



# Growing Opportunities for Equitable, Interdisciplinary Undergraduate Food Systems Education: A Review of Food Systems Education at Land-Grant Institutions and Development of Open-Access Materials

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University of Calgary, Canada

### \*Correspondence:

Rebecca A. Seguin-Fowler  
r.seguin-fowler@ag.tamu.edu

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Emily H. Belarmino<sup>1,2</sup>, Jane Kolodinsky<sup>2,3,4</sup>, Alice S. Ammerman<sup>5,6</sup>, Leah Connor Volpe<sup>7</sup>, Covington Brown<sup>5,6</sup>, Stephanie B. Jilcott Pitts<sup>8</sup>, Karla L. Hanson<sup>7</sup>, Marilyn Sitaker<sup>9</sup>, Weiwei Wang<sup>4</sup>, Jared T. McGuirt<sup>10</sup>, Michelle Carfagno<sup>11</sup>, Emily Hunsinger<sup>11</sup> and Rebecca A. Seguin-Fowler<sup>12\*</sup>

<sup>1</sup> Department of Nutrition and Food Sciences, University of Vermont, Burlington, VT, United States, <sup>2</sup> Gund Institute for Environment, University of Vermont, Burlington, VT, United States, <sup>3</sup> Department of Community Development and Applied Economics, University of Vermont, Burlington, VT, United States, <sup>4</sup> Center for Rural Studies, University of Vermont, Burlington, VT, United States, <sup>5</sup> Department of Nutrition, Gillings School of Global Public Health, University of North Carolina at Chapel Hill, Chapel Hill, NC, United States, <sup>6</sup> Center for Health Promotion and Disease Prevention, University of North Carolina at Chapel Hill, Chapel Hill, NC, United States, <sup>7</sup> Department of Public and Ecosystem Health, Cornell University, Ithaca, NY, United States, <sup>8</sup> Department of Public Health, East Carolina University, Greenville, NC, United States, <sup>9</sup> Ecological Agriculture and Food Systems, The Evergreen State College, Olympia, WA, United States, <sup>10</sup> Department of Nutrition, The University of North Carolina Greensboro, Greensboro, NC, United States, <sup>11</sup> Division of Nutritional Sciences, Cornell University, Ithaca, NY, United States, <sup>12</sup> Agrilife Research, Texas A&M University, College Station, TX, United States

Post-secondary coursework related to agriculture and the food supply has been at the core of the United States' land-grant system for more than 150 years. However, as the complexity of food systems has grown, so too have critiques that the education provided in these programs is too narrow to adequately prepare graduates to address pressing food systems issues. In response, some higher education institutions have developed degrees in food systems. To support development of this burgeoning field, we created, tested, and refined four evidence-informed, interdisciplinary, equity-oriented, open-access teaching modules. These modules are based on our experience conducting a multi-site, multi-year transdisciplinary investigation of subsidized, or "cost-offset", community supported agriculture and a survey asking instructors at land-grant institutions ( $n = 66$ ) about topic offerings and current unmet needs for instructional materials. Our collaboration illuminated the potential and challenges of food systems research; underscored the value of transdisciplinary research teams; and identified several equity-oriented topics related to the design, implementation, and evaluation of local food initiatives suitable for advancing sustainable foods systems education. Instructors reported that the most helpful teaching aids would be case studies, lesson

plans with active learning components, and reference lists with relevant peer-reviewed publications. The final modules seek to shed light on the complexity of food systems projects and build knowledge, vocabularies, and skills across disciplines engaged with food systems. Per instructor-defined needs, each module features a case study, active-learning activities, and references. We anticipate that the adaptable modules will be suitable for a wide range of students and courses.

**Keywords:** higher education, land-grant institution, open-access education, community-supported agriculture, knowledge translation

## INTRODUCTION

In the U.S., there has been a long tradition of agricultural education that dates back to the Morrill Act of 1862 and the establishment of the land-grant system. By its mandate, the land-grant system was uniquely designed to provide educational opportunities to future farmers, tradespeople, and food system leaders (Schuh, 1986; Barrick, 1989; Grant et al., 2000; Parr et al., 2007). Initially intended to integrate technical education and the liberal arts and to translate research into practical applications, over the twentieth century agricultural education became increasingly specialized and technical in response to population growth and rapid scientific advancements (Schuh, 1986; Grant et al., 2000).

In recent decades, recognition has grown that addressing the complex issues facing food systems requires a workforce equipped with disciplinary expertise and a transdisciplinary focus. Necessary skillsets include technical and technological skills, systems thinking, and facilitating collaborative processes and decision-making that engage diverse stakeholders and enhance equity at all stages of the food system from production to distribution (Anderson, 2013; Ebel et al., 2020; Ingram et al., 2020). The next generation of food system professionals will be expected to possess more advanced social, emotional, cognitive, and technological skills than prior generations (Akyazi et al., 2020). Many traditional agriculture and food-related programs may be too narrowly focused and highly specialized to adequately prepare graduates to deal with the complexity in food systems. Thus, some colleges and universities – including land-grant institutions (LGIs) – have endeavored to meet this need by building food systems educational programs that teach students about the full range of people and activities involved in producing, supplying, and consuming food, as well as how these are interconnected.

As the field has evolved, several scholars have sought to characterize food systems education at the undergraduate level and identify best practices for faculty and essential skills or competencies for students (Mendes et al., 2011; Galt et al., 2012a, 2013; Clark et al., 2013; Galt, 2013; Jordan et al., 2014; Hartle et al., 2017; Valley et al., 2017, 2020; Brekken et al., 2018; Ebel et al., 2020). Most of this work has been based on experiences developing food systems courses and degree programs, often framed as sustainable food systems education (SFSE). In tandem, professional societies dedicated to advancing teaching in this area have emerged to support the development and exchange

of teaching and learning practices. These professional societies include, among others, the Community of Practice on Teaching Food Systems, the Sustainable Agriculture Education Association [Teaching Food Systems: Community of Practice (CoP), 2021], and the National Collaborative for Food, Energy, and Water Education (Welcome to NC-FEW, 2021). Yet, despite these efforts, there is still a gap in information on the instructional support needs of educators in this field. Additionally, the availability of rigorous, open-access teaching resources for SFSE remains limited, especially resources that are transdisciplinary, evidence-based, and contain equity-oriented topics and processes that explore social justice themes.

With the goal of contributing to the development of SFSE, this paper has three objectives. The first is to briefly describe the current landscape of undergraduate food systems programs at LGIs and identify the types and formats of teaching materials needed by instructors of food systems courses. The second is to describe how the Farm Fresh Foods for Healthy Kids (F3HK) study, a transdisciplinary research collaboration that investigated the effects of subsidized community-supported agriculture programs on diets, farm businesses, and local economies (Seguin et al., 2017), informed the development of SFSE teaching materials. The third objective is to describe how we used the lessons learned from our research to develop open-access, evidence-informed, equity-oriented teaching materials for food systems-related courses.

## LANDSCAPE REVIEW AND INSTRUCTOR SURVEY

To understand where food systems degrees were available and the needs of instructors, we conducted a landscape review of undergraduate programs at LGIs and deployed a survey for course instructors. For feasibility, we limited the scope of work to LGIs due to their historic emphasis on agriculture and community development, their wide reach, and lower costs relative to comparable private universities [de Vise, 2012; IPEDS (Integrated Postsecondary Education Data System), 2021]. We focused on undergraduate programs since most post-secondary degree students are enrolled at the undergraduate level (Schmidt, 2019). In 2017, we used the Carnegie Classification of Institutions of Higher Education to identify LGIs offering a four-year degree ( $n = 89$ ). For each LGI, we accessed at least one undergraduate course catalog from the academic

years encompassing 2016–2018 and screened course titles and descriptions to identify those courses addressing food systems (i.e., course containing the phrase “food system” or a synonym in the course title or description). For each relevant course, we identified the instructor of record by searching online or contacting the university. In 2018, we sent a survey on course content and instructional needs to the 241 identified instructors.

Twenty-seven percent ( $n = 66$ ) of instructors invited to the survey responded to at least one question and were retained for analysis. To assess course content, the survey asked participating instructors about the disciplines integrated into their food systems course(s) and the geographical contexts of their courses. The survey also included two questions to assess instructional needs. First, respondents were asked how helpful the following course materials would be on a 4-point scale ranging from “Not Helpful At All” (1) to “Very Helpful” (4): (a) reference lists for current peer-reviewed publications on specific food systems topics; (b) PowerPoint slide modules addressing specific food systems topics; (c) case studies to illustrate food systems topics; (d) reflection exercises for service learning; and (e) lesson plans addressing specific food systems topics that integrate active learning strategies, such as peer instruction, problem-based learning, and flipped classrooms. Next, respondents were asked to indicate if materials in any of 14 topic areas would be useful for their undergraduate teaching (see **Table 1** for complete list). Questions were developed with expert input from instructors at LGI and non-LGI institutions to reflect materials and topics relevant for a range of food systems courses. The survey was approved by the Institutional Review Boards (IRBs) at the University of Vermont and Cornell University.

Nearly all respondents (92%) reported that their courses cut across two or more disciplinary focal areas (data not shown). In fact, over half (54%) reported incorporating content from five or more focal areas. The five most common focal areas were environmental studies or science (55%), nutrition (52%), public health (49%), applied economic or community development (49%), and food safety (43%). The three least common focal areas were veterinary science (5%), journalism or communications (11%), and bioengineering (14%). Most courses (83%) focused at least somewhat on the U.S. food system.

Respondents reported that the most helpful materials would be case studies to illustrate specific food systems topics, lesson plans that integrate active learning strategies, and reference lists for current peer-reviewed publications (**Table 1**). Among the most sought teaching materials were those focused on introducing basic food systems concepts, and community and social sustainability in local food systems.

In 2020, we searched the websites of all LGIs offering a four-year degree to identify undergraduate food systems majors, minors, associate degrees, and credit-bearing certificate programs. To be included, programs had to integrate interdisciplinary content from “farm-to-fork” using a systems perspective that focuses on the whole picture and context, and interactions between dimensions of the system [IOM (Institute of Medicine), 2010]. Thus, programs that centered on one dimension (e.g., agriculture, food science, nutrition) were not eligible. We compiled a list of potentially relevant

programs and augmented this list with SFSE programs at LGIs identified by Valley et al. (2020) in 2019. Two co-authors then independently applied our inclusion criteria to the list and resolved discrepancies through discussion. For programs that met our criteria, we compiled basic information (institution; department, school or program; degree name; and degree awarded).

We identified 53 programs at 34 institutions (**Supplementary Table 1**), representing a growth in the number of programs and LGIs offering programs since reviews in 2015 (Hartle et al., 2017) and 2019 (Valley et al., 2020). Mapping the density of food systems programs at LGIs, we identified geographic differences (**Supplementary Figure 1**), with few programs available at LGIs in the southern U.S. and none offered at LGIs in the south-central U.S.

## THE FARM FRESH FOODS FOR HEALTHY KIDS STUDY

Although modern industrial food systems often result in highly efficient production and less expensive food for consumers, the externalized costs on the environment and public health are well documented [IOM (Institute of Medicine) and NRC (National Research Council), 2015; Campbell et al., 2017]. In recent decades, local, community-based systems have reemerged as alternatives that offer farmers and consumers opportunities to engage directly about their foods. Because SFSE programs aim to prepare students to contribute to the creation of healthier, more sustainable, and more equitable food systems, they often emphasize progressive and alternative models of food production, distribution, and consumption (Valley et al., 2017). Community supported agriculture (CSA) is one such direct-to-consumer marketing model that has grown in popularity (Woods et al., 2017). In CSA, community members pay for a share of the farm’s crop prior to the growing season and then receive fresh produce on a regular basis throughout the season. CSA participation has been linked to positive diet and health outcomes (Ostrom, 1997; Perez et al., 2003; Cohen et al., 2012; Minaker et al., 2014; Arbuckle, 2015; Curtis et al., 2015; Vasquez et al., 2016; Allen et al., 2017; Galt et al., 2017; Rossi et al., 2017; AbuSaba and Gargin, 2018) and may provide better economic returns to farmers (Sabih and Baker, 2000; Stagl, 2002; Saulny, 2008; LeRoux et al., 2010; Paul, 2019). CSA farmers often report the advancement of social and environmental commitments as primary motivations for pursuing CSA (Galt et al., 2012b; Morgan et al., 2018). However, recruiting and retaining lower income members has been identified as a challenge (Morgan et al., 2018), leading to mostly higher income membership and critiques that the marketing model perpetuates inequalities in access (Galt et al., 2017). To address this critique and support more equitable participation, some farms have developed mechanisms to offset the costs of membership, hereafter referred to as cost-offset CSA or CO-CSA. CO-CSA models take diverse forms, but share the common feature of reducing the large up-front costs to membership as a way to create a more just food system.

**TABLE 1** | Instructors' needs for food systems-related teaching materials ( $n = 66$ ).

Types of teaching materials on a scale of 1 (not helpful at all) to 4 (very helpful)	Mean (SD)
Case studies to illustrate specific food systems topics	3.4 (0.9)
Lesson plans addressing specific food systems topics that integrate active learning strategies, such as peer instruction, problem-based learning, and flipped classrooms	3.2 (0.9)
Reference lists for current peer-reviewed publications on specific food systems topics	3.1 (1.1)
PowerPoint slide modules addressing specific food systems topics	2.9 (1.1)
Reflection exercises for service learning	2.9 (1.1)
Topics for teaching materials related to the U.S. food system	n (%)
What is a food system?	47 (71.2)
Community and social sustainability in local food systems	44 (66.7)
History of local food systems/movements	40 (60.6)
Ethics relating to local food systems	38 (57.6)
Food distribution in local food systems	38 (57.6)
Impacts of local food systems on community development	38 (57.6)
Impacts of local food systems on nutrition and health	38 (57.6)
Methods for analyzing impacts of local food systems on diets and nutrition	31 (47.0)
Case study: impacts of subsidized CSA on diet, health, and local economies	31 (47.0)
Methods of economic analysis of local food systems	30 (45.5)
Food safety in local food systems	28 (42.4)
Engaging a broad range of stakeholders in local food systems	26 (39.4)
Laws pertaining to local food systems	26 (39.4)
Introduction to agroecology	23 (34.8)

In the absence of evidence on the impact and feasibility of CO-*CSA* models, the F3HK study was implemented by researchers with expertise in four disciplines relevant to food systems: public health, nutrition, applied economics, and agripreneurship (i.e., entrepreneurship in agriculture). F3HK was a community-based, randomized controlled trial to conduct rigorous between-group outcome evaluation as well as robust formative research, cost-effectiveness analysis, and economic impact assessments at the farm and community level. The project also included the creation of learning and teaching materials for farmers, community-based health educators, and university instructors. A full description of the study is provided by Seguin et al. (2017). Multiple aspects of F3HK can help advance SFSE, including the focus on an emergent equity-focused marketing model, working across disciplines, and building and disseminating evidence.

Although our team had extensive experience with community-engaged research at the onset of this five-year study, the collaboration deepened our understanding of the opportunities and challenges of transdisciplinary partnerships to address food systems issues. These included developing shared vocabularies, acknowledging disciplinary assumptions about what constitutes high-quality research and/or analytic approaches, building trust with communities and partners unfamiliar with *CSA* models and/or academic research, exploring diverse indicators to measure impact, learning new methods, and working through differences of opinion regarding topics such as study approaches, methods, and measures. In designing teaching materials, we wanted to integrate these experiences and lessons to provide a more nuanced and authentic perspective of food systems research.

## MODULE DEVELOPMENT AND TESTING

Leveraging the findings of our research and drawing lessons from our collaboration on F3HK (Seguin et al., 2017; Becot et al., 2018; McGuirt et al., 2018, 2020; Morgan et al., 2018; White et al., 2018; Hanson et al., 2019; Sitaker et al., 2020), we developed a series of four modules for use in SFSE courses and programs (Table 2). The modules focus on case studies relevant to local food systems in the U.S., relate to insights that emerged from our research, and seek to help students build skills working across disciplines. Our intent was to introduce perspectives, vocabularies, and methods from different fields; provide real-world examples of equity-oriented food systems topics, and integrate core elements of SFSE pedagogy (Valley et al., 2017), especially systems thinking, collaboration across disciplines, and exploring problem-solving in situations of uncertainty. To align with the four disciplines most intensely involved in F3HK, the modules primarily draw from public health, nutrition, applied economics, and agripreneurship. The first module introduces students to some of the challenges inherent in developing local food systems interventions in communities with little awareness of the local food system and teaches how to apply a systems approach to identify local assets, strategic partnerships, and strategies to overcome obstacles. The second module aims to teach students how to evaluate the appropriateness of various dietary assessment tools for different research contexts and assess the impacts of community-based local food interventions on dietary quality. The third module introduces economic impact studies and teaches the fundamentals of economic impact assessment as it pertains to local food interventions. The final

**TABLE 2** | Summary of education modules included in the “design, implementation, and evaluation of local food initiatives for farms and families” series.

Module	Objectives
1. What’s a CSA? Creating a community-based local foods intervention where “local food” is a foreign concept	<ol style="list-style-type: none"> <li>1. Identify ways to overcome barriers to create a successful cost offset CSA intervention in a setting not conducive to local food interventions</li> <li>2. Identify ways to educate consumers to create a successful cost offset CSA</li> <li>3. Identify ways to use existing systems and networks to create a successful cost offset CSA</li> </ol>
2. Assessing dietary quality in community-based local foods interventions and evaluations	<ol style="list-style-type: none"> <li>1. Describe the link between dietary quality and health, and the potential for changes in fruit and vegetable intake to alter risk for morbidity and mortality</li> <li>2. Compare different ways to measure dietary quality including fruit and vegetable intake</li> <li>3. Evaluate ways to measure dietary quality given specific objectives, resource constraints, and community settings</li> </ol>
3. What is an economic impact study? Identifying how local food systems add to the economic engine of a community	<ol style="list-style-type: none"> <li>1. Describe the difference between an economic contribution study and an economic impact study</li> <li>2. Understand the basics of economic impact analysis, including data requirements</li> </ol>
4. Adapting a CSA to open new markets for farmers and increase low-income families’ access to local foods	<ol style="list-style-type: none"> <li>1. Use basic principles of marketing when planning a cost offset CSA program</li> <li>2. Describe how CSA farmers can go about developing a continuation plan to operate a cost offset CSA program</li> </ol>

module presents the basic principles of marketing and helps students consider business decisions facing farmers interested in implementing a sustainable CO-CSA program. By prompting deep inquiry into and reflection about contextual issues and opportunities in local food systems, the modules prepare students for situations they are likely to experience as food systems professionals. CO-CSA models provide a grounding example for the first and fourth modules, while the second and third modules are relevant to a breadth of local food system models.

To help meet identified needs, each module includes background reading, PowerPoint slides (with audio narration available), a case-based classroom activity, reflection/discussion questions, and a reference list. Instructors can deliver two or more modules together, or can select the modules or module components that are best suited for their courses. We designed the modules for undergraduate courses; however, each includes suggested modifications for delivery in graduate courses.

Beta versions were drafted and piloted in spring 2019. Based on feedback, the modules were fully developed and tested during the 2019–2020 academic year. Following implementation, we asked instructors about the method of delivery of their course; whether they were teaching undergraduate or graduate students and how many; and to share their perspectives on the module(s) in free-text. We also asked students to rate their confidence in abilities related to each learning outcome before and after the session and the quality of the materials and implementation.

The modules were implemented through in-person, distance, and hybrid formats in undergraduate- and graduate-level classes across four institutions in three states (New York, North Carolina, and Vermont). Each was tested at least twice. Class sizes ranged from <10 to >50 students (median of 18 students). Instructor feedback indicated implementation was feasible and highlighted specific areas for enhancement (e.g., reducing redundant content, rearranging the order of content).

Sixty-seven students submitted surveys. For half of the learning outcomes, students’ confidence in their abilities significantly improved after the lesson ( $p < 0.05$ ; data not shown). Across the modules, students positively rated the overall

understandability, flow of information, background readings, and quality of the slides. Most felt that the lessons helped them develop intellectual and critical thinking skills and increased their ability to identify, formulate, and solve problems. Class activities and discussions were rated least favorably and identified areas that could use further development.

We finalized the modules based on student and instructor feedback. Revisions included streamlining content to better focus on the learning outcomes, incorporating new recommendations for facilitation (e.g., encourage students to read assigned materials before and after sessions, pause for discussion and to check for understanding more frequently), and adopting a uniform PowerPoint template.

## DISCUSSION AND CONCLUSIONS

This paper describes how we combined our transdisciplinary F3HK experiences with research on offerings and gaps in SFSE at LGIs to develop, test, and refine four new equity-oriented, open-access, evidence-informed food systems teaching modules. Although prior efforts to understand this nascent field have cast a wider net (Hartle et al., 2017; Valley et al., 2020), our focus on LGIs enabled a more systematic approach. LGIs have been criticized in recent decades for veering away from their mission of applied research, teaching, and extension and more toward differentiation of knowledge and skills within narrowly defined disciplines (Schuh, 1986; Grant et al., 2000). This paper helps to document a shift toward interdisciplinary education within the land-grant system. However, this shift appears unevenly applied, with multiple food systems programs available to students at LGIs in some states and no programs available in others. This could have consequences for equity in the food system and ultimately impact sustainability and public health.

The “Design, implementation, and evaluation of local food initiatives for farms and families” educational modules respond to the need for teaching materials that are rigorous, draw from transdisciplinary food systems research, and use active learning approaches. In line with the open access philosophy, the modules

are freely available at [www.rebeccaseguin.weebly.com/farm-fresh-foods-for-healthy-kids.html](http://www.rebeccaseguin.weebly.com/farm-fresh-foods-for-healthy-kids.html). Open-access teaching resources can lighten the load of instructors facing an increasingly demanding academic employment environment (Sabagh et al., 2018). By reducing labor needs, open-access materials represent a possible cost and timesaving innovation, which may be especially relevant in emerging areas such as SFSE.

To ensure that the modules were grounded in actual research experiences and evidence, we balanced instructor preferences with lessons from the F3HK study. This means that there is not perfect alignment between the topics most preferred by instructors and the topics covered in the modules. However, a key strength of the final modules is that they respond to instructor-identified gaps in teaching resources by presenting real world research case studies alongside references to relevant peer-reviewed papers. We believe that – taken together – the content and teaching methods of our modules support all eight program learning outcomes for SFSE outlined by Ebel et al. (2020).

Future research could rigorously evaluate the modules, explore their reach and impact, and identify appropriate adaptations for different contexts and populations. These data could be obtained through tracking module downloads and surveying and/or interviewing instructors and their students. Research is still needed on the content of existing SFSE courses and how this content aligns with essential professional competencies identified by food systems practitioners. Additional modules can be developed that draw on other interdisciplinary or transdisciplinary field-based work, address unmet instructor preferences or practitioner skillsets, and incorporate other important food systems topics. We believe the core elements are the focus on systems thinking, working across disciplines, and evidence-informed problem solving to support more equitable food systems. We hope that this description of our process and the open-access dissemination of the modules will help spur further discourse, collaboration, and equitable sharing of evidence-informed food systems teaching materials.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Review Board for Human Participant Research, Cornell University and the Institutional Review Board Committee on Human Research in the Behavioral and Social Sciences, University of Vermont. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

## AUTHOR CONTRIBUTIONS

RS-F, SJP, KH, JK, AA, and MS conceptualized, designed, and led implementation of the Farm Fresh Foods for Health Kids (F3HK) research project. EB led the review of food systems courses and the instructor survey, drafted the manuscript, and made final revisions. EB and JK conducted the content analysis of food systems programs to ensure that all programs listed in this paper met the decided upon criteria. SJP, MS, LC, KH, JK, WW, and JM developed the modules and SJP, EB, LC, and KH field-tested the modules. MC, EH, and CB contributed to data collection and analysis. All authors have revised the manuscript for important content and approved the final version.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fsufs.2021.756584/full#supplementary-material>

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