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University Food Gardens: A Unifying Place for Higher Education Sustainability

Leslie A. Duram
Southern Illinois University Carbondale, duram@siu.edu

Sydney K. Klein
Southern Illinois University Carbondale, kleinsk@siu.edu

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Leslie A. Duram* and Sydney K. Klein

Department of Geography and Environmental Resources
Southern Illinois University, Mailcode 4514
Carbondale, IL 62901
Email: duram@siu.edu
Email: sydney.k.klein@gmail.com
* Corresponding Author

Biographical notes:
Leslie A. Duram is Professor of Geography and Environmental Resources and Director of Environmental Studies at Southern Illinois University. She has published 30+ peer-reviewed journal articles and given 50+ conference presentations that address environmental sustainability. Her books include: Good Growing-Why Organic Farming Works (2005); The Encyclopedia of Organic, Sustainable and Local Food (2010); and America Goes Green-An Encyclopedia of Eco-Friendly Culture in the United States (2013). Leslie was a Fulbright Scholar in Ireland. Her current work investigates social and ecological aspects of mediating climate change through dietary choices.

Sydney K. Klein is the Agricultural Outreach Coordinator in Polk County, North Carolina. She earned her Master of Science Degree in Geography and Environmental Resources at Southern Illinois University. She was the Graduate Research Assistant at the SIU organic garden (LOGIC.siu.edu), where she managed the site and all volunteers. She has worked in Environmental Education in Maine and has volunteered for numerous youth education gardens. Her international work includes agricultural experience in Jamaica, educating beginning farmers on best growing practices and marketing skills.

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Abstract:
　　　This research describes the key characteristics of campus food gardens and investigates their contribution to overall campus sustainability. An email-survey of fifty-two campus garden managers in North America provided quantitative and qualitative data for this analysis. It was found that gardens are often student initiated and managed, but also bring together diverse stakeholders from the campus and community. These sites increase sustainability awareness as well as overall institutional sustainability. University food gardens provide formal education that overcomes many institutional barriers to interdisciplinary programs. Informal education also occurs at these sites through experiential learning which leads to greater environmental awareness among garden participants. Campus gardens increase sustainability of institutions by providing local organic food, sustainability education, campus biodiversity, and community-building. Overall, this research indicates that campus food gardens take root for the long-term with strong student participation and institutional support.

Keywords: Campus Garden, Experiential Education, Community Garden, Higher Education, Innovation, Sustainability, Sustainable Development

Introduction
　　　Sustainability strategies in higher education must be integrated at all institutional levels and occur within both operations and academic programing. Rigid administrative structures should be modified to encompass interdisciplinary sustainability education through innovative activities that unify students, faculty, staff, administration, and the community. A campus food garden is one such collaborative activity that has the potential to promote sustainability across traditional academic boundaries and institutional levels. They do so in a way that no other campus organization or initiative can because food—eating—is universal. Case study research has been undertaken (Ahee 2013; Borgman et al., 2014; Reeve et al., 2014), but relatively little survey research has investigated how campus food gardens contribute to sustainability programs in higher education overall. As we end the 2005-2014 UN declared Decade of Education for Sustainable Development (UNESCO, 2003), it is time to assess innovative programs in higher education that seek to train future sustainability professionals.
　　　This research investigates the role of university food gardens within the broader context of sustainability in institutions of higher education. This analysis specifically addresses the extent to which university gardens serve as sites for formal and informal education. Relevant literature provides the background for survey questionnaire development and mixed-methods analysis of the survey data. The overall objectives are: 1) to describe the characteristics and structure of university food gardens and; 2) assess the extent to which these gardens bridge institutional constraints to serve as venues for interdisciplinary collaboration and sustainability education.

Background and Relevant Research

Because they are relatively new initiatives, there is little research on campus food gardens, thus the research context is framed by literature on 1) the "greening" of higher education and 2) the complexity of defining and addressing both operational and curricular components of sustainability. Institutions of higher education have the opportunity to be agents of change and innovation to promote a sustainable society. This can be achieved through 3) interdisciplinary programs and 4) multiple types of learning that encourage collaboration. Such educational initiatives reflect broader 5) community resilience as evidenced in gardening initiatives.

1) Institutional Commitment to Sustainability

The published goals of higher education institutions commonly include statements about their moral obligation to promote sustainability (Wright, 2002) but the "greening" of colleges has mostly focused on marginal adjustments and lacked broader comprehensive changes that would fully embrace a sustainable campus (Rappaport, 2008; Sharp, 2002). Key steps in successful institutional sustainability include: a vision, mission statement, and university-wide sustainability committee; all these components must be fully embedded into the education, research, and outreach activities of the university (Cortese, 2003; Velazquez et al., 2006). This is often an insurmountable task due to common barriers: lack of awareness or interest, inflexible organizational decision-making structures, and inadequate funding (Rappaport, 2008; Velazquez et al., 2005).

Sustainability initiatives are driven by both the potential opportunities for cost savings and diverse stakeholders: enthusiastic students, faculty, alumni and the local community who wield great influence in the adoption of green practices (Rappaport, 2008; Stafford, 2010). However, this complicates actual action, as students have a sense of urgency for change, but have limited experience and only spend a few years at the institution, while faculty/staff possess long-term ties and knowledge to instigate change, but may have different goals for sustainability (Wright and Horst, 2013). In addition, faculty and staff may find themselves deeply entrenched in the current system and unable to envision possible changes (Stephens and Graham, 2010).

Agile administrative planning can incorporate sustainability as the basis for institutional success which could overcome current challenges within higher education by clearly integrating sustainability into all levels of the operations and curriculum (Driscoll, 2013; Martin and Samels, 2012). Universities offer the unique opportunity to act as agents of change by promoting innovation, engaging the community, and partnering with students, faculty and staff to act sustainably well into the future (Rappaport, 2008; Sharp, 2002; Stephens et al., 2008). But how can higher education overcome institutional barriers and turn a handful of "green" activities into true sustainability education?

2) Complexity of Sustainability in Higher Education

A generally accepted definition of sustainability is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (UN, 1987, p. 43). But sustainability has diverse meanings and is often defined according to context (North and Jansen, 2013). As noted by Wals and Jickling (2002), sustainability "is as complex as life itself" (p. 227) and there is no universal definition of sustainability education (McFarlane and Ogazon, 2011). This leads to questions about the role of sustainability in

advancing change versus continuing the status quo. For example, perpetuating "sustainability" (i.e., continuation) of economic consumerism is often in conflict with ecological sustainability. At the heart of this dilemma is the fact that we do not know, or science has not proven, what "the right sustainable way of living is" (Wals and Jickling, 2002, p. 224). In higher education, we tend to focus on the cognitive domain of learning which focuses on learning facts (Bloom et al., 1956), but to address the complexity of sustainability, we must delve deeper. The affective domain of learning involves values, behaviors, and attitudes and through this realm, we can teach students to change their behavior in light of new evidence (Shephard, 2008). To do this, we need a paradigm shift to encompass the full "web of experience" (Cortese, 2003) and promote participatory sustainability education through experiential learning and teaching skills such as collaboration (Wals and Jickling, 2002).

3) Interdisciplinary Education

To grapple with the complexity of defining and addressing sustainability, education must "transcend" specialization and become a "pedagogical big idea" (Sherman, 2008, p. 188). The United Nation's "Educating for a Sustainable Future" has called for "transdisciplinary reflection and action" since the mid-1990s (UNESCO, 1997.) Indeed, sustainability education could be the unifying concept that acts as the foundation of education for all college students (Elder, 2008).

Unfortunately, faculty apply sustainability criteria very differently depending on their discipline's interpretation of the issues and their departmental perceptions; this affects how topics are addressed in sustainability related teaching (Minguet et al., 2011). And most universities are too fragmented in learning and teaching; faculty are not accustomed to interdisciplinary work and there is an overall ethos that encourages individual competition (Cortese, 2002).

It is time to move from "good intentions to realizing the vision" of embracing sustainability within higher education and overcome disciplinary structures with collective strategies (Elder, 2008, p. 325). We know that interdisciplinary action-oriented projects can best address problems in sustainable development (Waas et al., 2010). The innovative ability of higher education allows it to teach "complex connections," interdependencies, and new ways of thinking and learning about integrated, systemic solutions (Elder, 2008, p. 108). Thus, a focus on sustainability as a pillar of education has some clear advantages, as it could push the faculty and administration to transcend traditional boundaries. But higher education leaders recognize ecoliteracy as a priority, while they rank interdisciplinary approaches lower—indicating its difficult implementation (Wright, 2002).

4) Multiple Types of Learning

In building these interdisciplinary approaches, there are several learning approaches to consider. Traditionally, the three types of learning are: 1) formal: government sponsored, institutional, hierarchical; 2) nonformal: deliberate, systematic, organized outside the formal system; and 3) informal: process of accumulating knowledge, skills, and attitudes from daily experiences (based on Coombs and Ahmed, 1974). These are not discrete entities and often learning occurs across the three approaches (LaBelle, 1982). Another relevant term in sustainability is experiential learning, which "engages students in critical thinking, problem solving and decision making in contexts that are personally relevant to them" (UNESCO, 2010). This often occurs in four stages: experience, processing the experience, generalizing, and then applying new knowledge (Kolb, 1984).

But educators in higher education must promote sustainability education and not be caught up in exclusive terminology that alienates both students and community members outside of academia (Wals and Jickling, 2002). So, rather than debate educational definitions, it is better to stimulate students' learning. In other words, higher education should create possibilities for students' futures by teaching them to work with others and think for themselves.

Higher education is an incubator for leaders, where we train future professionals (Elder, 2008) and our society needs collaborators with skills to work in teams (Shephard, 2010) in order to address the complex ecological and social issues that we face. Team projects and developing cooperation among students is a key skill that higher education must teach (Chickering and Gamson, 1987). Dupuis and Ball (2013) elaborate: teaching sustainability must go beyond simply "what" (facts) and into "how"—this includes interactive, collaborative projects and practice-based knowing. We must put students in situations where they must collaborate in groups and learn from others with different worldviews: students need to hear other opinions (Biedenweg et al., 2010). "What we know (and how we come to know it) is not separate or distinct from what we do" (Dupuis and Ball, 2013, p. 68). We need a "living laboratory for practice and development of environmental sustainability" (Sharp, 2002, p. 144) because in sustainability education "real-world experience matters—getting out there and getting your hands dirty matters" (Sustainability, 2012, p. 220).

5) Campus Gardens as Unifying System

Gardens are an ideal setting for learning skills and building collaboration. By getting our hands dirty, we develop our sense of place that ties us to our local environment (Relph, 1997). Gardening provides physical activity and positive health outcomes through relaxation and connecting with nature (King, 2008; Twiss, et al. 2003). Life skills gained from the garden can be applied to everyday life to create a "holistic sense of health and well-being" (Hale et al., 2011, p. 1859). Literature on campus food gardens focuses on case studies (Sayre and Clark, 2011). To make useful generalizations about these various university gardens and understand their role in sustainability education, we must also understand what gardens can contribute to a community—whether a neighborhood community or a campus community.

Community gardens are sites that promote "learning for socio-environmental change" (Walter, 2013, p. 535). Gardens unite people and link people to the environment through a broad definition of "community" resilience, which creates local and ultimately global ecological solutions (King, 2008; Maye et al., 2007; Okvat and Zautra, 2011). Gardens, as a shared space, increase social cohesion through bonding (increasing ties among similar people) and bridging (forming new relationships among people from different backgrounds) (Larsen et al., 2004; Firth et al., 2011). Social cohesion helps to create a sense of well-being among members, leading to greater overall community involvement, increased volunteerism and activism (Alaimo et al., 2010; Firth, et al., 2011; Glover, 2004; Johnson, 2012). Garden members collectively broaden their cultural, environmental, and social perceptions through collective actions (King, 2008; Pudup, 2008; Schmelzkopf, 1995; Twiss et al., 2003).

Experiential coursework can be readily linked to garden education to unify classroom and independent learning (Biernbaum et al., 2006). Garden education includes ecological knowledge, place-based connections, and the competence to take action (Johnson, 2012). Taking this a step farther, Walter (2013, p. 527) explains that "in the environmental and other social movements, education and learning is not so much about individual behavioural change, but 'educative-activism' and consciousness raising." In teaching sustainability successfully, we can

draw on independent free-thought to promote creativity, communication, and interaction with one another and with society (Stephens et al., 2008). Gardens "provide opportunities to reconnect people with people and people with food, opening up spaces for 'ecoliteracy' to develop through shared and reflective learning" (King 2008, p. 123). This education can extend beyond science-based learning to address broader sustainability frameworks that include the integration of ecological facts and social concerns (Hempel, 2014).

Research Approach

To assess the institutional role and educational aspects of university food gardens, this paper describes the key characteristics of university food gardens and the extent to which these gardens serve as sites for sustainability education. In winter 2014, data were gathered from a survey of campus garden managers identified through the Association of the Advancement of Sustainability in Higher Education (AASHE). The AASHE Sustainability Tracking, Assessment and Rating System (STARS 1.2) constitutes the most comprehensive database in the United States for comparing sustainability at universities across education and research, physical operations, and administration and planning (AASHE, 2013). A sample population (n=195) was defined as universities that self-identified with an organic garden on campus. A garden manager was identified through each university website, contacted via email, and invited to participate in an email survey following accepted protocol and follow up reminders (Dillman, 2000). This yielded 52 valid survey responses with both detailed quantitative and rich qualitative data for analysis.

The email-survey, comprised of open-ended, closed-ended, and rank-scale questions, was used to gather data on the following topics: garden characteristics, overall sustainability goals of the institutions, obstacles encountered and benefits derived from the gardens, and factors that influence long-term viability of university food garden initiatives. Details on the survey questions are noted in the findings below. Quantitative data analysis (inferential and descriptive statistics) allowed for the identification of patterns and generalization of characteristics, while the qualitative data analysis (coding) provided deeper insight into processes and interactions occurring at the garden sites (Creswell, 2014; Dennis and Garfield 2003; Jick, 1979; Johnson et al., 2007; Miles et al., 2014; Reichardt and Rallis, 1994; Tashakkori and Creswell, 2008; Venkatesh et al., 2013).

Research Findings

Univariate quantitative and rich qualitative data analyses describe: 1) the key characteristics of campus food gardens; and 2) the role these gardens currently play in sustainability education. Map 1 depicts that a geographically diverse group of campus garden managers responded to the survey, which is associated with great variation in the agroecological conditions of the gardens. These garden managers have various roles on campus: 58% are university staff, 25% are faculty, and students comprise 17% of the respondents. Some of these managers take on their role in addition to other duties, thus their work is voluntary. In terms of the staff, many stated that their position was 'sustainability coordinator,' which indicates a strong linkage between the gardens and broader institutional sustainability efforts.
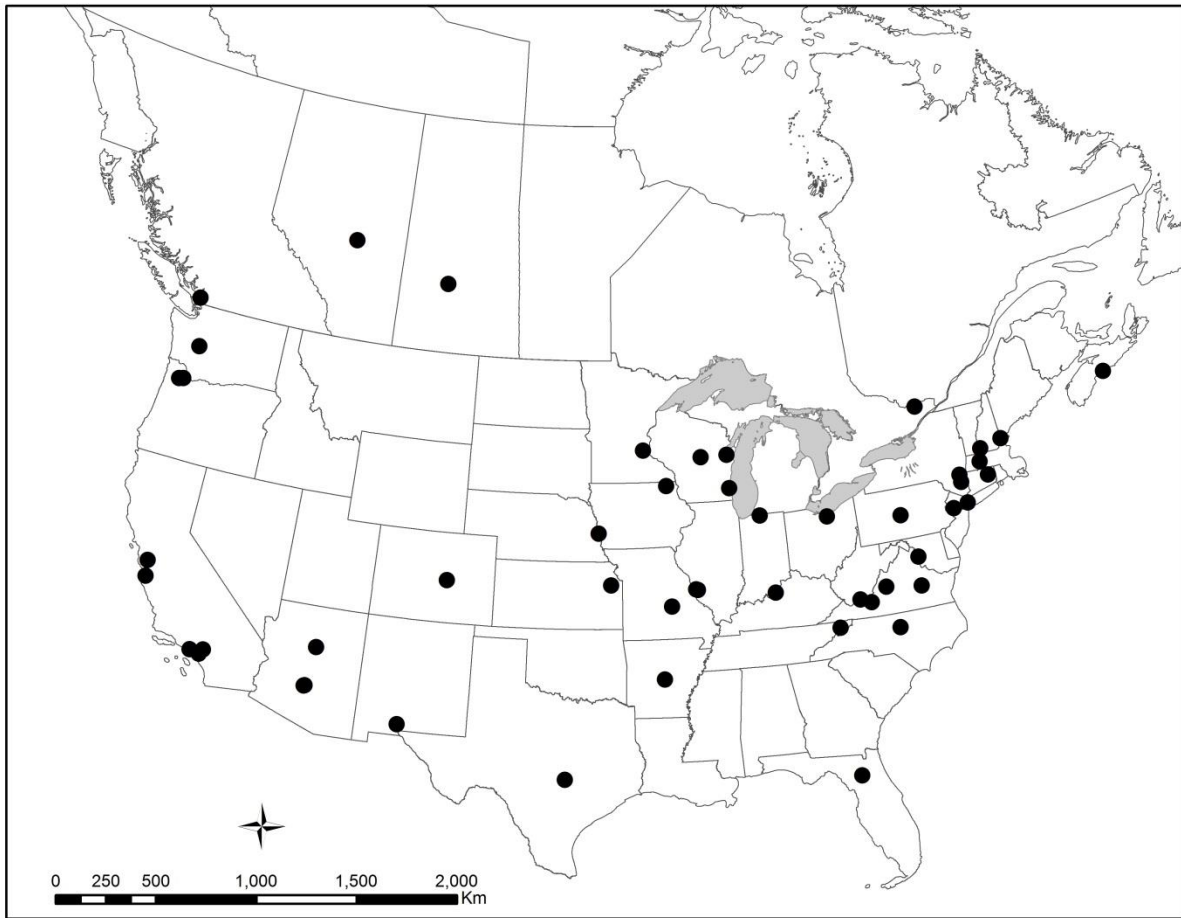
Map 1: Location of Surveyed Campus Gardens (credit: Jon Bathgate, 2014)

1. Characteristics of Campus Food Gardens

Garden Start-up, Size, and Crops

        Campus food gardens are a relative new phenomenon in higher education. In fact, 92% of the sampled gardens have been established since 2001. Student leadership is evident here, as students initiated the gardens on nearly three-quarters of these campuses. A vast majority, 85%, of the gardens are located on the university's central campus. Gardens not located on the central campus were still quite close-by, within an average of 1.6 kilometres (1 mile).

        The gardens promote sustainable agroecological methods, with 96% using organic methods consistent with national US Department of Agriculture standards (although not necessarily certified organic). Permaculture methods are employed at 56% of the gardens. Most (70%) of the campus gardens are 0.4 hectares (1 acre) or smaller. In terms of crops produced, all campus gardens grow vegetables and 80% also produced fruit. A diversity of vegetables are grown, with an average of 24 different types and a huge range from just 5 types to over 200 types of vegetables. Fruits, including berries, melons and treefruit (peaches, dates, lemons, etc.) are also popular, with an average of 10 different types; this varies from just 1 type to 90 types of fruits in any given garden. The campus gardeners also diversify by growing herbs, flowers, and heirloom varieties of vegetables.

Administration of Campus Gardens

　　　　Table 1 shows key findings in regard to the creation of the gardens, current management, and funding structures. Students certainly played a significant role in establishing the sites, but faculty, administration, and staff also acted to initiate the gardens. Once established, actual garden management is typically accomplished by students with faculty advisors, students alone, and other staff. Gardens are primarily funded by internal university sources, as noted by nearly 90% of garden managers. Some gardens receive funding from donations, sales of crops/products, and "other" sources that include grants and club/membership fees. Findings show that most gardens are heavily reliant on a single source of funding, specifically their university, and for nearly 20% of gardens, this funding is not guaranteed in the future**.**

Table 1. Garden Establishment, Management and Funding

Who initiated the garden? (mark all that apply)	
Students	73%
Faculty	46%
Administration	33%
Staff Interest: kitchen, daycare, etc.)	29%
Outside Community	6%
How is the garden managed?	
Students with Faculty Advisor	42%
Other Staff	40%
Students	40%
Faculty	14%
Kitchen Staff at Dining/Residence Halls	2%
What are the major sources of funding?	
Within University	89%
Donations	46%
Sales: produce, bake sales, plant sales, etc.	33%
Other: grants, fees	17%
Private	14%
State	4%
Federal	2%
Funding Details	
Heavily Reliant on One Source (university)	69%
Heavily Reliant/ Not Consistently Available	19%

Markets and Advertising

　　　　Table 2 shows that the main venues for selling the garden products are campus dining halls and on-campus farm stands/markets. Many other gardens bypass the marketing aspects and produce food that is donated to food banks. Still other gardens produce food for garden volunteers and community members. A few gardens even sell produce at community farmers' markets or run a CSA (Community Supported Agriculture). "Other" sales locations include: food co-ops, restaurants, and local chefs. Only 8% of gardens do no advertising. Indeed, most garden managers do opt to advertise to attract volunteers and customers. They use a variety of methods to advertise their gardens: university websites, email lists, and Facebook/Twitter. Flyers, fairs, university newspapers, blogs, and word of mouth are also employed.

Table 2. Garden Food Distribution and Advertising

What is the market for produce and/or products grown or created at the garden? (mark all that apply)	
Campus Dining Halls	39%
On-campus Farm Stand and/or Market	37%
Food Banks	35%
Volunteers and Community Members	31%
Other: coop, restaurant, chefs	23%
Off-campus Community Farmers Market	12%
CSA (Community Supported Agriculture)	10%
How is the garden advertised?	
University Web Site	75%
Email List	73%
Facebook & Twitter	71%
Flyer & Signs	44%
Fairs & Events	42%
University Newspaper	35%
Word of Mouth	25%
Blog	21%
Other: class, club, local media	19%
We do not advertise	8%

2. Role of Campus Food Gardens in Sustainability Education

Goals and Participation

Gardens play a significant role in overall sustainability aims in these institutions. The majority of garden managers (83%) state that their garden is part of university-wide sustainability goals.

Table 3 shows that each garden has its own specific goals within each institutional setting. Education is the primary goal for the vast majority of these campus food gardens. Other objectives are the provision of local food for campus and the community, contributing to healthy campus initiatives, and youth programs. "Other" goals center on sustainability: advocating for sustainable food, student engagement, community building, and connection to the land. Table 3 also details the variety of stakeholders who use the sites: students, faculty, community members, classes, administrators. Emphasizing the importance of volunteers, 98% of the university gardens rely on them, while only 40% have paid student workers.

Gardens are used as formal teaching sites at 81% of the universities. Of the universities that hold classes at their garden, Table 3 shows that 66% of these classes are sustainability focused and 47% are used for environmental studies, while only 18% had a production agriculture focus. In addition, 44% of sampled universities conduct academic research at their garden.

Table 3. Garden Goals and Participation

What is the primary goal of your garden? (mark all that apply)	
Education: Garden, Sustainability, Agriculture, Science	92%
Local Food Source for Dining Halls/Cafes	48%
Provide for Local Food Banks; Donations	33%
Local Food Source for Campus Store/Farm Stand	23%
Health Purposes	21%

Science Education	21%
Youth Programs/Daycare	21%
Other: Research, Community, Engagement	12%
Who participates at the garden?	
Student Volunteers	98%
Faculty	60%
Outside Community Members	51%
Classrooms	46%
Paid Student Workers	40%
Administration	30%
Other	13%
What is the focus of classes linked to the garden?	
Sustainability	66%
Environmental Studies	47%
Education	26%
Health/Medicine	20%
Production Agriculture	18%
Physical Science	16%
Culinary	16%
Social Science	15%
Other	11%

Current Benefits and Obstacles

Qualitative analysis of managers' written survey responses was used to fully explore the benefits provided by the gardens. As noted in Table 4, this analysis indicates numerous benefits: providing food, community building, formal education, networking, institutional sustainability, experiential education, and building individuals' skills.

Table 4. Benefits Provided by Campus Gardens

What are the top benefits the garden has provided? *(write in):*	
	Percent of Universities
Providing Food	46%
Community Building	42%
Formal Education	42%
Networking	39%
Institutional Sustainability	37%
Experiential Education	35%
Individual Skills	35%

Qualitative analysis of the managers' written statements indicates that the main obstacles fit into several categories, as seen in Table 5. Participation and insufficient funding are key obstacles, along with agroecological and infrastructure problems.

Table 5. Obstacles Encountered by Gardens

What are the main obstacles encountered by the garden? *(write in)*

	Percent of Universities
Lack of Participation	62%
Unreliable/Low Funding	48%
Agroecological problems	40%
Infrastructure problems	39%
Lack of Institutional Support	33%
Lack Permanent Management/Leadership	25%
Lack of Knowledge (inexperience)	25%

Factors in Long Term Viability

The majority of managers (73%) answered affirmatively to the question: "In your opinion, will your university garden exist for the long-term?" Qualitative analysis was used to follow up on written responses which asked "why?" as noted in Table 6. According to the managers, several key factors increase their confidence in the longevity of the garden: high interest/demand, institutional support, and existing infrastructure.

Table 6. Successful Gardens: Key Factors Ensuring Garden Viability

Main factor	Percent
High Interest/Demand	34%
Institutional Support	32%
Significant Infrastructure	21%
Secured Funding	8%
Secured Management	5%

On the other hand, nearly a third of the garden managers are unsure their garden will exist in the future (27%). As shown in Table 7, this negative assessment is primarily due to lack of institutional support, uncertainty about land availability for the garden site, and questions about student interest and leadership.

Table 7. Failing Gardens: Conditions Causing Uncertainty about Future Viability

Main Factor	Percent
Need for Institutional Support	31%
Need for Secured Land Tenure	25%
Lack of Continued Interest/Participation	18%
Lack of Leadership	13%
Site too new	13%

Overall, this research focused on innovative, sustainable institutions of higher education, which are AASHE STARS rated universities. This ranking system recognizes different levels (Gold, Silver, and Bronze) based on points each institution earns for sustainability in three categories: Education/Research; Operations; and Planning/ Administration/Engagement. The STARS 1.2 score of each institution in this study was compared to the manager's statements about their garden's perceived viability in the future. Table 8 displays the finding that universities with higher STARS rankings are correlated with higher perceived garden

continuance. Managers who stated their confidence in the future viability of their garden, tended to be at institutions with higher sustainability scores. Thus campus gardens are expected to flourish for the long-term where they play a role in campus-wide sustainability goals.

Table 8. STARS Rating and Perceived Future Viability of Garden

	Yes	Unsure/No
Gold	75%	25%
Silver	81%	19%
Bronze	44%	56%

Discussion

The research findings presented here unify and extend concepts from diverse literature in institutional sustainability, education, and gardening. Quantitative and qualitative analyses found that these gardens can play a significant role in the overall sustainability initiatives in higher education **(Table 9)**.

Table 9: Campus Food Gardens as Sustainability Innovations in Higher Education
Innovation and Education
Established post-2001: student interest Informal Education: experiential, leadership, sustainable worldview Formal Education: teaching, research, interdisciplinary
"Green" Showcase
Tours, workshops Biodiversity Food to Campus and Community
Social Connections
Students-Faculty-Staff-Administration Teamwork and Leadership University-Community
Sustainable Campus
Garden Viability: participation, institutional support (funds, land) Stakeholder Collaboration Healthy Campus Institutional Commitment: programs, food, aesthetics

Innovation and Education

Many campus sustainability activities are relatively recent endeavors (AASHE, 2014). Indeed, our research finds that the vast majority of campus food gardens have been established

within the last decade. Findings further indicate that students are key to the establishment and current management of the gardens.

Campus gardens enhance the informal education opportunities at their universities. The gardens exemplify how sustainability education, based on interdisciplinary and experiential approaches, can lead to changes in worldview and lifestyle (Bacon et al., 2011; DuPuis and Ball, 2013). Through this survey, managers noted that gardens provide an "interactive and educating green space for students." Managers state that, as a result of garden participation, students adopted more sustainable lifestyles, a broader worldview, and more interaction with other campus sustainability groups. Additionally some students applied this learning to post-graduation life, as one manager stated: "People involved in the garden have gone on to do great things in their community."

These findings support the fact that experiential learning is gained through gardens that "provide an interactive and educating green space for students." Another garden "has allowed students to connect to their food on a personal level." Further, "students increase knowledge of how to grow food plants and seem to sustain the interest after graduating." Overall, this analysis indicates that campus gardens can increase participants' knowledge and awareness of local food systems, agroecology, seasonality, and healthy food, while providing opportunities for developing leadership skills. Thus, one manager stated that the garden is "changing lives of students in many ways" which can influence sustainable lifestyle shifts.

Our research findings also show that gardens serve as formal education sites. Other research also notes that food gardens serve as sites for 'eco-literacy' (Hempel, 2014; King, 2008). Indeed, 39% of managers list formal education as a key benefit provided by their garden: food gardens are not only supplements to classrooms but actually serve as specific sites for courses and academic research. They note the "educational opportunities" their garden facilitates, and one manager noted a specific example: "Education on how food scraps are an asset and composting can close the recycling loop."

Classes from varied disciplines are held at the garden sites, which emphasizes that gardens provide a place for cross-disciplinary activities: Agriculture/Gardening, Physical Science, Social Science, Health/Medicine/Nutrition, Education, Environmental Studies/Ecology, Sustainability, Volunteerism/Community service, Culinary, and Engineering. Further, managers state that there are significant "research outcomes" gained at the gardens, which is another example of formal educational contributions to campus sustainability goals. These findings support previous research which notes that sustainability and environmental studies courses often use the gardens for class settings and gardens encourage interdisciplinary learning and research (Elder, 2008; Waas et al., 2010).

"Green" Showcase

Our findings show that most gardens are centrally located on campus and host events that increase campus sustainability awareness. Various activities are demonstrated at these sites, serving as tangible examples of sustainability for any passerby to observe. One gardener notes "It is the most visible campus sustainability initiative with multiple demonstrations (e.g. water catchment, composting, permaculture, solar power, etc.) - great tour stop!" Gardens can provide a hands-on example of sustainability: gardening and food workshops are often held on the garden sites. These are ecologically diverse sites, employing sustainable agroecological methods to grow a large variety of produce. Campus food garden initiatives not only practice ecological agriculture, but also increase food growing capacity and can increase biodiversity in the midst of

a busy campus. The gardens allow people to interact with nature: one manager states that their garden is a "paradise on campus."

This analysis finds that gardens distribute their produce to a variety of outlets. Building on the current diversity in local food initiatives (Feagan, 2007; King, 2008), some campus gardens have built their own CSA (Community Supported Agriculture) or participate in off-campus farmers' markets. Campus gardens are more than a money-making venture. Diverse advertising allows each garden to establish networks of interested stakeholders, both to serve as volunteers and to purchase produce. Likewise, some advertising promotes the garden as a 'green' initiative on campus. This type of outreach allows a campus to reach out campus-wide and community-wide to increase awareness of food issues (Duram and Williams, 2015; Rappaport, 2008). Thus one manager notes that food from their garden "aids students under financial strain," while another "supplies fresh healthy food to our local food banks." Thus gardens provide food to various campus stakeholders (e.g., dining services, farm stand, and student volunteers) and to the community (e.g., food banks, donations), which promotes positive accomplishments in higher education to the wider community.

Social Connections

The garden is an "inviting community space," according to one manager. Indeed, this research aligns with previous literature that finds campus gardens can provides a place for various campus stakeholders to meet and develop relationships (Sayre and Clark, 2011). As a gathering place, the garden promotes networking among campus members and between the university and outside community.

Thus, students, faculty, staff, and administrators may all be involved with the garden, which can greatly increase "collaboration across campus," as noted by one manager. This replicates findings from research on campus gardens and natural areas which shows that such sustainability initiatives can unite campus stakeholders (Duram and Williams, 2015; Krasny and Delia, 2014). Our survey showed that the relationships between teachers and students is enhanced because of the "great teaching opportunities" provided by gardens. Likewise, the garden "builds community amongst students" as they work together for a common goal and gain "new personal experiences" as a group. Activity among students is increased as one manager explained: "The garden provides positive social activity for student participation." This is where teamwork skills are developed (Shephard, 2010).

Linked to producing food, is sharing this food; indeed garden managers specifically note "community building" as a benefit of their site. These findings build on previous literature that shows how community gardens act as a space for gathering, learning, and encouraging diverse social interactions (Firth et al., 2011; Hale et al., 2011; Rojas et al., 2011).

Our findings support previous research that emphasizes how gardens can enable a university to build stronger relations with the off-campus local community (Hoffman and Doody, 2014; Stafford, 2011). Indeed, social ties were created among garden participants to strengthen relationships within the larger university as well as with non-university communities. According to one manager, gardeners "act as agents of social change within the university and city." The garden can provide a "mixing of community members, students, faculty and youth" where higher education "links to the outside community."

Sustainable Campus

This research investigated campus garden viability and found interesting linkages to previous literature on community gardens. Indeed, both campus and community gardens face similar obstacles in securing land and maintaining interest and volunteers (Blake and Cloutier, 2009; Eizenberg, 2012; Milburn and Vail, 2010; Ohmer et al., 2009). Campus gardens, however, do have additional obstacles to overcome: high student turnover at graduation time and lack of student volunteers present during summer months. Managers note a problem with "consistent participation (because students are transient and not always committed)." And busy college students may be unwilling to commit the time that is necessary for garden success. As noted by one manager: "Students use the garden, but few are willing to step up and take the leadership role."

Campus garden managers also note key obstacles: "unreliable funding from institution", "lack of buy-in from institution", "administrative neglect", and "lack of funding" (stated repeatedly on surveys). One manager summarized the overall situation as "difficulty securing support (financial and otherwise) from university administration." In a busy university setting, construction of new buildings often takes priority, sometimes forcing gardens to give up their land. "The garden is currently not in the University's 10 year plan and our current site has been under consideration [for development] since the garden's inception." Managers note that the best way to balance this administrative neglect and lack of land tenure is to show "continual student and faculty interest" with "continued use for research and education." Thus, most garden managers realize that they need broad stakeholder involvement to remain viable in the future.

Luckily, successful gardens can stimulate multiple stakeholder involvement and create unique collaborations at each institution of higher education, as part of university-wide sustainability goals. Managers note that their garden has "provided an interactive and educating green space for students" and acts as "a living lab for students to test their learning." One manager provides a clear summary: "Yes the garden will exist for the long term because there has always been a strong student interest as well as the community. And now with local healthy food being a popular topic, I think that it will continue to grow."

Gardens can also play a role in campus health initiatives. Garden managers take pride in their crops and frequently emphasized the taste, quality, sustainability, and health benefits of the produce grown at these campus gardens. Managers note that because of their garden: "Dining services can get produce they wouldn't otherwise be able to procure due to cost." Further, the garden "has provided students with healthier and cheaper food options" and promoted "learning about and eating good food." This is reinforced by previous research that shows the educational and health benefits of gardens in school settings (McAleese and Rankin, 2007; Ozer, 2007). Overall, this is important for higher education, as grade point averages are higher in students who consume more fruit and vegetables (Wald et al., 2014), and garden participation may contribute to these healthy food choices.

Our analysis shows that institutions with higher overall sustainability ratings are more likely to have a garden that is viable for the long-term. Institutional commitment is reflected in the curriculum and programs offered: environmental studies, sustainability classes, and interdisciplinary programs. According to managers, gardens provide "good PR" regarding sustainability initiatives and also "hands-on, informal sustainability learning space." Thus, the campus benefits from "education and understanding the role of community gardening in sustainable living" while also gaining "great food" and "wonderful produce." In addition, many garden managers emphasize another benefit of their garden: "It beautifies the campus."

Certainly, "aesthetic beauty," as noted by garden managers, can promote sustainability in higher education.

Conclusion

This analysis shows that university food gardens can have a positive influence on sustainability in higher education, in both academic endeavors and institutional operations. The gardens provide opportunities for learning sustainability principles and lifestyle skills through informal and formal education at the sites. In addition, food gardens can enhance the overall sustainability of their institutions by: providing a collaborative education and research site, producing sources of local food, creating biodiversity hotspots, and increasing community interactions. When incorporating sustainability into aspects of higher education, success depends on the development of collaborative projects that bring together members of the campus and community with diverse skills to create long-term change. Gardens can provide healthy food and stimulate interactions with the non-academic community in ways other campus initiatives cannot, thereby breaking down the 'ivory tower' image.

The goal of sustainability education must be to create graduates who possess skills necessary to lead a sustainability shift in society as a whole. Campus food gardens have the ability to increase awareness by serving as a visible site to promote discussion, understanding, and actions related to local food, health, and sustainability. Indeed this is why many campuses incorporate gardens into their institutional sustainability goals. The STARS institutions analyzed in this research are innovators in sustainability education, suggesting that broad institutional commitment can encourage campus food gardens to sprout up and flourish.

As noted in the UNESCO initiative in Education for Sustainable Development, key topics must be included in teaching and learning for a sustainable future (UNESCO 2014). These include several themes that can be addressed through campus gardens, particularly biodiversity, health promotion, and sustainable lifestyles. As evidenced in this research, campus food gardens can stimulate, promote, and help grow innovative sustainability actions in higher education.

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