Planning for Urban Agriculture Education

WORKSHOP REPORT

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UNIVERSITY OF THE FRASER VALLEY
FOOD AND AGRICULTURE INSTITUTE

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1. Summary

The *Planning for Urban Agriculture Education: Workshop Report* presents an analysis of the outcomes from two pilot workshops on pedagogical approaches to food system planning education. Insights from these workshops are being used to inform the development of a series of online micro-credentials in planning for urban agriculture and agri-tech. The aim of this work is to promote effective integration of academic research with practical application.

In October 2025, two virtual workshops were held that brought together students and professionals involved in studies and work related to environmental sustainability and/or sustainable food systems. Workshop 1 focused on systems thinking, and it involved the use of participatory modelling techniques and collaborative system mapping tools (i.e., PRSM and LOOPY). Workshop 2 explored spatial and place-based issues and aspects of local food systems, using a 3D visualization (i.e., an application developed using Unity3D) and a spatial data mapping tool (i.e., Agrilyze).

Workshop outcomes were assessed utilizing the "head, hands, heart" framework, which frames effective education in terms of cognitive development, practical skill acquisition, and the cultivation of values and inclusivity. Outcomes from this assessment include:

- Knowledge (i.e., head): Participants demonstrated enhanced systems thinking by transitioning from linear to circular conceptualizations of food systems, and they exhibited improved spatial data literacy. Additionally, they developed critical perspectives on the limitations and underlying assumptions of digital modelling tools.

- Practical skills (i.e., hands): While some digital tools were intuitive, technical challenges and limited mobile compatibility of some of the applications/tools hindered participant engagement. In addition, large group sizes (exceeding 20 participants) negatively impacted software performance and collaborative dynamics in the participatory modelling exercise.

- Values and inclusion (i.e., heart): The workshops revealed that conventional Western planning metrics often marginalize Indigenous food networks and diverse cultural foodways. Such findings highlight a need for more inclusive and representative planning data and methodologies.

To advance food system education, the report provides three recommendations. First, educational activities should be structured to progress from foundational to advanced tools and from regional-scale analysis to site-specific planning, supporting incremental knowledge acquisition. Second, group work should ideally consist of three to six participants per group to reduce technical challenges and promote meaningful participation. Finally, collaboration with Indigenous educators is important for developing curricula in ways that ensure representation of traditional food systems and prevent colonial biases in educational frameworks.

1. Introduction

Food systems are featured very little within planning education, despite their critical role in shaping sustainable, just, and resilient communities (Dring, 2023; Greenstein et al., 2015). The evolving challenges of rising food insecurity, climate change, and local economic development in the face of geopolitical tensions demand a new generation of planners equipped with systems-based, cross-sectoral competencies. Yet, formal training opportunities in local food system planning are underdeveloped and limited.

This report presents findings from two workshops held in October 2025 that piloted and evaluated pedagogical activities for food system planning education. The workshops were designed to test emerging teaching approaches and competency-based learning outcomes for professionals and students working at the intersection of food systems, agriculture, and urban planning. The findings offer valuable insights into how food system planning pedagogy can be designed as interactive, experiential, and engaging micro-credential programs. Such programs can bridge the gap between academic learning and practical application in local planning.

1.1 Background and Rationale

Research highlights the need for structured, competency-based training to professionalize the field of local food systems. Based on a survey study, Dankbar et al. (2023) argue that curriculum development in local food systems should involve piloting pedagogical activities that directly align with core competency areas. They emphasize that such training programs strengthen practitioner capacity and the effectiveness and coordination of local food systems. Relatedly, survey studies conducted by the North American Food Systems Network (NAFSN) in the United States and Canada during 2012 and 2019 identified education and professional development as key priorities for food systems practitioners (Hilchey et al., 2021).

Scholars argue that the complex nature of food systems work requires a systems-oriented educational framework that cuts across academic disciplines, institutions, and program boundaries (Dunning et al., 2012). Practitioners entering this field often come from diverse professional backgrounds, ranging from agricultural sciences, public health, economics, rural sociology, to community development. These practitioners work across varied institutional settings, including university extension, nonprofit organizations, government departments, and private enterprises. Each sector is associated with distinct forms of food system knowledge and expertise, making it essential for practitioners to combine technical proficiency (e.g., in production or business development) with facilitative and leadership skills to engage in collaborative, cross-sectoral initiatives (Raison, 2010).

Jawabreh and Gündüz (2021) explain that curriculum development is an iterative process that requires continuous feedback from educators, learners, and practitioners to ensure the relevance and coherence of education programs. Ongoing evaluation during curriculum design is essential for assessing whether learning objectives are effectively incorporated into educational activities and for refining teaching approaches to align with current competency frameworks (Mack, 2025). Testing and adapting instructional strategies through formative assessment allows educators to respond effectively to learners' needs in applied fields, such as urban and regional planning.

After two decades of incremental progress, food system planning remains a niche specialization within the broader planning discipline. Agricultural planning in particular has received little scholarly and pedagogical attention (exceptions being Connell, 2023; Dring, 2023). Such a lack of attention can reinforce misguided perspectives that conflate rural and agricultural land uses and overlook the planning profession's critical role in shaping food environments across the urban–rural continuum.

A lack of formal educational programming in ag-tech and food systems planning leaves multiple learner groups underserved. Such groups include postsecondary students who are pursuing careers in environmental, health, food, and community planning. Additionally, planning and community development professionals who seek flexible agrifood-related opportunities for upskilling often struggle to find them. Practitioners who facilitate public engagement processes related to urban agriculture, local planning, and emerging food production technologies are also underserved.

Addressing the need for local food system planning education requires accessible, credible educational options recognized by both government and industry. The research effort presented in this report informs the development of micro-credential programs designed to meet these needs. Such programs can offer flexible, online, and stackable training opportunities that strengthen food systems planning capacity across British Columbia (BC) and beyond.

1.2 Micro-Credential Development

This study is part of a larger curriculum development project that directly addresses educational and professional gaps in local food systems practices. The objective of this larger project is to develop four online, stackable micro-credentials in urban agriculture and agri-tech that are accessible to learners in rural, urban, and remote settings. The micro-credential programs (respectively) focus on:

- Vertical agriculture for local-regional food systems
- Planning for urban agriculture
- Agricultural data and local-regional food system development
- The business of ag-tech and entrepreneurship

Urban agriculture and agri-tech micro-credential programs are particularly relevant for farmers, food system practitioners, and underemployed workers interested in building new competencies and/or exploring ag-tech entrepreneurship. The programs are designed for online delivery to support inclusive participation, and the micro-credential series uses a stackable structure so learners can build comprehensive skill sets over time by combining different credentials. The programs align with provincial initiatives in BC, such as the StrongerBC Future Skills Grant, which provides financial support to help British Columbians develop in-demand skills.

2. Methods

This study consisted of two virtual workshops (October 6 and 10, 2025) that engaged people from diverse educational and professional backgrounds in food systems, sustainability, and community planning. Potential participants were identified using the professional and academic networks of the Royal Roads University and the University of the Fraser Valley researchers involved in this project. Recruitment commenced approximately one month prior to the first session via email. The e-mail invitations sent to these potential participants outlined the research objectives and included a link to register for the workshop. Interested individuals completed online registration forms and received details about the workshop, including schedules, Zoom links, and research consent materials. Participation was voluntary, and the participants were given the opportunity to review and sign research participant consent forms before engaging in the workshops.

The first and second workshops respectively engaged n=23 and n=7 participants. All participants in the second workshop had previously participated in the first workshop. The recruitment process was designed to include a participant group representing a broad spectrum of roles, including students, academics, consultants, community organizers, policymakers, and practitioners in urban agriculture, food security, and environmental planning. This recruitment strategy ensured a diverse range of perspectives across multiple sectors and regions.

Participants demographics included diverse ages including those aged 25 to 34 years (n=8), 35 to 44 years (n=3), 45 to 54 years (n=3), and 55 to 64 years (n=1). However, it is worth noting that approximately one third of the participants (n=8) did not identify their age. Participants also identified as being a woman (n=10) or being a man (n=6), but similar to age, several provide no gender identification (n=7). Some participants identified as Indigenous (n=2).

Most participants (n=14) were located in BC communities, but some participants (n=4) were based in other provinces (the remaining n=5 participants did not identify a location). The inclusion of these interprovincial perspectives provided valuable comparisons across different policy and planning contexts, enriching the discussions by highlighting a broader range of regional challenges and opportunities within food systems.

Most attendees (n=17) reported prior experience or knowledge in food systems, urban agriculture, or sustainability initiatives. Several participants (n=7) held mid- to senior-level positions, including urban planners, program managers, policy advisors, and community leaders. The diverse professional backgrounds of participants resulted in a comprehensive and dynamic exploration of the opportunities, needs, and best practices for local food systems planning education programs.

2.1 Workshop 1 - Exploring Systems Thinking through Food System Mapping, (PRSM & LOOPY)

The first workshop was held online via Zoom on October 6, 2025, and was attended by 23 participants. The primary goal of the workshop was to introduce participants to systems thinking concepts and systems mapping and modelling tools that can support food system planning and education (i.e., PRSM and LOOPY). Table 1 provides details on the workshop.

Table1. Workshop 1 overview and data collection process

Workshop Details	Description
Date	October 6, 2025
Title	Exploring Systems Thinking through Food System Mapping (PRSM & LOOPY)
Duration	2 hours
Participants	23
Facilitators	Robert Newell, Colin Dring, Bahar Nikpey
Data Collection Methods	Participant observation, systems maps, group discussions
Main Activities	PRSM Demo & Collaborative Mapping; LOOPY Simulation Exercise
Group Discussion Focus	The usefulness of the tools, educational effectiveness of the exercises, and comparison between the tools and exercises

The session commenced with a presentation on how food systems involve the interconnected processes of food production, processing, distribution, access, and waste that interact with a wide range of social, environmental, cultural, political, and economic factors. The presentation also involved a discussion on systems thinking concepts, such as feedback loops, interdependencies, and leverage points as essential elements for understanding complex systems. The presentation concluded with a discussion on food system sustainability and resilience issues, such as the loss of farmland, reduced agricultural production, and supply-chain vulnerabilities (see Dring & Newell, 2022).

2.1.1 PRSM Demonstration and Collaborative Mapping

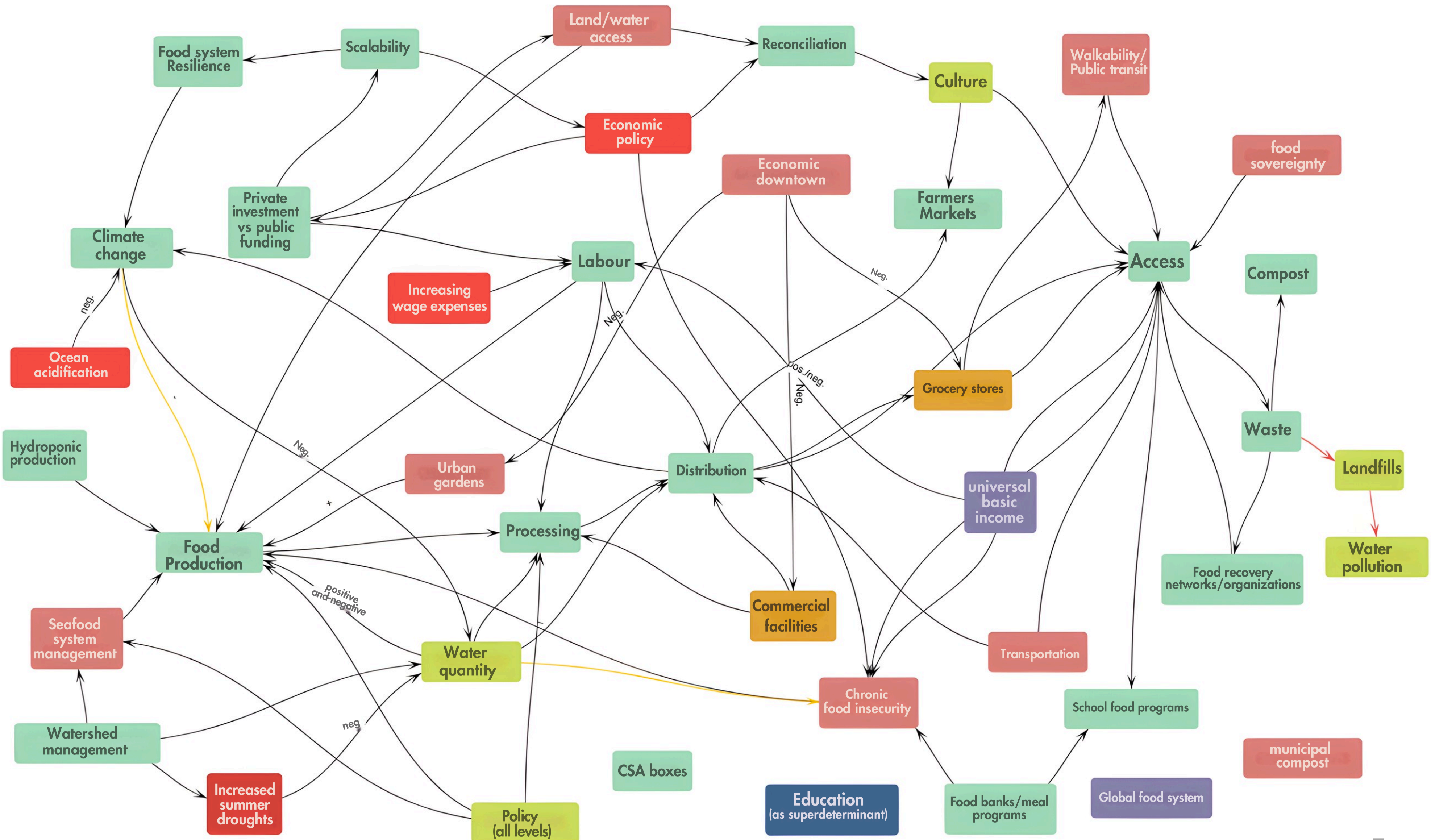
After the presentation, the participants were given a demonstration of the Participatory System Mapper (PRSM) platform (www.prsm.uk/prsm.html). The demonstration introduced the application's basic functions, namely adding factors (nodes), linking relationships, and colour-coding connections. The demonstration also involved an example system map that illustrated how food systems include the connected processes of ***production*** → ***processing*** → ***distribution*** → ***access*** → ***waste***.

Following the demonstration, the facilitators guided the group through a participatory modelling activity in which participants collectively developed a system map focused on issues and concerns that stem from and affect local agri-food systems. Each participant contributed new elements by drawing from their own experiences and/or disciplinary perspectives to identify social, policy, and environmental factors that influence food-system relationships. The facilitators encouraged real-time dialogue and reflection during this exercise in order to enhance participant understanding of how multiple factors interact within a complex system.

Upon completion of the PRSM activity, participants engaged in group discussions on the system mapping process and its outcomes. Participants discussed the usefulness of the PRSM activity and its role in supporting systems thinking in food system planning. The discussion was guided by the following questions:

- What insights did this activity provide about local food and/or urban agriculture planning?
- What activities did you find most useful for learning about food systems?
- What activities did you find not useful and/or would change?

Figure 1. System map developed through the PRSM-based participatory modelling activity



2.1.2 LOOPY Demonstration and Simulation Exercise

In the second part of the workshop, participants were introduced to LOOPY (www.ncase.me/loopy), a systems simulation platform for visualizing system relationships and dynamics. The activity began with a brief introduction on the purpose of LOOPY and how it complements the participatory modelling done with PRSM. The main features of the tool were also presented, including how to create variables, draw system relationships, and visualize the effects of changes through dynamic simulation.

Following the introduction to LOOPY, the facilitators provided a demonstration of the application to illustrate how to build a simple system model based on some of the food system factors identified in the participatory modelling exercise. The demonstration showed how positive and negative interactions operate within a system, for example, how increased food production can improve access while also generating more waste.

After the demonstration, participants engaged in an exercise where they built their own LOOPY models. While developing their food system models, the participants also asked questions about the software and food systems and shared observations about their model simulations verbally and using Zoom's chat function.

The facilitators further developed the demonstration system model while participants engaged in the LOOPY exercise, and they shared their screen so that participants could view the model development process. This allowed participants to observe the facilitator's live example while experimenting with their own model building and simulations. Throughout the activity, facilitators provided continuous guidance and responded to participants' technical and conceptual questions, supporting them as they explored system feedback and experimented with different variables. The exercise encouraged hands-on engagement and real-time reflection on how food system components influence one another within dynamic feedback structures.

Following the LOOPY exercise, a final group discussion was held, in which participants compared their experiences with PRSM and LOOPY. In this discussion, participants reflected on which aspects of each tool were most useful, the challenges they encountered during the exercises, and how these tools enhanced their understanding of food system complexity. The discussion was guided by similar questions as used for the PRSM group discussion, with an additional question of:

- How effective are PRSM and LOOPY for facilitating learning about local food systems?

2.2 Workshop 2 - Food System Scenarios & Spatial Mapping

2.2.1 Visualization: Agri-Tech Park Scenarios

The second workshop took place online via Zoom on October 10, 2025, and was attended by 7 participants. The workshop explored how 3D visualizations and spatial tools can support decision-making in food system planning and policy development, as well as education in food system planning and policymaking. Table 2 provides details on the workshop.

Table 2. Workshop 2 overview and data collection process

Workshop Details	Description
Date	October 10, 2025
Title	Exploring Scenarios and Spatial Mapping for Food System Futures
Duration	2 hours
Participants	7
Facilitators	Robert Newell, Bahar Nikpey
Data Collection Methods	Participant observations, group discussions
Main Activities	3D Visualization (Agri-Tech Park Scenarios); Spatial Data Maps (using Agrilyze)
Group Discussion Focus	Insights from exploring the visualization tool, the value of spatial data for food system planning, and the usefulness of 3D visualizations and interactive maps as tools for food system planning education

The session opened with a presentation on the purpose and communicative value of visualizations as tools for planning and sustainability analyses. The presentation illustrated how visualization tools can be used to engage diverse audiences and reveal trade-offs, co-benefits, and vulnerabilities in local food system planning. Following the presentation, a demonstration was given on the Langford Heights Agri-Tech Park visualization tool (www.triaslab.ca/agrigenomics#visualization), which consists of an interactive virtual environment that users can explore from a first-person perspective to examine different urban agriculture development scenarios. The visualization centred on a business park development site in Langford, BC, and illustrates three development scenarios:

- **Scenario 1** consists of indoor industrial food production facilities, such as a vertical farm system, mushroom farm, and cellular fish farm.
- **Scenario 2** includes Scenario 1 elements, with the addition of a farm gate stand where visitors can sample and purchase products and public amenities and interact with educational interpretive signage about the agri-tech facilities and their production processes.
- **Scenario 3** includes Scenario 1& 2 elements, with the addition of soil-based urban farms and garden plots and an apiary for food production, engagement, and education opportunities.

Using the visualization tool, participants were guided through each scenario. During the demonstration, the group considered how spatial development patterns, design, and infrastructure influence social equity, environmental performance, and economic opportunity. Participants were also invited to explore the interactive tool on their own devices and observe how different land-use configurations yield different spatial and sustainability outcomes. Throughout the activity, participants were asked to reflect on the following questions:

- What did you like or dislike about the scenarios?
- What planning problems do these configurations address?
- What community benefits or trade-offs can you identify?

After the visualization activity, participants engaged in a group discussion. Participants were encouraged to share feedback on the usefulness of the visualization activity as an educational and analytical tool. The following questions guided the discussion:

- In what ways did the visualization activity help you understand local food system planning?
- What did you find useful or engaging about the visualization activity?
- What aspects did you find challenging or less useful?
- How could the visualization experience and its application in teaching and planning be improved?

2.2.2 Spatial Data and Local Food-System Mapping

Following the visualization activity, participants were introduced to the use of spatial data for analyzing local food systems and supporting evidence-based decision-making. Using the Agrilyze map-based spatial data platform (www.agrilyze.ca), the facilitators demonstrated how to visualize and examine different spatial layers to gain insights into local food systems issues and priorities. Such layers included data related to population distribution, food inaccessibility, land use, and food infrastructure. Participants explored how these data may illustrate the distribution of food system assets across communities and how spatial data can support the identification of planning gaps and opportunities.

Participants were invited to explore the Agrilyze platform independently on their own devices by selecting and focusing on regions or communities of their interest. As they interacted with the data related to their region/community, the participants analyzed how the location of infrastructure, zoning constraints, and demographic indicators influence the sustainability and equity of local food systems. Participants reflected on several key planning questions while exploring the data:

- How did you decide where to locate your proposed development or intervention?
- What potential social, environmental, and economic outcomes could result from your scenario?
- What additional data are needed to fully understand local planning opportunities and challenges?

Participants compared insights from the 3D visualization and spatial data exercises. They considered how qualitative scenario insights gained from the visualization tool compared to and complemented spatial insights from Agrilyze thus informing comprehensive planning approaches.

The workshop concluded with a group discussion on the key learning outcomes from both the visualization and spatial data exercises. Participants reflected on the insights gained from the exercises and tools and considered the broader relevance of these insights to food system education, planning, and policy development. The discussion was guided by the questions:

- How did the exercises together help you understand food system planning and decision-making?
- Which part of today’s session was most useful for your learning, and why?
- Which part did you find most challenging or less useful, and why?
- What is one key takeaway from this workshop?

During the discussion, participants were encouraged to summarize the main lessons drawn from both exercises and to think critically about the use of complementary applications (i.e., 3D visualization and spatial maps) in food system planning research and education. The discussion concluded the workshop, and it explored how combining visualization and spatial data tools can strengthen systems thinking, support informed decision-making, and advance sustainable food system planning practices.

2.3 Data Analysis

The analysis drew on multiple sources of data, including group discussion transcripts and Zoom chat comments. These data were organized using a framework consisting of the categories: (1) knowledge and content, (2) planning tools and skills, and (3) values. The categories were derived from research on food systems education and pedagogy (Dring, 2023; Hammer, 2004; Greenstein et al., 2015).

Following the data categorization, inductive thematic analysis was conducted. This analytical technique is used to identify themes, ideas, and patterns that emerge from qualitative data (Braun & Clarke, 2006). The analysis began with an initial round of open coding to identify salient concepts and recurring ideas. Axial coding phase was then done to group conceptually related codes into broader thematic categories (Williams & Moser, 2019). The coding was guided by three questions:

- What factors motivated participants to attend the workshops?
- Which educational themes or topics did participants emphasize?
- What teaching methods and learning formats were identified as most relevant to this field?

The interpretation of the results is guided by the Transformative Sustainability Learning framework. The framework consists of three categories: (1) head, (2) hands, and (3) heart. When applied to the findings of this study, the framework enables an examination of how the educational activities conducted in the workshops enhanced or hindered cognitive understanding of food systems challenges and topics (i.e., head), practical planning skills (i.e., hands), and values/principles, emotional and ethical engagement with food system issues (i.e., heart) (Sipos et al., 2008; Valley et al, 2017).

3. Results

The thematic analysis of workshop transcripts and participant input was organized according to the categories of: (1) knowledge and content, (2) planning tools and skills, and (3) values. A total of nine themes were identified across these three overarching categories. Table 3 summarizes these themes and their associated codes. A detailed description of each theme follows below.

Table 3. Emergent themes and associated codes from workshop data.

Category	Themes	Codes	Total codes (n)
Knowledge and Content	**Systems Thinking Development**	Circular Systems, Defining System Boundaries, Visualizing Complexity, Variable Definition and Precision	n=10
	Spatial and Planning Literacy	Infrastructure Dependencies, Data Validation, Zoning and Land Use Constraints	
	Developing Critical Modeling Competence	Urban Agriculture Scalability, Model "Tidiness" vs. Reality, Unpacking Assumptions	
Planning Tools and Skills	**Tool Functionality and Usability**	Ease of Use, Interface Challenges, Device Compatibility, Gaming Literacy and Generational Divides, Maintenance Burden	n=13
	Pedagogical Sequencing and Scaffolding	Activity Sequencing, Macro-to-Micro Sequencing, Pre-structuring Activities, Contextualizing Before Creating	
	Co-production of Knowledge and Sensemaking	Crowdsourcing Knowledge, Need for Individual Learning, Optimal Group Size for Engagement	

Table 3. Emergent themes and associated codes from workshop data (continued)

Category	Themes	Codes	Total codes (n)
Values	**Indigenous Food Sovereignty**	Cultural Food Systems as "Invisible", Recognitional Justice	n= 6
	Cultural Food Assets	Diverse Food Retail, Rural vs. Urban Assumptions	
	Livability and Community Health	Mixed-Use Tensions, Biosecurity and Public Health	

3.1 Knowledge and Content

3.1.1 Systems Thinking Development

Participants demonstrated significant engagement with systems thinking concepts throughout both workshops. The analysis revealed that participants engaged with fundamental systems thinking competencies, including circular systems, defining system boundaries, visualizing complexity, and defining variables.

Circular systems

Participants actively sought to create feedback loops representing circular food systems. The following comments demonstrate participants' interest in closed-loop thinking, which is a foundational concept in sustainable food systems.

"For me right away I wanted to go from waste to production. I wanted to tie it in for a circular system" (about PRSM, Participant 5, Workshop 1).

"It's from waste to production, but I'll try again... Yeah, it's not just compost, like you can take waste even like human waste... 'Cause your waste can help actually make your production better" (about PRSM, Participants 4 & 5, Workshop 1).

Defining system boundaries
A recurring challenge involved establishing appropriate system boundaries and scales of analysis. This comment below highlights the cognitive complexity of systems thinking and the need for explicit boundary setting before conducting system mapping exercises.

"Creating a context like what problem are we trying to solve? Are we trying to increase our urban food system, or build resilience into our broader food system? What's our scale? What's our range?" (about PRSM, Participant 8, Workshop 1).

Visualizing complexity
The LOOPY tool was noted by participants to be particularly useful for considering and understanding system complexity. The participant quote below captures both the cognitive challenge and the pedagogical value of direct engagement with complexity.

"The more I think about the relationships between the elements, it just gets bigger and bigger... having some contextual setting, I picked policy as my main focus point and then thinking about the interactions at the different scales of governance just adds a whole different element of craziness to it" (about LOOPY, Participant 10, Workshop 1).

Variable definition and precision
Participants discovered that precise variable definition was critical for accurate system modelling. The following comment demonstrates an awareness of how language shapes system representation.

"Word choice was really important with this. Like, the word 'scarcity' as opposed to 'availability' basically determines whether something is positive or negative... You kind of have to figure that part out even as you're building this" (about LOOPY, Participant 5, Workshop 1).

3.1.2 Spatial and Planning Literacy

The 3D visualization and Agrilyze developed participants' capacity to think spatially about food systems infrastructure, access, and equity. The analysis revealed how the tools stimulate thinking specifically about infrastructure dependencies, data validation, and zoning and land use constraints.

Infrastructure dependencies
Participants demonstrated the ability to engage in complex analysis of how food system assets depend on broader urban infrastructure. Multiple participants raised critical questions about transit connectivity, parking, utilities, and service quality.

"I am also a bit curious about bus routes. Just because there's a stop doesn't mean central Vancouver is connected to Aldergrove...simple stop doesn't tell you much about the transit service quality" (about Agrilyze, Participant 4, Workshop 2)

Data validation

Participants used map-based representations of data and their local knowledge in a complementary manner to consider food system issues. Participant observations demonstrated an ability to critically interpret data and integrate information.

"How did [the data source] determine high, low or medium food inaccessibility? Because it seems not in line with my own knowledge of some of these areas" (about Agrilyze, Participant 5, Workshop 2).

"I was noticing there's a spot that actually didn't have a lot of people, and it looks just like a park, and then it says it's high food inaccessibility... if no one lives around there then there's no need for the food" (about Agrilyze, Participant 5, Workshop 2).

Zoning and land-use constraints

Participants demonstrated understanding of regulatory frameworks that shape food system development. The spatial data exercise illustrated how map-based data exploration can be used to stimulate an integration of legal and regulatory knowledge with spatial planning considerations.

"I've been looking at Pitt Meadows... The only thing I'm having trouble with there is that there's a lot of ALR [Agricultural Land Reserve] land in that area. Finding the right spot to have an industrial or commercial zoned facility that's not encroaching on ALR land... But it doesn't seem like they've got that much infrastructure for food. Adding something to that community could be helpful. Factoring in can people walk or bike, or is it still car-centric?" (about Agrilyze, Participant 5, Workshop 2).

3.1.3 Developing Critical Modelling Competence

Beyond technical application, a central skill developed was critical modelling competence. Such competencies involve the ability to both build complex system maps and rigorously assess their validity. Participants demonstrated the capacity to identify the structural limitations and reductive assumptions inherent in digital simulations. Participants discussed the scalability of urban agriculture, the appearance and representativeness of a system model, and assumptions about food systems.

Urban agriculture scalability

Some participants questioned the scalability assumptions underlying urban agriculture, as presented in the workshop system maps. The participant comment below reveals how system models can be critiqued on the basis of complex understandings of the relationships between local food production and regional food security.

"Scalability of urban agriculture does not meet the needs of our food requirements... We can't grow enough food in cities to feed all the people... Transportation specifically is a resiliency planning piece. I think that it really gets missed entirely here" (about PRSM, Participant 8, Workshop 1).

Model "tidiness" versus reality

Participants recognized the tension between simplified models and complex reality. The participant comment below demonstrates advanced critical thinking via an awareness of the model's limitations.

"I would be very cautious to think that we've summed it all up... And to me, this system seems very tidy that we've set up...I'm struggling to see the utility of this in the context of a much, much, much more complicated system than this could possibly capture" (about PRSM, Participant 8, Workshop 1).

Unpacking assumptions

LOOPY's dynamic simulation features helped participants identify hidden assumptions in their mental models of food systems. The visual feedback mechanism prompted participants to revise their initial assumptions about system relationships.

"Yeah, I mean once you see the arrows going, you're like, Oh, but that actually does affect that, so I need a line [i.e., system connection] here." (about LOOPY, Participant 5, Workshop 1).

3.2 Spatial and Planning Literacy

3.2.1 Tool Functionality and Usability

The analysis revealed strengths and limitations associated with the digital tools, offering critical insights for pedagogical design. Participants commented on the user-friendliness of the tools, technical challenges related to the interfaces, device compatibility, technical literacy, and maintenance.

Ease of use

The LOOPY tool received praise for its intuitive interface. The comment below suggests that user-friendly interfaces can reduce cognitive load and allow learners to focus on conceptual understanding rather than technical operation.

"I found the tool really easy to use to change and edit things... So, the complexity just started building up in it for sure" (about LOOPY, Participant 6, Workshop 1).

Interface challenges

Multiple participants experienced technical difficulties that disrupted learning. Participant comments indicated that these technical barriers prevented effective exploration of the data and information, highlighting the critical importance of robust user testing and on-demand technical support.

"The [visualization] navigation doesn't work well...I got into the salmon farm, I got out, and then when I went into the vertical garden, I couldn't get in, and then a thing popped up... and they won't let me close it" (about 3D Visualization Tool, Participant 6, Workshop 2).

"I've opened up a slider, but it's not changing anything as I slide it across the map" (about Agrilyze, Participant 6, Workshop 2).

Device compatibility
A participant attempted to use the tools on mobile devices with limited success. This finding suggests the need for responsive design or clear device requirements prior to conducting education activities.

"I just think that...you can tell everyone that just having a mouse and being on a computer, because if you are on a mouse pad or on a phone, it can be very, very difficult. I actually tried to start on my phone, but it was impossible" (about 3D Visualization Tool, Participant 7, Workshop 2).

Gaming literacy and generational divides
Participants noted that familiarity with video game interfaces affected tool usability. This observation has implications for inclusive design and instructional scaffolding.

"Navigating these things might be second nature to kids who grew up with video games...how intuitive it is for me versus someone who's younger, right? (about 3D Visualization Tool, Participant 6, Workshop 2).

Maintenance burden
Participants with experience in spatial data management raised concerns about the labour required to maintain accurate and up-to-date food data maps. The below comment highlights the practical challenges of keeping digital planning tools up to date.

"We get into asset mapping...It actually becomes really complicated to keep it updated...farm stands or you know, there's like an endless list of things...It needs to be updated regularly...I've created asset maps that take me sometimes months to stay on top of" (about Agrilyze, Participant 4, Workshop 2).

3.2.2 Pedagogical Sequencing and Scaffolding

Participants offered valuable insights into the sequencing of learning activities and needs for instructional scaffolding. Participants discussed the sequence and structure of activities, as well as the development and provision of context for the activities.

Activity sequencing
One participant proposed using LOOPY before PRSM to build foundational understanding. This comment suggests that progression from simpler to more complex system tools is useful for supporting effective learning.

"This one [i.e., LOOPY] might be a good exercise before the PRSM version...Starting with this LOOPY might help them understand that positive and negative [systems relationships]" (about LOOPY and PRSM, Participant 5, Workshop 1).

Macro-to-micro sequencing
For the visualization and spatial tools, one participant suggested reversing the order of the sequence to go from larger to smaller scales. This recommendation indicates that food system education activities are best conducted by starting with broad spatial contexts before narrowing to specific sites.

"I'd almost reversed the order. Like, I found this Agrilyze tool to be more helpful for visualizing communities, and then going into the visualization of a particular facility... I think it would give a little bit more context" (about Agrilyze and 3D Visualization Tool, Participant 2, Workshop 2).

Contextualizing before creating
Participants emphasized the importance of establishing context before engaging in system mapping exercises. This finding aligns with constructivist learning principles that emphasize developing learning activities that build on prior knowledge and real-world occurrences and experiences.

"Contextualizing the different categories, I think it's a lot easier to go into it than trying to start from scratch." (about PRSM, Participant 10, Workshop 1).

3.2.3 Co-production of Knowledge and Sensemaking

The participatory modelling exercise revealed that knowledge production was not solely an individual act but a social one. Participants engaged in collective sense-making, leveraging group intelligence to fill knowledge gaps and to construct robust system models. The analysis reveals that successful co-production also relies on a dynamic balance between individual and group work and appropriate structural conditions, such as the group size.

Crowdsourcing knowledge
Participants explicitly stated that collaboration expanded their systems thinking beyond their individual capacities. The co-production process allowed the group to "crowdsource" a level of complexity and breadth that no single participant could have achieved alone.

"A lot of this stuff I wouldn't have thought of... people were adding things where my brain didn't go" (about PRSM, Participant 6, Workshop 1).

Need for individual learning
A tension emerged between the value of collective breadth of knowledge and the need for individual focus. Effective co-production required moments of individual exploration of specific sub-systems.

"Working more by myself versus in the group, I was able to look more at the distribution aspect of it and kind of explore that. But I think the tool led itself for me to focus on an area that I was interested in..." (about LOOPY, Participant 6, Workshop 1).

Optimal group size for engagement

The analysis indicates that the motivation to co-produce knowledge is heavily influenced by group size. Participants identified that large groups (i.e., over 20 participants) hindered the collaborative dynamic, and it caused technical issues (i.e., lags and delays) with the PRSM platform. The findings indicate that group work is most effective when group sizes permit meaningful interaction.

"Ideal circumstance [are] where you have about six people to a group, instead of twenty…" (about PRSM, Participant 7, Workshop 1).

3.3 Values: Equity, Culture, and Inclusion

3.3.1 Indigenous Food Sovereignty

A noteworthy finding is that conventional food system models often exclude Indigenous perspectives and food sources. Participants discussed the importance of representing cultural food systems and ecological memory in food system activities.

Indigenous Foodways as "Invisible"

A First Nations participant provided an important critique of standard food access metrics that reveals how spatial maps (which appear comprehensive from a Western perspective) may underrepresent the realities of different cultural food systems and ways of knowing. Areas can be seen as "food deserts" from an Indigenous perspective, even if they are not categorized as such from a Western perspective.

"I think one challenge for me, and it kind of goes back to food security and food sovereignty for First Nations people, the idea that those natural sources of food might not be even considered, right? Because I think about what I want to eat as a First Nations person, and I would consider the whole area a desert, right? Because where are those natural food sources? Food sovereignty is gaining momentum within First Nations. And so that understanding that cultural land use and you know how we're accessing food sources is really important to us because those food sources are cultural and a lot of our spirituality is based around being able to access that food and being able to eat that food, right? Because it's part of the practices we do" (about Agrilyze, Participant 6, Workshop 2).

Recognitional Justice

A participant highlighted the absence of Traditional Ecological Knowledge in urban planning and development processes. Such comments emphasize a need for planning tools that incorporate ecological histories and Indigenous knowledges.

"Also documenting changes right…None of its documented, and none of its like look at what it used to be…nobody's documenting those areas like the salt licks that the animals go to right…Somebody in Stony Plain built their house where the garter snakes used to go and nest…are we interrupting that?" (about 3D Visualization Tool, Participant 6, Workshop 2).

3.3.2 Cultural Food Assets

Participants recognized that standardized food access metrics often fail to capture cultural diversity associated with food needs and food security. Participants made comments about diverse food retail and about assumptions about rural versus urban contexts.

Diverse Food Retail

Participant comments highlighted how aggregated grocery store data masks important variation in culturally appropriate food access and dietary needs.

"I noticed that the second map focused on major grocery stores, but some individuals might be shopping at specific food providers, such as those that offer halal products or even individuals who focus on organics only" (about Agrilyze, Participant 1, Workshop 2).

Rural versus urban assumptions

Participants questioned whether urban-centric food access metrics apply in rural contexts. The participant comment below reveals how planning tools may embed urban assumptions that do not translate to rural or peri-urban contexts.

"I assume most people drive...do people get some of their produce at farm stands? Do most people have farmland that they grow crops on to consume?" (about Agrilyze, Participant 2, Workshop 2).

3.3.3 Livability and Community Health

Participants raised concerns about the social and environmental impacts of different food system development scenarios, with comments relating to mixed-use developments and public health.

Mixed-Use Tensions

One participant questioned whether industrial agriculture belongs in residential areas, reflecting awareness of socio-environmental health and well-being concerns stemming from poor urban design.

"There are houses right across the street...thinking about industrial eras in general, do we want them to be mixed uses? Right? Like that's something to think about...high traffic trucks, smell, noise" (about 3D Visualization Tool, Participant 6, Workshop 2).

Biosecurity and Public Health

Participants raised practical concerns about urban agriculture in public spaces that demonstrate how using digital tools in food system education can reveal important public health.

"Some small farms that I saw on the sidewalks...have you considered [disease] control, or animal control?" (about 3D Visualization Tool, Participant 7, Workshop 2).

4. Discussion and Conclusions

The results of this study are interpreted using the Transformative Sustainability Learning framework to examine how the workshops combined cognitive understanding (i.e., head), practical skills (i.e., hands), and emotional-ethical engagement (i.e., heart) (Valley et al., 2017). This framework provides a useful lens for understanding the strengths and weaknesses of the activities and tools used to support food system planning education.

5.1 Head: Cognitive Engagement and Systems Literacy

The systems tools appeared to successfully help participants move from linear to circular thinking. Participants actively redesigned systems to reconnect waste to production, achieving a key goal of ecological literacy. The participants also engaged in deep reflection on system boundaries and the challenge of defining where a complex system starts and ends. The findings of this study indicate that it is important to introduce concepts and tools for complex systems gradually.

The workshop activities enhanced learners' critical data literacy, which is needed for evidence-based planning. By comparing spatial map data with their own local knowledge (e.g., recognizing that having a transit stop nearby does not guarantee food access), participants revealed the limitations of relying solely on quantitative and/or spatial data, while also demonstrating the value of leveraging multiple information sources in complementary ways. Through the educational activities, participants demonstrated critical reflection skills by examining the limitations of the models, questioning assumptions about the scalability of urban agriculture and using simulations to identify hidden biases.

5.2 Hands: Practical Skill Development

The results of this study highlighted the critical role of effective interface design. While user-friendly tools like LOOPY reduced cognitive load, the technical demands of PRSM, Agrilyze, and the 3D visualization tool navigation (as well as mobile incompatibility) created accessibility barriers, underscoring the need for responsive design. Additionally, a "gaming literacy" divide within the participant group indicates that navigation controls familiar to younger learners may pose challenges for other learners if clear, detailed tutorials on these controls are not provided (or if alternative pedagogical activities are not offered).

Participants recognized the value of collaborative group work; however, collaboration in the participatory modelling activity was weakened by due to a group size of over 20 people, as such a group size affected PRSM performance. Such a finding indicates that software choice can (in part) determine the optimal group size. Additionally, participants discussed practical limitations related to running activities with current data and information. A participant commented on the effort required to maintaining and updating spatial datasets, noting this to be a significant obstacle to long-term use.

5.3 Heart: Affective and Ethical Engagement

The "heart" dimension was apparent in participants' enthusiasm for learning together. Participant indicated valuing human collaboration more than automated digital learning platforms, and their engagement in the workshop activities resembled a short-term community of practice. In addition, the place-based visualization tools facilitated their emotional engagement with the educational topics and materials, as evidenced by participant comments about ecological empathy and an ethical commitment to documenting "invisible" ecological histories.

The workshop participants engaged in and commented on considerations around food system ethics and social justice, particularly during discussions on Indigenous food sovereignty. One participant explained how standard (i.e., Western-science produced) maps portray her territory as a "food desert," which reveals the cultural blind spots of Western knowledge frameworks. Such comments stimulated thinking beyond abstract food system concepts to ideas on the challenges and needs for making progress toward equitable and just food systems.

5.4 Integration and Pedagogical Implications

The workshops successfully demonstrated educational activities and tools that can integrate the three domains of the Transformative Sustainability Learning framework. In addition, this study showed how hands-on tools can make abstract systems concrete and how collaborative learning can strengthen understanding of issues. The study also revealed challenges, such as how technical problems often interrupt the flow of thought and how a large volume of ideas generated through group work can affect individual skill development.

The findings from this work inform the following recommendations:

- **Scaffolding:** Learning should proceed from simple to complex tools and activities (e.g., LOOPY before PRSM) and macro- to micro-scales of analysis (e.g., Agrilyze before the 3D visualization tool).

- **Group design:** To prevent information overload in collaborative work, large groups should be divided into smaller units of three to six people or group activities should use asynchronous approaches.

- **Culturally responsive design:** Indigenous perspectives must be central in food system education, and future workshops on food system education programs should be co-designed with Indigenous educators to examine how planning tools may unintentionally reinforce colonial assumptions.

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