DESIGN OF PRODUCTIVE AND REGENERATIVE FOOD SYSTEMS THROUGH A LANDSCAPE ARCHITECTURE STUDIO FRAMEWORK

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ABSTRACT
Agriculture and food systems are foundational in delivering ecosystem goods and services. There are significant opportunities for landscape architects to engage in the planning and design of regenerative agricultural systems. Particularly when conducted at a land grant university, design studio courses can prepare future landscape architects to work collaboratively toward more resilient and equitable food systems under a changing climate. This paper presents a studio course pedagogy for designing agroforestry systems in a rural county by linking research to extension through student design proposals. A central goal of the course is to establish reciprocity in which new knowledge is generated collaboratively between students, landowners, extension, and agency-based landscape architects.

The course served as a platform for the landscape architecture program to connect university agricultural resilience initiatives such as the Nebraska Regional Food System Initiative and the Regional Food System Summit to landscape architects working in government agencies. For students, the course provided practice in designing regenerative food systems and an awareness of professional opportunities in the United States Department of Agriculture (USDA), such as the Forest Service's Resource Assistants Program. For landowners, the students' work illustrated opportunities to integrate agroforestry concepts into existing operations in new and novel ways. Participating landscape architects also gain new perspectives and insights by engaging with students and landowners. The course demonstrates how to provide students with skills and experience to pursue career opportunities in agencies while strengthening sustainable food system research and teaching initiatives through collaboration between the university and its partners.

Keywords
Agriculture landscapes, Agroforestry, Food systems, Conservation, Studio-based learning

1. INTRODUCTION

Land used for agricultural purposes—cropland, grassland pasture and range, grazed forestland, and land in farmsteads—is the largest use of land in the United States, encompassing 1.18 billion acres, or 52% of total U.S. land area (Bigelow & Borchers, 2017). Estimates available from 1960 through 1995 indicate that agriculture accounted for over 80% of the nation's consumptive use of water, with that figure as high as 90% in many western states (Wiebe & Gollehon, 2006). In 2020, 11% of U.S. greenhouse gas emissions came from the agricultural sector (EPA, 2020), and the delivery of many ecosystem services and biodiversity are intertwined with how we produce food. Similarly, food insecurity, access, and sovereignty are crucial environmental justice issues that need to be addressed. Ecologically, economically, culturally, and socially, agriculture and food production shapes the United States.

As climate change accelerates, it is crucial that we design regenerative food and agricultural systems. While there are numerous definitions of regenerative food and agricultural systems, central themes include creating resilient systems that are ecologically, socially, and economically equitable and sustainable (Newton et al., 2020). While agriculture remains a significant source of greenhouse gas emissions, it also offers one of the largest opportunities for reduction and sequestration if approached with a regenerative perspective.

As transdisciplinary practitioners, landscape architects can play a key role in leading this change (Nassauer, 2023); however, proper educational training will need to provide landscape architecture students with the understanding and skills to operate in this sphere. As stated by Nassauer (2023, pg. 8), *To affect the trajectory of our profession, we teachers of new generations of practitioners should engage our students in doing boundary work*. While previous landscape architectural studios have explored agricultural topics such as community food gardens and rooftop farms, there exists a need to foster students' ability to investigate and address the issue of regenerative food systems at a larger scale to affect change. Creating this kind of learning environment for students requires a pedagogical shift to one where input from multiple collaborators is incorporated as part of an interactive design process that allows iterative learning to flow between collaborators (Poole et al., 2002).

This paper describes the creation and delivery of a studio course that can serve as a crucial building block for students to learn about regenerative agriculture and develop their problem-solving approaches for this sector. An additional goal of the course was to establish reciprocity, in which new knowledge is generated collaboratively between students, landowners, extension, and agency-based landscape architects.

1.1 Design Pedagogy

The design studio process provides an opportunity for testing research through projective design proposals. The pedagogical course design for the studio applies the definition of a landscape as a *boundary object* as following that "a landscape, represented and experienced, can be iteratively shared and conceived by different disciplines and communities" (Nassauer, 2023, pg. 6). In keeping with this framework of representing and experiencing landscapes by different disciplines and communities, using a rural agricultural county for our studio site allowed students to understand the perspectives, goals, and interpretations of different types of collaborators around a shared geographical area. Despite different interpretations, the agricultural county remains a common, recognizable entity that facilitated dialogue. Particularly, geospatial mapping provided an important research method for synthesizing knowledge related to agriculture into maps across multiple scales that can be used across disciplines. The USDA National Agroforestry Center's research linking conservation planning methods to climate-smart landscapes serves as the foundational research method for the studio's geospatial analysis, resulting in a framework for projective design strategies in this collaborative studio structure (Bentrup, 2008).

2. RESEARCH OBJECTIVES

The primary goal of the design studio was to bring together students, landowners, extension, and agency-based landscape architects to design sustainable food systems. The course had three primary learning objectives:

1. Increase students' awareness of the importance of agriculture and food systems.
2. Identify the roles that landscape architects could play in the sector of agriculture and food systems.
3. Apply skills relevant to conservation planning and landscape architecture to professionally participate in creating regenerative agriculture systems.

3. METHOD: STUDIO COURSE STRUCTURE

The studio course is an advanced undergraduate landscape architecture design studio in which design is explored in relation to ecological and cultural landscape systems. The course occurs in the third year of the landscape architecture undergraduate curriculum and is taught over a fifteen-week semester. Student design projects emerge from research exploring ecological design and the management of landscape and cultural systems across scales. The course site is set within a rural county in Nebraska, and the student projects from the course apply landscape conservation strategies that investigate the possibility of linking climate-smart methods to rural food production through landscape architecture. In addition, the studio's collaborative framework allows student designers to collaborate directly with academic and government researchers to develop design proposals for agricultural food systems. Throughout the studio course, student designers apply validated geospatial research methods as part of their iterative design process, making it possible for their work to contribute to ongoing conservation conversations. Finally, beyond the geospatial research, the course framework creates relationships and iterative dialogue between diverse project stakeholders (e.g., students, academic and government researchers, and landowners), which are fundamental to enhancing experiential learning and gaining public input (Kolb & Kolb, 2017). See Table 1 for a full list of collaborators from three areas (Extension, Landowners, and Government Agency).

Table 1. Studio Collaborators

Partner	Affiliation	Area of Contribution
Extension	• Nebraska Regional Food Systems Initiative • Katie King, Nebraska Extension Regional Food Systems • Vanessa Wielenga, Extension Educator • Dr. Brad Lubben, Agriculture Economics	Regional food systems, agricultural markets, and policy and funding opportunities
Landowner	• Regenerate Nebraska • Graham Christensen, GC Resolve and RegeNErate Nebraska • Aaron LaPointe, Ho-Chunk Farms	Priorities for regenerative agricultural methods for landowners in the state
Government Agency	• USDA National Agroforestry Center • Gary Bentrup, Research Landscape Planner • Kate MacFarland, Agroforester • Todd Kellerman, GIS Specialist	Conservation planning and design methods for agroforestry

All students were presented with the studio research question: How can your proposal improve health, increase rural food access, and protect soil through the design of agroforestry systems? To address the studio research question, students were aided by collaborators with expertise in relevant areas that included farming and policy. The primary goal of these collaborations was to broaden the studio dialogue, aiding in the development of students' design proposals. The studio collaboratively assessed opportunities for agroforestry to contribute to Nebraska's regional food system through emerging markets, conservation policies, and funding sources. Throughout the studio, landowner perspectives were central to identifying need and framing project priorities. In addition, students collaborated with landscape research planners at the USDA National Agroforestry Center to define landscape-scale proposals integrating contemporary agroforestry geospatial research methods into working landscape design strategies. Over the course of the semester, students presented their design proposals at multiple stages of development to our studio partners, who contributed their time and expertise to the studio learning environment. The type of feedback given to students through these collaborations is shown in Table 2.

Table 2. Collaborative Feedback

Assignment	Collaboration	Presentation Audience	Feedback
Regional Food Systems Mapping	Studio attended 2021 Nebraska Food Systems Summit: Food System Sustainability. Students worked with Extension team to define Regional Food Systems criteria for mapping assignment.	Students presented State and County scale GIS mapping to all collaborators for discussion and feedback.	Landowners identified three priority areas for agroforestry. Extension team identified potential markets for agroforestry products.
Landscape Assessment	USDA taught students geospatial mapping methods. USDA aided in the identification of key geospatial resource and provided feedback on environmental analysis.	Students met weekly with members from the USDA to present and refine the landscape assessment mapping process.	County scale geospatial maps were created and used to locate priority areas for agroforestry applications.
Planting Typologies	USDA shared agroforestry planting resources. Extension team identified local market opportunities for agroforestry products.	Students presented planting typologies to Extension team, landowners, and the USDA.	Planting strategies were identified for local food markets and/or environmental improvement. Agricultural policies were identified for further research related to conservation or local food production.
Field Guides	Students worked with an Agricultural Economist to understand opportunities and constraints of existing agricultural policies related to their proposals.	Students synthesized the entire semester process into a field guide for final presentation to all collaborators.	Opportunities for agroforestry were presented across multiple landscape scales (from county scale landscape analysis to species selection) and were analyzed within current agricultural policy frameworks.

4. RESULTS

The various studio projects synthesized research data and methods into their final design proposals by:

1. Contextualizing the need for sustainable food systems.
2. Addressing landowner input to identify agroforestry priorities.
3. Selecting suitable sites for conservation measures through landscape assessment methods.

4. Creating innovative planting strategies that could contribute to regional food markets.
5. Identifying policy and funding opportunities associated with their proposals.

To understand the importance of regional food systems across Nebraska, the studio participated in the University of Nebraska's 2021 *Food Summit: Building Resilience in the Nebraska Food System* and received project guidance during the semester from faculty in the Nebraska Regional Food Systems Extension Initiative. Working with UNL Extension faculty, students discussed parameters that make up a food desert and the interaction of these parameters. Students then moved from a theoretical concept to a data-driven understanding of not only what food deserts are, but where they exist in Nebraska. Students identified the paradox between agricultural production and food deserts; ironically, farming in many rural counties is critical to the local economy, but residents have limited access to healthy and affordable food (see Figure 1).

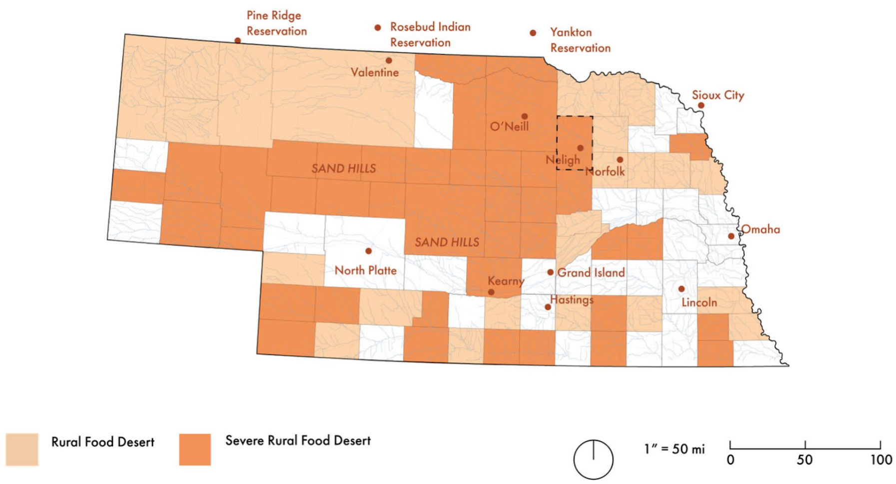

Figure 1. Rural Food Systems Mapping Exercise: Food Deserts.
Credit: Shelby Warrick
Utilizing Geographic Information Systems (GIS) offers a transformative educational experience by enabling the visualization and analysis of complex data sets. In this project, students engaged in a multifaceted exploration of state food deserts—areas with limited access to affordable and nutritious food. By overlaying variables such as income levels, the location of grocery stores, and public transportation routes onto a comprehensive map, students developed a nuanced understanding of the prevalence and distribution of food deserts. This hands-on approach not only dismantled their initial preconceptions about food deserts, but equipped them with advanced spatial analysis skills, resulting in a data-driven understanding of a complex social issue and fostering critical thinking and social awareness.

To incorporate a landowner's perspective on regenerative agricultural practices in Nebraska, the studio collaborated with local landowner and Regenerate Nebraska founder Graham Christensen. Regenerate Nebraska is a network of regenerative farms, ranchers, tribes, and urban farmers across the state who are committed to ethical food systems. Christensen introduced the studio to a series of agroforestry projects across the state, including Native agricultural practices of the Winnebago Tribe (Hochungura). As a landowner, Christensen identified three priority areas for rural agroforestry:

1. Micro-orchards.
2. Conservation buffers.
3. New Deal shelterbelt renovations.

Taking landowner priorities into consideration, students worked independently to develop their reflections and ideas for conservation buffers, shelterbelts, and micro-orchards. Working with the USDA, they created a county-scale GIS landscape assessment methodology identifying sites for design interventions and incorporating planting design research to create landscape typologies that could contribute to both conservation initiatives and food production (see Figure 2 and 3).

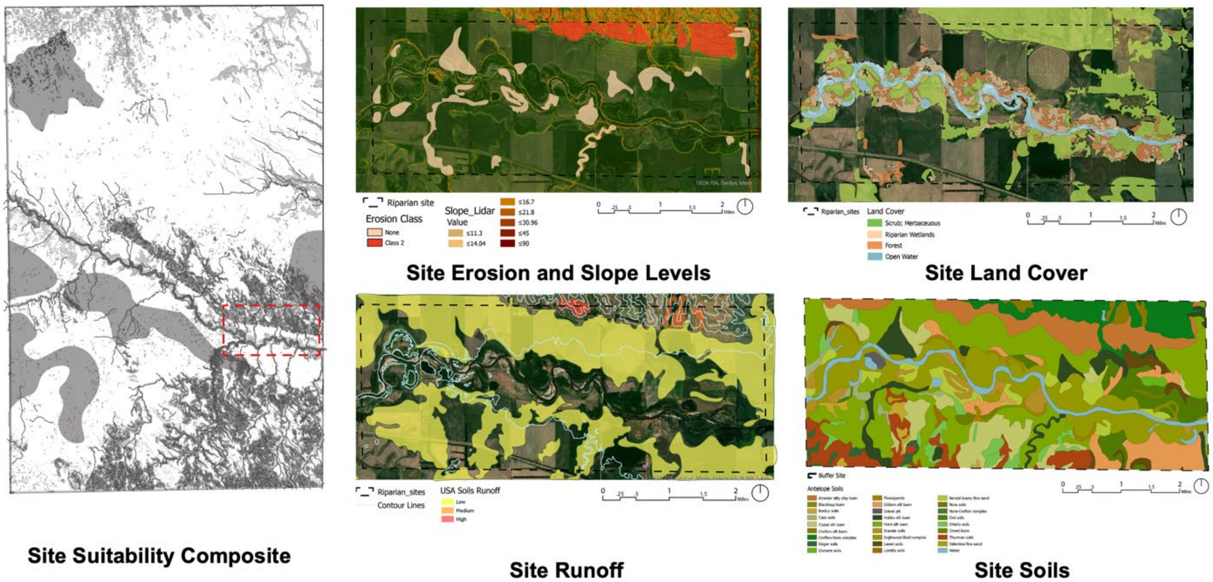

Figure 2. Geospatial Landscape Assessment: Conservation Buffers
Credit: Jessica Kleinschmit
Collaborating with the USDA, students applied a GIS-based landscape assessment methodology on a county scale aimed at pinpointing optimal sites for design interventions. This systematic approach combined various data layers (e.g., land use, soil erosion, land cover) to create a comprehensive spatial model. The result was a data-driven framework that not only identified potential locations for conservation buffers, but also provided valuable insights into the unique challenges and opportunities within each county. By integrating expert resources from the USDA with GIS technology, students were able to offer actionable insights for landowners.

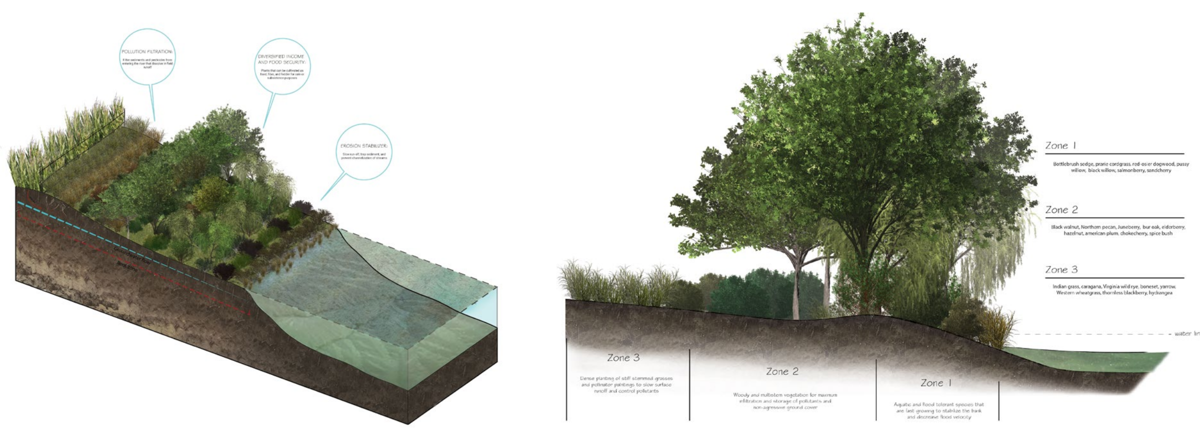

Figure 3. Agroforestry Planting Typology: Edible Conservation Buffer.
Credit: Jessica Kleinschmit
A student's concept for a conservation buffer established an innovative approach to land management and sustainable agriculture by synthesizing elements of agroforestry, which integrates trees and shrubs into crop and animal farming systems, with conservation buffers—strips of vegetation placed in the landscape to absorb or filter runoff and improve environmental quality. By adding a goal to diversify income for landowners, plants were also selected for their potential to be cultivated as food, fiber, and fodder.

4.1 Final Design Proposals

The goal for the final design proposal was to synthesize the key lessons learned during the studio process and translate the work in a format that could be disseminated to a local audience. The students chose to refine their semester's work into a series of three "field guides" designed for a rural audience. The main function of the guides was to help readers identify opportunities for agroforestry across multiple landscape scales ranging from county-scale landscape analysis to species selection. The field guides shown in Figures 4-7 below and the supporting text each illustrate a unique student proposal for the three priority areas for rural agroforestry: micro-orchards, conservation buffers, and shelterbelt renovations.

4.2 Micro-Orchards

The primary problems motivating Allison Sheen's project, *Resilient Orchards* are rural food insecurity, soil health, and the lack of diverse food producers in Nebraska. Environmentally, resilient orchards can help to sequester carbon and minimize inputs while creating environmentally friendly "green" jobs. Lastly, resilient orchards can provide access to farming for many people excluded from current agricultural practices: for example, minorities often excluded from access to agriculture can find viable pathways through resilient orchards that require less land. Additionally, food insecurity in rural settings, especially concerning affordable fresh produce, will be reduced as more resilient orchards are implemented and mature. The student field guide to resilient orchards shows how versatile and beneficial this form of agroforestry can be in the move toward a more sustainable and equitable food system, as Figure 4 demonstrates.

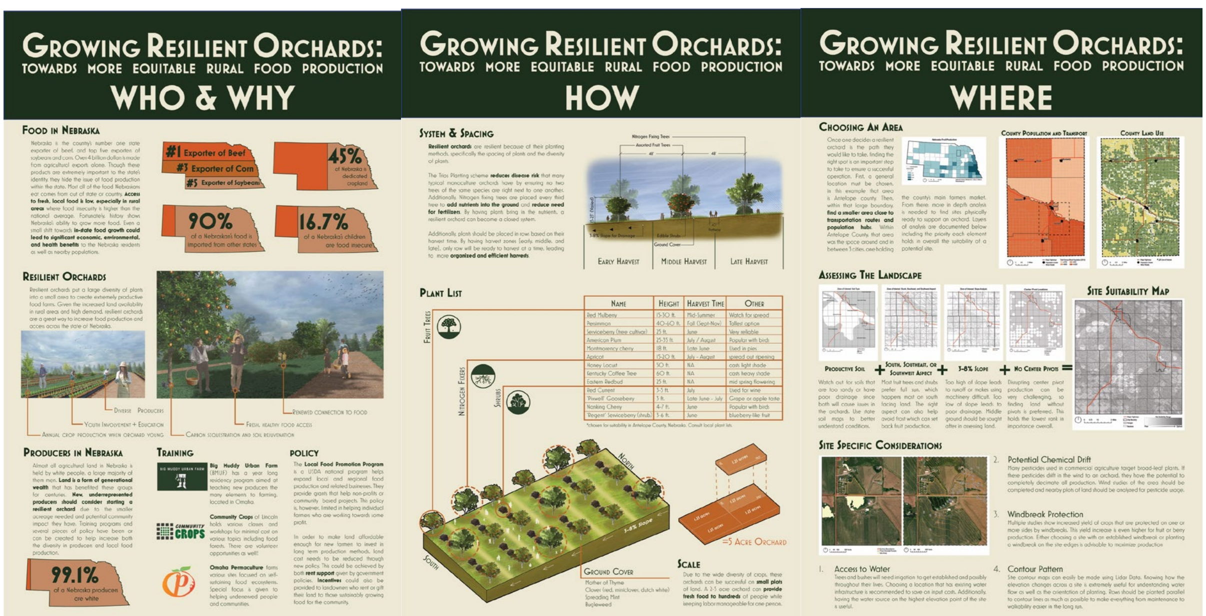

Figure 4. Field Guide: Resilient Orchards
Credit: Allison Sheen

The student field guides offer a comprehensive toolkit for landscape management, delivering practical insights that can be applied from overarching county planning down to the nuanced selection of individual species. Students applied landscape assessment methods and planting strategies relevant to their agroforestry strategy. For example, student Allison Sheen's Resilient Orchards *initiative serves as a compelling case study that tackles rural food insecurity, soil degradation, and monoculture in agriculture through the adoption of micro-orchards as a sustainable farming practice. Sheen discussed the benefits that micro-orchards and other such initiatives could have on rural communities, helping to alleviate food insecurity and even improve economic conditions through diversified farming.*

4.3 Conservation Buffers

Jessica Kleinschmit's studio project, *Edible Riparian Buffers*, applied riparian buffers as an agricultural conservation measure to address soil erosion and water quality. The field guide highlighted the benefits of edible riparian buffers for landowners and their surrounding communities. Riparian buffers can improve conservation practices by minimizing effects of water pollution, flooding, and soil erosion. This conservation practice can be a means for crop protection and for farmers to diversify their harvest products. By developing riparian buffers to allow for edible plants, farmers may be more willing to move some of their farmable lands into conservation programs. Planting design in riparian buffers can help achieve both overarching goals; for example, perennial vegetation in locations with annual plantings can sequester carbon through the soil and vegetation, improving soil nutrients and stability. Less erosion means more high-quality land for enhanced crop production, as well as cleaner water. Along with sequestering carbon, buffers can reduce pollution by filtering water runoff and slowing down soil erosion. Although the effects of one riparian buffer may seem minor compared to larger environmental goals, developing a buffer system in critical locations across the state could protect our natural resources while fighting climate change (see Figure 5).

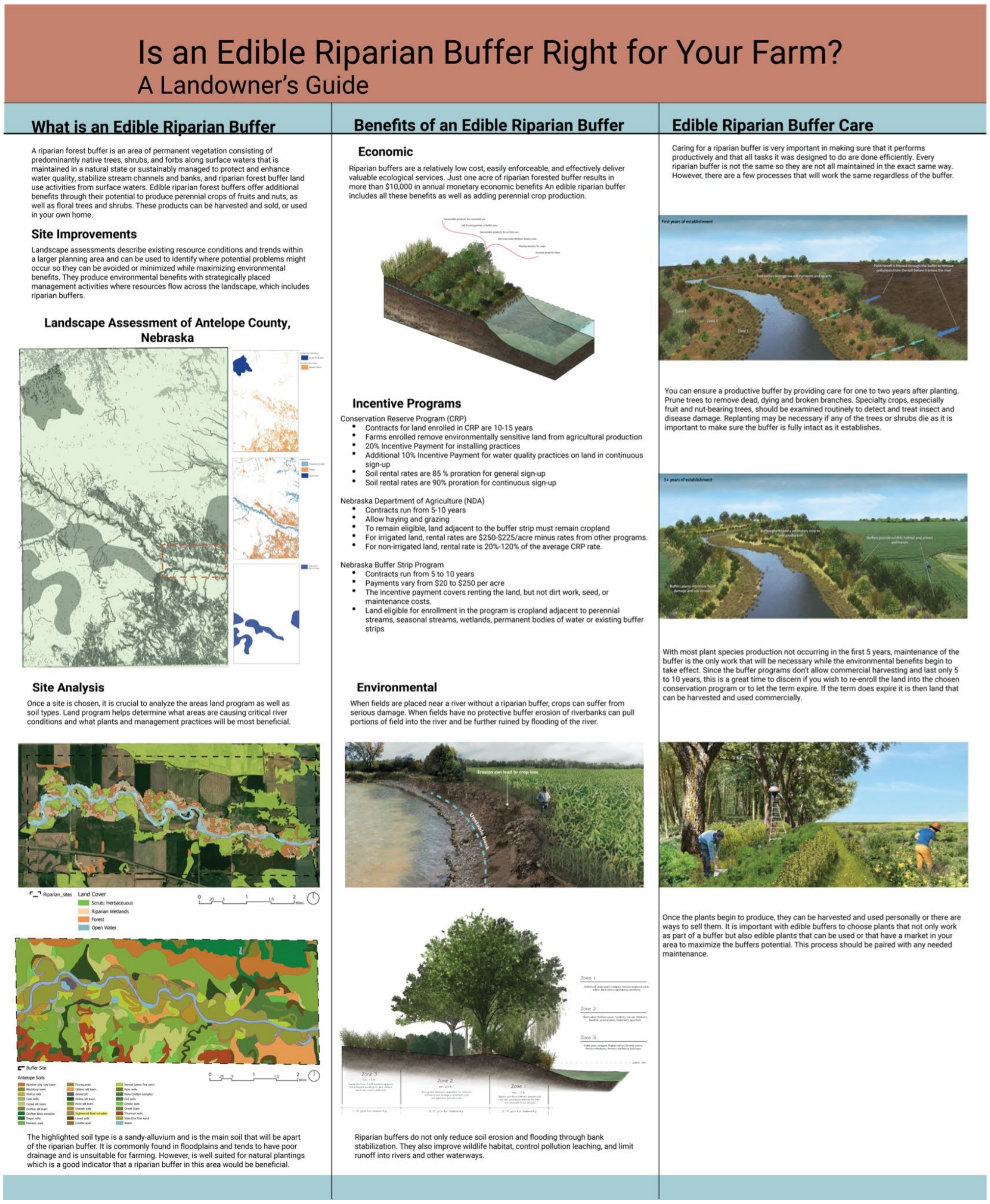

Figure 5. Field Guide: Edible Riparian Buffers
Credit: Jessica Kleinschmit
Student Jessica Kleinschmit's project, Edible Riparian Buffers*, enhances agricultural conservation by tackling soil erosion and water quality. The approach not only diversifies farm harvests, but also supports community and global environmental goals, including carbon sequestration and pollution reduction. By integrating aspects such as water quality, soil health, crop diversity, and climate data, Kleinschmit developed a holistic understanding of agricultural landscapes and their interactions with broader ecosystems.*

4.4 Shelterbelt Restoration

Shelby Warrick’s design project, *A Landowner’s Guide to Shelterbelt Restoration*, developed a field guide to aid landowners in the restoration of culturally significant shelterbelts in the state of Nebraska. These shelterbelts were originally planted in the 1930s as part of a New Deal soil conservation measure and are today considered relevant regenerative agricultural practices. Building upon the USDA National Agroforestry Center historical GIS datasets, a landscape assessment method was applied to identify the extent of this remaining New Deal cultural landscape at a county scale. The result of the assessment highlighted the locations of fully intact shelterbelt plantings, which indicated the need for a series of alternative management and planting schemes that would provide landowners with conservation and food production opportunities. In conjunction with landscape architects at the USDA National Agroforestry Center, a series of three planting schemes were developed, one emphasizing historic integrity, another focusing on edible shelterbelt plantings, and a third focusing on minimal maintenance and ecological benefits. However, one significant limitation with regard to shelterbelt restoration for landowners is the overall expense. While landowners may recognize the benefits of these plantings, the required investment is one of the largest hurdles for shelterbelt restoration. Funding opportunities were explored at both a national and a local level, with the Conservation Reserve Program, the Environmental Quality Incentives Program, and the Natural Resources Defense Council all revealed as options for policy and financial support at the national level. Locally, state funding, historic preservation efforts, and individual implementation all currently provide support for these conservation efforts. Shelterbelts continue to be a way that agriculture can contribute to climate-smart agricultural objectives as they preserve topsoil, rebuild organic matter, restore water, and air health, sequester carbon, and increase food access (see Figures 6-7).

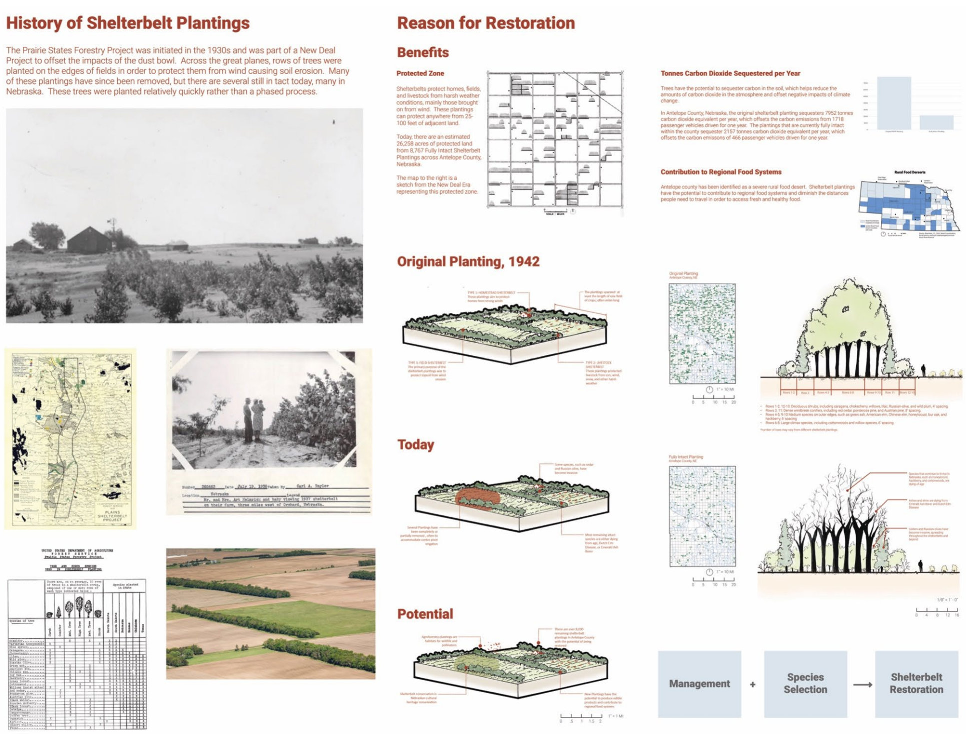

Figure 6. Field Guide: A Landowner’s Guide to Shelterbelt Restoration

Credit: Shelby Warrick

Student Shelby Warrick's project, A Landowner's Guide to Shelterbelt Restoration*, leverages historic GIS data to aid Nebraska landowners in reviving 1930s New Deal shelterbelts for modern regenerative agriculture. Offering three distinct planting schemes for historic preservation, food production, and ecological benefit, the guide also navigates funding hurdles, making a case for shelterbelts as a climate-smart agricultural solution.*

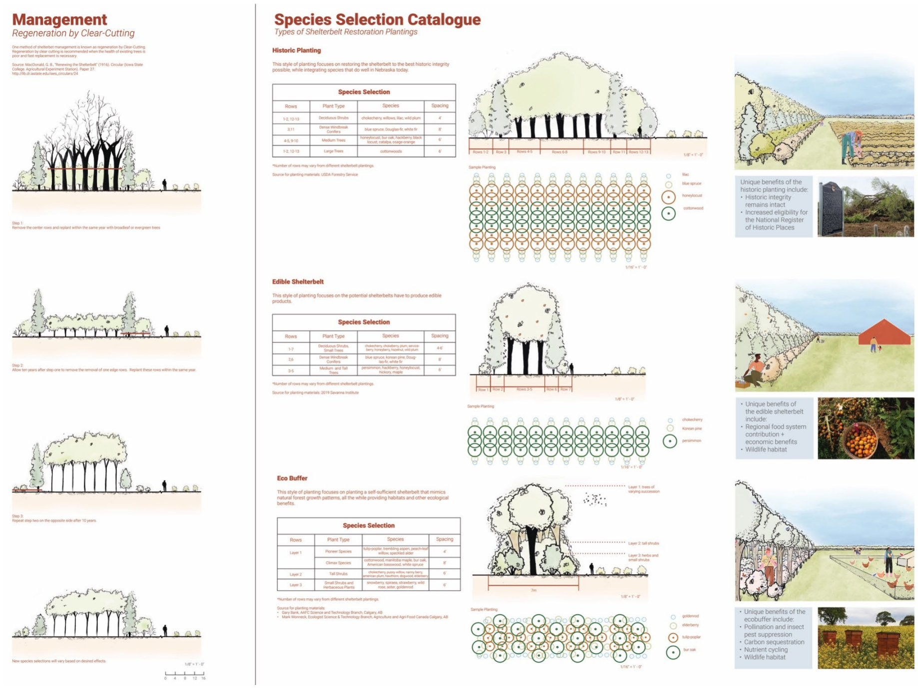

Figure 7. Field Guide: A Landowner's Guide to Shelterbelt Restoration.
Credit: Shelby Warrick

Through her project, Warrick gained a comprehensive, multi-faceted education, combining historical study, practical application, policy analysis, and community engagement. Her project reinforced the idea that agricultural practices can align with broader objectives for climate change mitigation, such as carbon sequestration and increased food access.

5. DISCUSSION

Landscape architects can contribute to the design of agricultural food systems by applying evidence-based conservation planning and design approaches learned through the interactive design studio environment. In this example, students learned and applied a landscape assessment method at a county scale that visually communicated the relationships between landscape structure, environmental problems, and agroforestry opportunities, an important professional skill that could be used for job opportunities in state and federal agencies, non-governmental organizations, and the private sector. The techniques and insights gained from the projects could likewise be scaled up to county-level planning or scaled down to individual farms or planting strategies. The student projects illustrated how addressing one issue such as soil health could have positive ripple effects on other issues such as food security and biodiversity.

Additionally, the course framework created relationships and iterative dialogue between diverse project stakeholders, which is fundamental to enhancing experiential learning and gaining public input. With its focus on rural communities, the studio course offers insights into how an undergraduate course can engage local stakeholders in sustainable practices, a component crucial for the long-term success of any landscape management initiative. For landowners, the students' work illustrated opportunities to integrate agroforestry concepts into existing operations in new and novel ways. One student project, *Edible Riparian Buffers*, was shared by one of the participating landowners with a local Natural Resource District as a novel approach for designing conservation buffers.

Further, the extension faculty who participated in the studio course also gained new perspectives and insights from engaging with both students and landowners. Whereas extension activities can often experience challenges for reaching landowner audiences and relaying new information (Genskow & Blasczyk, 2013), the studio environment provided a non-prescriptive opportunity for collaboration and disseminating information.

Finally, the studio environment provided a unique opportunity for the staff at the USDA National Agroforestry Center to engage with students and landowners, leading to innovative discussion and problem-solving. Fresh perspectives and reframing by students allowed new approaches and strategies to emerge, expanding the range of options that government staff had previously considered on their own. Communication methods with landowners were expanded, and the three field guides prepared by the students provided tangible ideas that could be incorporated into the center's science delivery activities.

5.1 Limitations

This studio course occurred during the COVID-19 pandemic, which necessitated a virtual learning environment. Despite several students having agricultural backgrounds, one limitation of the studio work was students' ability to visit our study area in person to conduct field research. Additionally, another limitation was the sole focus on a rural county. Future research could apply these same conservation planning methods to urban counties, and could highlight equally important opportunities for agroforestry methods and diverse stakeholder engagement in different areas. Finally, we did not incorporate landscape performance evaluation tools or criteria into the course, thus limiting the dialogue around the landscape performative aspects for the ecological and economic contributions of these tree-planting initiatives.

5.2 Suggested Areas for Future Research

The major objectives of this design studio experiment were to increase students' awareness of the importance of agriculture and food systems, identify the roles that landscape architects could play in this sector, and develop student skills to professionally participate in creating regenerative agriculture systems. To further this development, survey and focus group work with agencies, non-governmental organizations, firms, and other potential employers and clients could help refine the knowledge, skills, and attributes critical for engaging in the agriculture and food sector. Longitudinal research that follows students in their remaining educational programs and future careers could be useful to assess the efficacy of the design studio and supporting curriculum (Crowther & Briant, 2020). Regardless of whether students end up working in this sector, a richer understanding of agriculture and food systems can lead to more sustainable design work across all sectors.

Further, in addition to pedagogical research, there are also opportunities for students to investigate the optimization of ecosystem services through better planning and designing food and agriculture systems. Evaluating and communicating benefits and trade-offs of design decisions is a well-established skill of landscape architects, and comprehensive evidence-based evaluations and performance measures could contribute significantly in this sector.

6. CONCLUSION

A central component of climate-smart agriculture is sequestering carbon through regenerative food, farming, and land-use practices. Public investment is occurring both nationally and internationally, focused on agroforestry methods: for example, the USDA has recently made significant investments to advance climate-smart agriculture such as the Partnerships for Climate Smart Commodities, which is investing $3.1 billion in 141 selected projects. This increased awareness regarding climate and the resulting investments present a growing number of opportunities for landscape architecture to contribute to the design of improved agricultural systems. Landscape architecture can play an essential role in the design of rural agricultural systems through the implementation of landscape assessment methods and innovative planting strategies. Although our studio scope focused on cropland in a rural county, courses like this and others can prepare students to participate in the design of agroforestry systems on a range of rural and urban landscapes across the country as a step toward achieving carbon neutrality.

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