture, environmental sustainability, and efforts toward alleviating food insecurity. Connecting with agencies with similar motivations may increase the likelihood for collaboration and resources, both human and financial.

TPS – Process Level

G1 produced five outputs: fresh produce for the food pantry, opportunities to fulfill volunteer hours for students and Master Gardeners, plots for families of refugee status, and a monthly newsletter for the RO. Because the primary focus of this project was to discover the practices that maintain cultivation of fresh produce at CGs, the focus of the process-level analysis is aimed at cultivation (see Fig. 1, middle panel). Six actors/sectors and nine steps were necessary for the cultivation process (i.e., CG coordinators, Master Gardeners and greenhouse specialists, the food pantry liaison, volunteers, the RO, and the consumers—the individuals who received the donated food).

First, Ainsley scheduled a meeting with Master Gardeners, master greenhouse specialists, and the food pantry liaison to plan seed orders, then the CG coordinator and Master Gardeners/Greenhouse Specialists planned which seeds to order from a catalog. This step was also informed by the food pantry liaison who communicated any feedback for food pantry produce recipients that pertained to preferences for specific crops (those that are culturally appropriate), as many accessing the food pantry were refugees and did not prefer some of the crops typically grown, such as kale and spinach. In the second step, Ainsley, Master Gardeners who attended the meeting, and the food pantry liaison considered where to plant the planned crops, how crops would be rotated, and how to organize the plants with similar watering requirements in the same planting bed. Next (Step 3), Ainsley ordered the seeds based upon their availability from the seed catalog. After the seeds were delivered, Ainsley and the CG volunteers (Master Gardeners, Master Greenhouse Specialists, the food pantry liaison, as well as unspecified CG volunteers) prepared the planting beds for planting by building new ones and fixing older ones, built supports such a trellis for climbing crops, and prepared the soil by adding appropriate amounts of amendments such as compost and mulch to make it a suitable growing medium particular for the crops that would be planted in the planting beds (Step 4). Next (Step 5), the same actors from the previous step planted the seeds either directly into the planting beds or started them in the greenhouse until they were ready to be

transplanted to the soil. The fifth step had to be planned according to weather conditions and the times for each crop are suggested by Master Gardeners and master greenhouse specialists. Steps 6 through 9 were recursive and were completed by the same actors involved in the third and fourth steps until the end of the growing season. In Step 6, the planting beds were watered as necessary for each plant species and in accordance with feedback from the RO regarding water use and conservation. Step 7 included harvesting the produce when it was ripe. Step 8 involved cleaning and packing the produce into a truck. Finally, Ainsley delivered the food to the pantry either immediately after harvest cleaning and packing, or stored it in the refrigerated storage shed until the next planned trip to the pantry.

G3 produced two outputs for its consumers: produce for the food pantry and produce for CG volunteers. The processes for both individual and donation plots are included here, although those CG volunteers who had their own plots were also the volunteers who grew primarily in the donation plots (see Fig. 2). First, Calendula purchased seeds and seedlings that the four main CG volunteers planned to grow, while accounting for crop rotation and appropriate types of plants for the season. Concurrently, CG volunteers completed this step independent of Calendula and the four main CG gardeners/volunteers. Both groups prepared the planting beds (Step 2) by adding appropriate amounts of soil and soil amendments to make it suitable for the type of crop they planned to plant. The four main CG volunteers worked together to do this in the donation plots, and CG volunteers prepared their own as well. Next, both groups independently planted the seeds (Step 3). Calendula and the four main CG volunteers planted their seeds in the donation plots, whereas CG volunteers planted their seeds in their individual plots. The planting beds were watered regularly (Step 4) by everyone, and CG volunteers notified Calendula if they were out of town so she could help tend to their plots. Crops were trimmed to keep them from obstructing the pathways or growing into neighboring plots (Step 5). Steps 4 and 5 were completed independently by both groups but were also completed collaboratively for donation plots on workdays. Members from the RO also participated in these steps occasionally during RO-assigned workdays. Calendula sent an email (Step 6) detailing which tasks needed to be completed on workdays, and she gave feedback to individual CG volunteers via email if their plants had grown outside of their designated plot space. Produce was harvested, cleaned, weighed, and packed into bins by (Step 7) Calendula and the four main CG volunteers, as well as by individual plot volunteers if they were donating produce. Finally, the harvested produce was donated to the food pantry on the first and third Tuesday of each month (Step 8).

The processing system for both CGs included multiple recurring IBCs (i.e., putting together planting beds, harvesting produce, making the list of seeds to purchase) that resulted in an AP (e.g., planting beds available, fresh produce for donation/self-consumption, and a plan for the growing season, respectively). The resulting AP was selected by the environment with which the AP was delivered (e.g., CG coordinator selecting whether to continue using raised beds, the food pantry recipients and/or individual CG volunteers, and the production of produce based upon which seeds were selected). Overall, none of the practices identified throughout the produce cultivation process were identified as missing or redundant for either CG. Therefore, no recommendations as to improving those practices analyzed were warranted.

Cultivating practices within the process were also identified and compared to best practices found in the literature. All practices identified for CG volunteers were represented within the process. The only recommendation posed was regarding low workday attendance at G3, which reflected many of the barriers noted in the literature review and could have been an indicator of any of the following: competing priorities for CG volunteers (Anderson et al., 2018), scheduling issues (Diaz et al., 2018), lack of compliance (Diaz et al.), or possibly a lack of leadership (Hazzard et al., 2011, Wesener et al., 2020).

TPS – Performer Level

Individuals at both CGs were subject to the individual contingencies that maintained their volunteer practices. Each participant's individual performance is described using the frame of the three-term contingency. The relevant behaviors of each of the CG coordinators (Fig. 1 bottom panel) and CG volunteers (Fig. 2 bottom panel) who participated in this study are discussed here in terms of their implications for G1 and G3 as well as considered in comparison to the literature regarding best practices. Finally, recommendations as informed by the analyses are included.

CG Coordinators

Both coordinators' job goals were to organize CG activities and serve as the communication source for all actors/sectors that were immediately involved in the processes just described. Among the behaviors required, defining volunteer tasks, managing volunteer attendance, and training and delivering consequences for volunteer behavior were critical. CG coordinators also were responsible for tracking the results of the activities (like crop produce) and communicating the garden's results to volunteers and the RO. Although there were differences in how much time each activity consumed, the critical behaviors and responsibilities were similar for both participating coordinators and included a great deal of individual responding. One barrier both garden coordinators faced, and explicitly noted by Calendula were the heavy workloads. This is a common barrier for garden coordinators (Diaz, 2018). Shifting responsibilities to other volunteers may work to offset some of the labor; however, the volunteers were also taxed in terms of time and responsibility. Additional considerations regarding this seemingly more challenging barrier are discussed further in the analysis of the matrix.

Garden Volunteers

Garden volunteers engaged in a variety of activities at their respective CGs, with a majority of these occasioned by the garden coordinator's workday email. Consequences and potential reinforcers for these actions included accessing social relationships at the garden, fulfilling a personal or religious mission, the food produced,

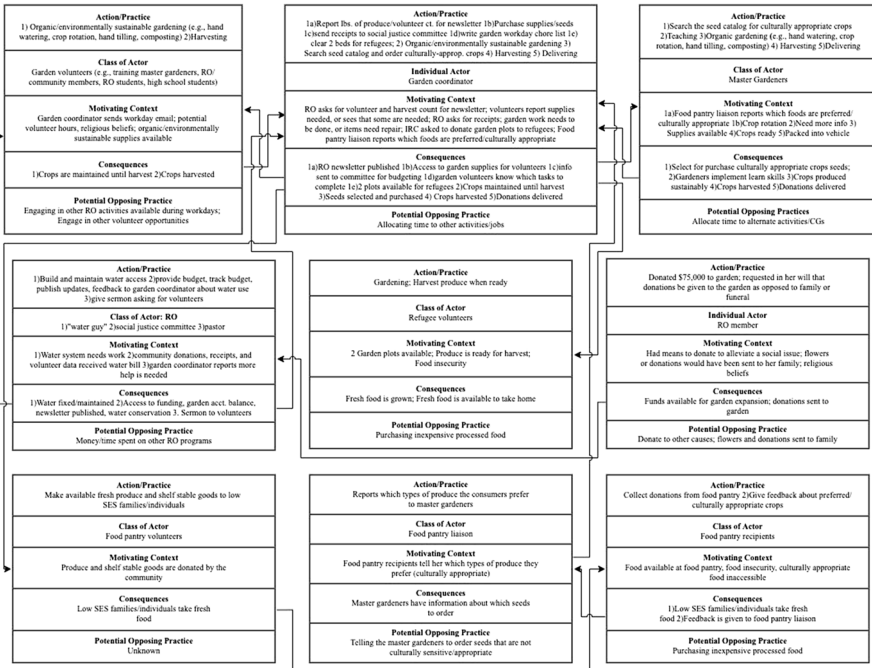


Fig. 3 Matrix Analysis of Garden 1

and even fulfilling required volunteer hours. In general, however, the typical immediate consequence was the completion of a work activity.

For Dahlia and Elm, the two participating CG volunteers who were part of the four main CG volunteers at G3, their three primary job goals included creating a list of seeds to order at the beginning of each season, cultivating and harvesting crops in donation beds, and donating produce to the food pantry.

One of G3's practices was to include a set of rules to guide garden volunteers. However, these rules were not always effective or followed, perhaps because the organization did not wish to use aversive control (see also, Hazzard et al., 2011, Mangadu et al., 2016, Ochoa et al., 2019, Sidman, 1989). However, this caused Calendula to send emails with feedback on rule violations, which set the occasion for the CG volunteers to correct their mistakes or to change their behavior. Nonetheless, compliance with the volunteer agreement and rules, particularly those related to organic farming, remained problematic. One strategy that Calendula could incorporate would be to communicate more frequently with the CG volunteers, reminding them of the rules, showing or highlighting examples of volunteers engaging in behaviors that correspond to the rules, and organizing more community building practices that further engaged the volunteers and could establish a culture of best practices, increasing the frequency of social positive reinforcement, potentially increasing attendance, and volunteer numbers.

Matrix

The matrix analysis aims to understand the interactions of different actors and sectors in a system, highlighting interdependencies (Mattaini, 2013). Different from the TPS, the matrix analysis allows the culturo-behavior scientist to identify barriers and strengths that may be part of the macrosystem, identifying multiple organizations and practices.

A matrix analysis for G1 is depicted in Fig. 3. Nine actors/sectors supported G1 directly: (1) the CG coordinator, Ainsley; (2) the RO and the “water guy,” the social justice committee, and the pastor, in particular; (3) a RO member who donated a large sum to the CG; (4) the food pantry liaison; (5) Master Gardeners; (6) CG volunteers who include Master Gardeners in training, RO members, community members, students from the RO, and high school students; (7) the food pantry, (8) families of refugee status; and (9) food pantry recipients.

Ainsley performed several activities that supported the CG’s longevity, five of which were identified as directly supporting the organization. The first task included sending the social justice committee at the RO volunteer information, such as the number of volunteers who attend each workday along with their demographics, and the number of pounds of produce harvested each workday as a response to requests previously sent by the RO. Second, Ainsley purchased supplies for volunteers to use, such as soil and gardening tools. This was either evoked by feedback from CG volunteers about missing items or items that Ainsley noticed were missing. Third, Ainsley sent purchase receipts to the RO’s social justice committee, per their request, to track available finances for the CG and to write off those expenses at the end of each year. Fourth, Ainsley wrote and sent a detailed list of tasks for volunteers to complete based upon those tasks she noticed needed to be completed prior to each CG workday. Finally, a local organization with which the CG partnered had asked Ainsley to set apart two planting beds for refugee families. Ainsley, along with volunteers, prepared the two planting beds so the families with refugee status could begin their own cultivating.

The RO was a sector that, for purposes of the current research, included three actors: the “water guy,” the social justice committee, and the pastor. Per Ainsley’s feedback, the “water guy” fixed any issues with the CG’s water supply to maintain the availability of water. The social justice committee tracked the CG’s finances, informed by Ainsley who reported her purchase receipts, and allocated donations made by community and RO members. The RO’s pastor collected volunteer data that Ainsley sends and placed that information into a monthly newsletter that was distributed to the RO members. Additionally, the RO’s pastor gave a sermon during assemblies to promote the CG and to try to increase the numbers of CG volunteers.

A member of RO who has now passed away gave the CG a \$75,000 donation to build additions to the CG. This enabled the G1 to build two new storage sheds, one of which was air conditioned, along with a second CG. This money was sent to the social justice committee that tracked the CG’s finances. Additionally, this member of the RO had asked that monetary donations be given to support the CG in lieu of flowers or donations to her family after she passed. The undisclosed

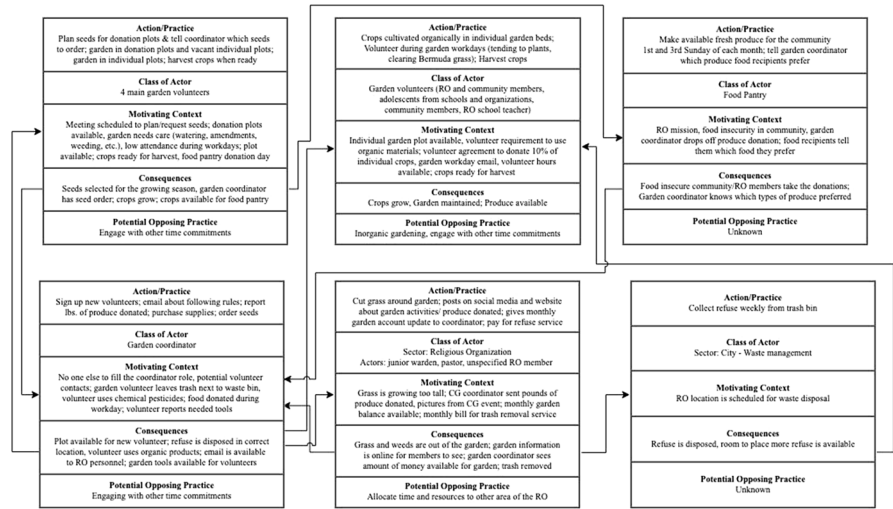


Fig. 4 Matrix Analysis of Garden 3

amount of money from the donations directly supported building the second supply shed and supported supplies purchases.

The food pantry liaison volunteered at both the food pantry and the CG. She received feedback from food pantry recipients about which foods were culturally appropriate and preferred. She then passed that information on to Ainsley and the Master Gardeners when they were planning and ordering the seeds for the upcoming growing season.

Master Gardeners included those individuals with a Master Gardeners Association certification who volunteer at G1. This included Ainsley, who had that certification as well as additional certifications earned from the same organization. Using input from the food pantry liaison pertaining to culturally appropriate and preferred crops, the Master Gardeners researched and ordered those crops. Additionally, they considered the growing season and planned where those seeds would be placed with respect to crop rotation from the previous season.

CG volunteers included the Master Gardeners in training, the RO and community members, students from the RO, and students from the local high schools. Master Gardeners in training and local high school students were required to fulfill a certain number of volunteer hours that they accumulated from volunteering at the CG. CG volunteers were sent a weekly email detailing the tasks to be completed during the workday. After crops were donated to the food pantry, volunteers at the food pantry distributed them among food pantry recipients. This cycle was completed weekly, and food pantry recipients expressed their gratitude for the produce and provided further input about preferences for future crops. As a response to a partnering organization, the CG had donated two planting beds for refugee families to grow anything they would like. They were responsible for their own plots, and once produce was cultivated, they were able to harvest it and take it home.

The Matrix Analysis for G3 is depicted in Fig. 4. For G3, six actors/sectors were identified as directly supporting its longevity: the CG coordinator, four main CG volunteers, additional CG volunteers, the RO, the food pantry, and waste management.

Calendula, the CG coordinator for G3, performed tasks critical to her position, including managing volunteers and providing feedback on their behavior, ordering seeds and equipment, and defining and publicizing individual tasks that needed to be completed during workdays. Calendula joined other volunteers in cultivating produce that was later harvested and donated to the food pantry. She sent follow-up emails to the RO's pastor describing the pounds of produce donated to the food pantry.

The four main CG volunteers tended primarily to the donation plots outside of workdays and attended workdays as prompted by Calendula's emails. They planned which seeds to order at the beginning of each season, and then notified Calendula so she could order them. As a result, crops were harvested, cleaned, and donated on the first and third Tuesday of each month.

CG volunteers consisted of RO members, community members, adolescents from schools and organizations, and a schoolteacher from the RO. CG volunteers primarily tended to their own plots, were sent emails by Calendula about workdays, and were informed that they can also donate produce from their plots to the food pantry. CG volunteers engaged in similar practices as Calendula and the four main CG volunteers with some restrictions. Cultivation practices were strictly organic at this CG, as defined within the volunteer agreement. Any CG volunteer seen using chemicals, such as chemical fertilizers and pesticides, was contacted by Calendula who described the difference between organic and inorganic products. Adolescents volunteering at the CG were required by their school or organization to fulfill a certain number of volunteer hours; Calendula signed off on those hours once they were completed.

The food pantry consisted of various personnel who volunteered their time. Produce from the CG and shelf-stable food were donated to the food pantry, and these donations were distributed to community members by the food pantry volunteers. The pantry is held on the grounds of the RO and was begun as a method of fulfilling one aspect of the RO's mission, reducing food insecurity within the community.

The RO consisted of several individuals, but for purposes of this analysis only three key personnel who interact with the CG were included. First, the RO's pastor organized workdays for various areas of the RO grounds, and occasionally attended in support of the CG. The RO supported the CG financially and provided the land upon which the CG was built. Finances were tracked and bank account funds were reported to Calendula each month by another RO member. Lastly, the junior warden's primary duty was to tend to the RO's grounds. His responsibilities for the CG included cutting the grass, removing the grass and weeds from the CG area, and reading the emails he received from Calendula.

The RO paid the city for waste management (i.e., trash removal). Any trash left outside the waste receptacle next to the CG could have resulted in a fine imposed on the RO. Calendula avoided those fees by prompting CG volunteers to throw away refuse from the CG.

An analysis of the interdependency diagrams for G1 and G3 highlight first, the contrasts between the number of practices/actions for each actor/sector. Then, while taking into consideration the number of individuals who would fall into each box, it is clear how many actions and practices are required of one actor, namely the CG coordinator. Other actors/sectors that also have a noticeably higher number of actions/practices than other actors/sectors include the Master Gardeners and the four main garden volunteers at G1. Additionally of note, is that the garden coordinators are required to interact with almost every other actor or sector needed to maintain their CG. This is a common barrier for CGs as indicated in the literature (Diaz, 2018) that states that a large amount of responsibility often falls on only one person. Moreover, it is often difficult for the CG or someone from within the RO to find a replacement if that person can no longer fulfill the role. Both CG coordinators reported that one of the reasons they took on the role as garden coordinator was because no one else would do it, a common challenge in volunteerism and a potential reason to further analyze the operant consequences maintaining each volunteer's behavior. Nevertheless, this can create an uncertain future for the CGs. Both G1 and G3 have put some safeguards in place to prevent the potential challenges such as a heavy reliance on the garden coordinator imposes. For example, both CGs had dedicated volunteers who take on more responsibilities than other volunteers might. The Master Gardeners for G1 and the four main CG volunteers for G3 are two such examples. Yet, additional safeguards might be put in place. Some recommendations that might further enhance the CGs' longevity if the CG coordinator can no longer fulfill their role, might include the creation of an additional class of actor: garden coordinators in training or a mentorship program for future garden coordinators. Those volunteers who express an interest in taking on more responsibilities could be given more tasks the CG coordinator might otherwise have to complete, such as facilitating CG activities and maintaining volunteerism. Over time, with direct training and experience working with the current garden coordinators, these individuals could be highly experienced and well-versed in the CG coordinator responsibilities and prepared to take over if a garden coordinator can no longer perform their duties.

A second theme that stands out in the matrices is depicted in the actors/sectors of the Master Gardeners in training (G1) and students from different organizations or schools (G1 and G3), both of which require volunteer hours. The requirement for volunteer hours for each of these actors/sectors likely functions as a motivating operation for connecting with and volunteering at the CG. Both CGs networked with other organizations, which in turn facilitated connections between individuals who need volunteer hours and the CGs. This is likely an important practice in recruiting and sustaining CG volunteers. One example, highlights this: Ainsley was a Master Gardener who appears to have had connections with other Master Gardeners and Master Gardeners in training. These connections likely led to the recruitment of more volunteers than those who do not have such a connection. Moreover, the connection to Master Gardeners also likely resulted in more volunteers who came with a skillset that is well-suited for CGs. G3 might consider increasing volunteerism by building similar connections with Master Gardeners as those in place at G1, establishing an interdependency between the CG and an organization that operates within the same macrosystem, urban agriculture.

Discussion

The purpose of this pilot study was to describe the ways in which researchers utilized interdisciplinary methods through a behavioral systems science framework to collect as much pertinent information as possible about participating community gardens. The methods employed included an ethnographic approach to data collection and observations, and tools such as the behavior systems analysis questionnaire for interviews. Researchers then used that information to diagram multiple levels of the organization and to depict the connections between different actors and sectors in the community gardens of focus. By developing these diagrams and conducting a literature review concerning best practices for community gardens, researchers were able to construct recommendations suited to each community garden based upon their unique circumstances. This final section brings the reader back to the introduction and describes how this work contributes to the research called for by behavior scientists regarding larger, systems-level interventions. Additionally, this section reflects upon the approaches used and highlights areas for future research.

The present study combined elements of CBS, namely the TPS, metacontingency, and matrix analysis as a comprehensive approach to studying a cultural system (CGs) that presents a strategy to mitigate socially significant issues (food insecurity, environmentally unsustainable food production). Each element affords a unique way of analyzing practices that have been selected over time, and in accordance with an ever-changing environment. Cultural systems are complex; they are made up of subsystems and behaviors interacting within a selective environment (Malott, 2003). It is necessary to adapt our own behavior as scientists if we are to gain an understanding of the way those simple parts function within a complex larger system to support valuable systematic change. Expanding research strategies with consideration to methodologies employed in CBS allowed for a thorough analysis of the CGs. The TPS afforded researchers a way to arrange that information to depict multiple levels of the organization. The matrix further categorized information and demonstrated the ways in which parts within and outside of the system interact. Finally, the individual behavior contingency and the metacontingency allowed researchers conceptual tools to identify the maintaining and selective processes for both individual behaviors and the organizational products and processes.

We employed an ethnographic approach in which the first author joined the CGs in their activities throughout the observation period as a participant observer. This method not only allowed her to see the practices that directly maintained the CGs but to also experience the tasks as if she were a volunteer. The approach used helped to build rapport with the CG members and represents a distinction between working *with* as opposed to *for* the gardens, much like community-based participatory action research methods (e.g., Fawcett, 1991). Not only do such methods lend to a cooperative approach, reflective of best practices for CGs, it can also serve to strengthen collective problem solving in determining what and which strategies for improving the CGs' practices might be adopted. Finally, this

approach also allows for the researcher to notice controlling variables that may affect the population with whom they are working but are not easily described by those engaging in the behaviors and practices.

The current analysis suggests that both G1 and G3 demonstrated unique combinations of practices and variables that generally align with those best practices found in the literature. Though there are many barriers and opposing practices that CGs may encounter, a few appeared to be salient to the present analysis; they appeared both in the literature reviewed, and to some degree, in the CGs that were the focus of the present study. The barriers and opposing practices include too high of a time commitment for CG coordinators and volunteers, a lack of community support, and a lack of funding. However, G1 demonstrated an effective system with which these issues did not appear to hinder its production. Instead, G1 engaged in many of the best practices common in the literature, particularly regarding maintaining access to funding, supplies, education sources, maintaining volunteerism, and providing fresh produce to those who face food security. Further, the results of this analysis suggest that best practices were maintained, particularly with reference to environmentally sustainable cultivation practices, funding, and importantly, providing access to fresh produce for those who face food insecurity. Nevertheless, it is possible that the CGs participating in the current analysis did not encounter as many barriers and opposing practices that other CGs may encounter due to their connection to a RO. The RO clearly served as an institutional/cultural milieu providing effective metacontingencies in the form of financial resources, land for growing, and a pool of potential volunteers. CGs without similar institutional support may face additional barriers and opposing practices that limit their sustainability and reduce their potential impact in reducing food insecurity.

Recommendations for each CG were reached after thorough consideration afforded by a multidisciplinary approach. Many, such as implementing harvest goals through data tracking software, offsetting the time commitment for CG coordinators through increasing participation at workdays, and engaging in more community outreach to sign up new volunteers, may be accomplished through further application of CBS. Similarly, as with this study, CBS can support CGs in adopting new practices and adjusting old ones where necessary, and in using the rigorous data collection and analysis tools to track the effectiveness of its interventions. With that in mind, as new information arrives with changing conditions and contingencies, the culturo-behavior systems scientist will be able to analyze and make recommendations that support the organization's adaptability.

CBS supports an interdisciplinary approach to studying systems and cultures, which promotes researchers' efforts in gaining a better understanding about the prevalent issues we face, toward discovering impactful and creative solutions. Perhaps the most salient strength of this study was the level of detail acquired. With that vast set of information, researchers were able to find potential solutions that, if applied, could very well lead to those CGs further reducing food insecurity in their areas and supporting sustainable food production as opposed to unsustainable methods. This research also lends to the growing collection of behavior analytic work on social issues at the systems level, while expanding the literature for CGs and similar urban agriculture practices. Notably, this study provides a model for

future culturo-behavior scientists to apply a solution-based approach to their work on socially significant issues. The methods employed here can be extended to any number of issues pertinent to our world today, such as supporting and developing best practices for solutions to immigration policies (e.g., Rakos & Switzer, 2021) and supporting groups that challenge institutional racism (e.g., Mattaini & Rehfeldt, 2020).

One limitation of the current study involves a lack of representation concerning actors at the CGs. Participant qualifications unintentionally excluded some actors who could have supplemented the analysis, such as food pantry recipients, RO personnel, and families of refugee status. For example, the current analysis could have been strengthened if various members of the leadership teams for the ROs of which G1 and G3 were a part were also interviewed. These interviews could provide valuable information as to how CGs align with the ROs' missions and the congregations' values, which could prove valuable in helping other CGs not affiliated with ROs to identify supporting institutional/cultural milieus with which to partner. Future research involving best practices with any organization/system/culture should include all sectors and their relevant interdependencies to gain a comprehensive understanding of what maintains them. This will allow researchers to view beyond the scope of the CGs and see what other interdisciplinary areas to include, such as policy change, where necessary. Additionally, future researchers might delve back into the literature concerning food production and take a similar approach as we did with other environmentally sustainable agriculture practices, such as hydroponic farming. Other methods of food production may be suitable for different environments, such as indoor cultivation for harsh climates, and CGs may not be the right choice for every environment, nor might they be the best method for increasing food security for every area. A further analysis of which solutions might fit best and have the most impact may be necessary for locales that face high rates of food insecurity. CBS may lend to this by first analyzing the functions that lead to high food insecurity before suggesting which practices/systems to introduce. Next, we did not select for variation within CG participants, as none of the CG volunteers who maintain their own planting beds were included. Similarly stated earlier, this would supplement the analysis and lend more information about maintaining individual's participation at CGs. Researchers attempted to combine interviews with observations, although much of the analysis was informed by self-report. This represents a potential lack of validity and necessitates future work in which researchers spend more time at the CGs and apply more quantitative measures to further support results and recommendations.

Second, generality may be limited due to the lack of representation because both CGs were maintained by a RO and environments were regionally specific; CGs in different locales and with different supports may have vastly different experiences. To broaden the scope and characteristics of CGs, future researchers should reach out to CGs from varying counties and those which are affiliated with varying organizations as opposed to solely religious-based organizations. Interestingly, ROs were not specifically named as key actors/sectors that support CGs in the articles identified by the literature review. Therefore, ROs

were not included as a key/actor sector in the resultant matrix analysis included in this manuscript. However, it is clear in the analysis conducted for G1 and G3 that the ROs were important institutional/cultural milieus, providing important metacontingencies related to financial and human resources support as well as land for growing, and seem deserving of more specific mention in the extant literature pertaining to local companies/private donors as key sectors. Moreover, partnerships between CGs and ROs could also present barriers, especially to CG volunteers and/or the recipients of the food grown. Some individuals may decline to participate in the CG if they are not a member of the RO, practice a different religion, identify as atheist or agnostic or nonreligious, and/or do not participate in organized religion. Additionally, the CGs chosen for this study were unlikely to be ones that faced barriers that may lead to closure, because they were both partnered with ROs, have been open for many years and exemplified many of the best practices as indicated by the literature. Thus, recommendations are not likely to be as useful or relevant to CGs that face more barriers. The CGs selected for the current research were included because participants from failing gardens were unavailable to the researchers, as is information about those which have failed.

A final limitation for the current study includes the sudden pause in research that restricted our research process and resulted in limited data overall that otherwise may have supplemented findings and supported stronger results. Future research may not encounter this limitation, though a future analysis of how COVID-19 influenced food insecurity and the role CGs played during these times would provide valuable insight into best practices for maintaining food security during an unexpected pandemic.

Community gardens represent a system of individuals who work together to achieve specific outcomes such as increased community food security and environmentally sustainable food production. Consider that in 2018, 11.5 percent of people in the U.S. experienced food insecurity. In Dallas County, the location in which this study was conducted, the percentage of people experiencing food insecurity is higher than in the US. In 2018, 15.1 percent of people in Dallas County experienced food insecurity (Feeding America, 2020). This study applied CBS to study CGs which offer a tactic that may help to mitigate two social issues, food insecurity and environmental sustainability. It combined ethnographic, behavioral, and behavioral systems science along with methods and tools to thoroughly analyze practices and variables that influence the longevity of community gardens. This resulted in recommendations for participating gardens and recommendations for future culturo-behavior scientists who are interested in broadening the science's scope and supporting and creating solutions for socially significant issues prevalent in our world today. We hope this paper contributes to the growing interest in culturo-behavior science as related to pressing social issues, and offers a solution-based approach to those issues.

Authors' note These data were collected in partial fulfillment of the first author's MS degree in Behavior Analysis at the University of North Texas (UNT). These data have been presented at the 2020 Association for Behavior

Analysis International Convention and the 2020 Association for Behavior Analysis International Culturo-Behavior Science for a Better World Conference. The authors would also like to thank Dr. Stan Ingman and Dr. Shahla Ala'i and the members of the Cultural Design & Systems Lab (later the Culturo-Behavior Science Lab) at UNT for their support in preparing this research and resulting manuscript.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s42822-023-00124-7>.

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