



# Food Systems Collaborations: 1st Annual Food Systems Institute Student Symposium

April 26, 2023, Lory Student Center Ballroom D  
Colorado State University

## Presentation Order

Round 1: 3-Minute Student Presentations			
	Name	Presentation Title	Department
A1	Azmal Hossan	In Search of Justice in the Food-Energy-Water Nexus in the Great Bengal Delta	Sociology
A2	Erin Jackson	Investigating the Multifunctionality of Ecosystem Services in Agroecosystems from an Interdisciplinary Lens	Soil & Crop Sciences
A3	Tais de Menezes	Potential Economic Impacts of Foot-and-Mouth Disease in Brazil: A Case Study for Mato Grosso and Paraná	Agricultural & Resource Economics
A4	Adam Snitker	Evaluating the social dimensions of the STAR program: The role of community capitals in understanding agricultural transitions	Sociology
A5	Laura Supple	Transdisciplinary Models of Community Infrastructure Transitions Towards Regenerative Social-Ecological-Technological Systems	Civil & Environmental Engineering
A6	Pratyoosh Kashyap	Diffusion of Universal Free School Meals in the United States: Examining Factors Influencing Adoption of Community Eligibility Provision	Agricultural & Resource Economics
A7	Jenna Bensko	Associations between sustainability scores and the likelihood of offering menu items with various protein sources in the top selling US restaurant chains	Food Science & Human Nutrition
<b>Break</b>			
B1	Jorge Rico	Transforming food waste into valuable resources: Rewiring anaerobic digestion for sustainable chemical production	Civil & Environmental Engineering
B2	Ana Altares	Finding Food Security without Federal Food Assistance in a Rural High Cost-of-Living Region	Food Science & Human Nutrition
B3	Cahill Shpall	Colorado Department of Education (CDE) Local Food Program (LFP) Data Analysis and Recommendations	Agricultural & Resource Economics
B4	Rebecca Wasserman-Olin	Finding Community Among Diversified Vegetable Farmers and Stakeholder Led Research	Agricultural & Resource Economics
B5	Amber Obermaier	Present Limitations and Future Projections: Food Insecurity, Housing Insecurity and Optimism Among College Students	Sociology
B6	Reid Maynard	Is Local Food More Sustainable? Comparing Local Food Production to Conventional Centralized Agriculture in the Contiguous United States Through Life Cycle Assessment	Mechanical Engineering



## In Search of Justice in Food-Energy-Water Nexus in the Great Bengal Delta

Azmal Hossan

Department of Sociology

Interdisciplinary Training, Education, and Research in Food-Energy-Water Systems (InTERFEWS)

**Abstract.** Bangladesh, located in the great Bengal Delta, is one of the highest groundwater-extracting countries. Large-scale irrigation to produce dry-season rice is the responsible factor behind groundwater abstraction. This made Bangladesh food self-sufficient but at a high price. The country lost significant terrestrial water storage. The Barind Tract Region, the agroecological-rich breadbasket of the country, located in the Northwestern semi-arid region has the highest depletion rate. Since the early 1990s, under the Green Revolution program, the Bangladesh government has been implementing a large-scale irrigation project called the Barind Multipurpose Development Authority (BMDA) to enhance dry season rice production. Groundwater extraction through thousands of deep and shallow tube wells under BMDA depleted the region's groundwater tremendously. This water crisis brought disproportionate negative consequences on the natural resource-based *Santal* – the most ancient and second largest indigenous community in Bangladesh living in the region for centuries. Shamsudduha et al. (2022), in their seminal research highlighted on the front page of the Science Magazine, proposed a nature-based solution to the groundwater depletion problem. Quantifying the magnitude of freshwater captured by what they called The Bengal Water Machine (BWM) through the operation of shallow tube wells by ~16 million smallholder farmers, they argued that groundwater depletion resulting from intensive irrigation practices created conditions for recharge from monsoon rains which then replenishes it. Using environmental justice lens, this study presents a critique of this nature-based solution arguing that the benefits of the BWM are not equally distributed among different ethnic groups. The preliminary data analysis indicates that BWM is controlled by the local political elites who are predominantly mainstream Bengalis and indigenous communities are often deprived of groundwater to irrigate their rice fields. This groundwater deprivation generates food insecurity among the indigenous community. The study also focuses on the energy implications of the BWM as the tube wells are run by either diesel or electricity produced by fossil fuels contributing to the global warming process through atmospheric carbon emission. Indigenous communities are disproportionately affected by global warming.



## Investigating the Multifunctionality of Ecosystem Services in Agroecosystems from an Interdisciplinary Lens

Erin Jackson

Department of Soil and Crop Sciences, Graduate Degree Program in Ecology

**Abstract.** Climate change is increasing the frequency of drought, heat and severe weather events, which is dramatically affect agricultural production systems that are under increasing demand to produce food. To enhance the ability of high plains agricultural systems to respond to forecasted climate variability and remain productive and profitable, while maintaining ecological health, there is an immediate need to alter food production methods. Agroecological practices utilize natural processes to replace human inputs while building self-regulation feedbacks for increased resilience. It is well understood that diversification enhances the multifunctionality of agroecological systems, or the ability of systems to provide ecological, social and economic benefits. However, there is a gap in understanding of how multifunctionality of ecosystem services translates to resilience in agricultural systems. Building on the existing network of 30 farms across Kansas, Colorado, and Nebraska engaged in the Farmers Advancing Regenerative Management Systems project, I will design and implement on-farm paired trials comparing ecosystem service multifunctionality and resilience outcomes between farms employing agroecological practices, such as cover cropping, crop diversification and animal integration, and those utilizing conventional farming practices. Ecosystem services will include biophysical indicators of soil carbon capture, soil fertility, microbial diversity and water retention, as well as provisioning services including crop yield and socioeconomic outcomes. Stakeholder interviews will be conducted and ecosystem services will be quantified based on perceived importance. This research will help us better understand the impact of management practices on agroecosystem resiliency and will inform environmental management programs and policies for a more sustainable and resilient future.



## Potential Economic Impacts of Foot-and-Mouth Disease in Brazil: A Case Study for Mato Grosso and Paraná

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**Abstract.** Brazil is one of the largest global suppliers of beef and pork and has faced challenges related to foot-and-mouth disease (FMD) in the livestock sector. FMD is one of the most important animal diseases in the world and has important consequences for Brazilian agricultural production and trade. Brazil initiated the suspension of FMD vaccination in 2020 and developed an emergency response plan to improve the country's FMD status with the World Organization for Animal Health and expand international trade. This study investigates the economic effects of FMD by employing a regional, dynamic computable general equilibrium model in tandem with results from an epidemiological model to simulate an FMD outbreak in Brazil. Results show that outbreaks located in two Brazilian states, Paraná and Mato Grosso, negatively impact other states in Brazil in higher proportions than in the directly affected state in some cases, demonstrating a spillover effect of economic losses beyond the region directly affected by the disease. Also, results highlight the distributive effects of FMD outbreaks with most of the negative impacts falling predominantly on lower income workers and households. This study shows the importance of animal disease surveillance and control in Brazil and provides needed estimates of the potential economy-wide effects of an FMD outbreak in Brazil.



## Evaluating the Social Dimensions of Expanding the STAR Program Across Colorado

Adam Snitker

Department of Sociology, Colorado State University

**Abstract.** In recognition of the economic and environmental importance of soil health to agriculture production, the Colorado State Legislature created the Colorado Saving Tomorrow's Agriculture Resources (STAR) program to promote increased soil health across agricultural lands. The program promotes soil health through programmatic interventions, such as financial and technical assistance, facilitated peer-to-peer learning networks, and a novel soil health rating system. Despite programs like STAR, producers face an array of social and material obstacles that make agricultural transitions challenging. The purpose of this research is to understand what factors either promote or prohibit Colorado agriculture producers to transition operations to support soil health. Further, the study aims to evaluate the STAR program's ability to mobilize, or fail to mobilize, resources producers need to transition operations. This research is informed by the Community Capitals Framework (CCF), a theoretical frame designed to evaluate how programs, or investments, impact and interact with existing community resources, or capitals, to enable community development and change. To assess community capitals among Colorado agriculture communities, this study employs a mixed-method approach with interviews, focus groups, and surveys as primary data collection tools. Participants will be recruited from four geographic regions, Eastern Colorado, San Luis Valley, Northwest Colorado, and the Front Range, to represent diverse characteristics of agricultural production and communities in Colorado. Research procedures will be conducted twice throughout a four-year period. There are many obstacles that make agricultural transitions challenging, this research seeks to identify those obstacles, understand the strengths and weaknesses of the STAR program, and identify additional areas where programs and investments may institute durable change.



## **Agents & Agency in Community Infrastructure Transitions: Implementing a Multidimensional Model of Agency within a Multi-Level Perspective on Social, Ecological, and Technological Infrastructure Transitions**

Laura Supple

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**Abstract.** The Anthropocene epoch represents a unique moment in history where human quality of life and the livability of the planet are shaped by increasingly complex human-environment interactions and highly uncertain social, technological, and environmental futures. In modern societies, an unprecedented convergence of disruptive forces are exposing critical vulnerabilities in engineered infrastructure systems responsible for regulating metabolic flows of food, energy, water, and waste; guarding against physical and biological hazards; facilitating exchange of information and knowledge generation; and supporting community health, vitality, and adaptability. Engineered to be “fail safe,” gray infrastructures designed for relatively static operating conditions now appear brittle, unresponsive, and increasingly susceptible to catastrophic failure in the face of rapid and unpredictable change. Preparing human society to adapt to and through complex and uncertain futures requires a paradigm shift in how infrastructure is designed, built, and managed to reposition built environments as multifunctional spaces of social and ecological regeneration, and transition existing infrastructure systems towards regenerative, living systems-of-systems. This research describes a participatory agent-based modeling framework to simulate the role of individual and organizational behavior, decision-making, and agency in driving these transitions through urban infrastructure co-creation, adaptive management, and social learning. The model applies a bottom-up, multidimensional model of agency to simulate causal processes and social mechanisms behind emergence and diffusion of niche-level innovations associated with more socially and ecologically resilient and regenerative cities. By modulating characteristics of individual and collective actors and their interactions with built and natural environments, the model is intended to support cooperative planning of community urban infrastructure, and allow researchers’ and participants’ to explore different scenarios for co-creating common spaces, cultures of practice, and networks for knowledge- and resource-sharing to support shared social values and priorities for infrastructure services in the face of challenging and uncertain futures.



## Universal Free School Meals in the United States: Examining Factors Influencing Adoption of Community Eligibility Provision

Pratyoosh Kashyap, Becca B. R. Jablonski

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**Abstract:** Food insecurity for households with children is a large problem in the United States, an issue exacerbated by the COVID-19 pandemic. Recognizing school meal programs as critical safety nets for children in low-income households, many states are passing legislation to adopt universal free school meals. Funding for the statewide program is tied with the federally funded Community Eligibility Provision (CEP) that became available to all school districts in school year 2014-15. A universal free school meal program, CEP is available to schools with high levels of low-income children. However, close to half of all eligible school districts did not participate in CEP in school year 2018-19 despite research showing benefits of adoption for the children, schools, and community. Using a policy diffusion approach and a Cox regression model, this research examines factors associated with higher rates of participation in CEP. Informing state and federal agencies, and policymakers, the results demonstrate the importance of a school district's identified student percentage (reflecting school district level poverty) and a state's direct certification rate (a process that certifies students for free school meals) in increasing the likelihood of CEP adoption.



## Associations between sustainability scores and the likelihood of offering menu items with various protein sources in top-selling US restaurant chains

Jenna Bensko and Dr. Megan Mueller

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**Abstract.** Today consumers are expecting businesses to behave responsibly and are looking for more information about the food they are consuming and its impact on their health. The food service industry has responded by creating corporate social responsibility (CSR) statements that indicate what initiatives they are taking to be more socially responsible. This study aimed to assess the sustainability-related practices of the top 66 restaurant chains in the US, as well as the differences in the environmental impacts of their menu offerings based on their sustainability score. Using an environmental assessment rubric developed by the research team, the sustainability practices of each restaurant were scored based on criteria such as menu offerings, energy management, water management, material waste management, food waste, packaging, supply chain, and GHG emission reduction practices. The scores were then summed up to give each restaurant a sustainability score. The restaurant sustainability score was then evaluated for its relationship with the environmental impact of menu offerings based on the protein content of entrees, sides, desserts, and beverages offered on the menus of these same 66 top-selling restaurant chains. The protein types were beef, chicken, pork, turkey, vegetarian, vegan, dairy/cheese, nuts, beans, and combo/multiple proteins. The study found that dairy proteins were associated with the highest mean sustainability score, followed by multiple/mixed proteins and pork. Fish and beans were associated with the lowest mean sustainability score. The findings suggest that there is a positive association between sustainability scores and the likelihood of offering items with certain protein types, such as vegetarian, vegan, nuts, and beans. We reassess the role of the food industry from a forward-looking perspective on responsibility and ask what food companies can and should do to promote planetary and human health.





## From waste to resource: Exploring the potential of food waste valorization for sustainable fatty acid production

Jorge L. Rico

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**Abstract.** Food waste is an inevitable byproduct of our food systems, and despite efforts to reduce, dispose of, or upgrade it into valuable derivatives such as compost or renewable natural gas, more than 50% of produced food waste in the U.S. ends up in landfills every year, amounting to over 30 million tons. This is largely due to a lack of economic incentives that encourage food waste utilization by different stakeholders. An opportunity to address this challenge lies in the development and adoption of novel technologies that can upgrade food waste into higher-value products than compost or biogas. One such emerging technology with increased research attention is rewilded anaerobic digestion. This process relies on microbes that can transform food waste into fatty acids, which have an increasing market in different industries such as fuels, pharmaceuticals, and food preservatives. Fatty acids are currently produced from petrochemicals and are used in various products, including food preservatives. Therefore, producing fatty acids from food waste presents a win-win opportunity to decrease the environmental carbon footprint of our food systems. This research explores the potential of RWAD to produce fatty acids from food waste. We conducted experiments using food waste from Colorado State University dining hall and evaluated the fatty acid production potential and profile using different microbial communities. Our results suggest that the production of a specific fatty acid is significantly impacted by the types of microbes and operating conditions. Among all fatty acids, potential platforms could be developed to produce acetic, propionic, or butyric acid.



## **Finding Food Security without Federal Food Assistance: A Look at Households above Poverty Thresholds for SNAP in a High Cost-of-living Region**

Ana Altares

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**Abstract.** Federal programs in the United States such as the Supplemental Nutrition Assistance Program (SNAP) address food insecurity by providing financial assistance to households with income at or below 130% of the federal poverty level (FPL). These income requirements are the same across the US, despite regional variations in cost-of-living. While food insecurity often tracks with poverty, households in high cost-of-living regions may report income above 130% FPL, making them ineligible for SNAP; yet they may still experience food insecurity. One particular mountain resort-rural region in Colorado experiences food insecurity challenges including high cost-of-living due, in part, to ski tourism, long travel distances to food sources, and limited transportation routes. This project will explore how households above and at/below 130% FPL in this region cope with food insecurity. Specifically, we aim to evaluate how they utilize community food assistance resources (i.e., food pantries) and whether they make different economic tradeoffs (i.e., forgoing medical expenses for food). We hope to understand how households navigate food access in this region and their lived experience of food insecurity. First, we will survey food insecure residents (n=1080) above and below 130% FPL within this region. We will assess food insecurity, use of community food assistance resources, and economic tradeoffs. We will analyze these findings using ordinal logistic regression to determine differences in food resources use and economic coping strategies by income group. We will then use a participatory action research method, photovoice, to encourage residents (n=30) to photograph and share their lived experience with food insecurity, and create action steps to improve regional food security. These findings will add to our understanding of food insecurity coping strategies and experiences, particularly among households that cannot access federal food assistance due to income. This research also hopes to encourage and empower residents to take part in community change and knowledge production. The findings from this study will inform 5-year strategic plan to end food insecurity within this region. This research may also serve as a model to other high cost-of-living regions impacted by food insecurity across the United States and other countries.



## Colorado Department of Education Institutional Procurement Data Collection and Trends Analysis

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**Abstract.** This project analyzes Colorado Department of Education's data-collection methods for institutional procurement. The research questions investigated in this project were aimed at analyzing how the 2021-2022 Local Food Program data was collected and analyzed by CDE and local partners. What is the level of detail included in the data, and what is its quality? Further analysis was conducted on distribution of purchasing and data collection methods between Urban, Rural, and Small-rural school districts. A comprehensive GIS map was created detailing all local producers, food hubs, and distributors that supplied CDE LFP enrolled school districts was compiled and aggregated by amount dollar amount of food provided. The results of this project are hoped to be used to inform data collection strategies for the next year of the LFP program, future policy involving localized institutional procurement, and the rollout of the 2024 universal school meals program.



## Improving Wholesale Local Food Procurement: A Farmer Choice Experiment

Rebecca Wasserman-Olin

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**Abstract.** Food hubs and wholesalers are an increasingly popular way for farms to sell fresh produce to receive increased profits over direct-to-consumer and retail market channels, but little is known about what drives farmers preferences for accepting orders or not. With many food hubs relying on grants, increasing an understanding of farmer preferences on wholesale orders will help them reach long term financial independence. By designing an experiment based on both farmer and food hub input as well as 10 years of farming experience by the author, we created a novel designing with factors never addressed in the literature in this way. We administer a choice experiment to farmers that grow fresh vegetables in the United States to evaluate preferences of wholesale sales opportunities across key attributes including profit margin, packing specifications, delivery method, and order size. By analyzing farmer marketing decisions, food hubs can have a better understanding of how to design offers that farms are more likely to accept. This research also presents a new way for farmers to think about wholesale contracts offered to them. The analysis provides evidence of farmer preferences for food hub orders with more flexible packing standards, for crops with high profit margins, on farm pick-up, and a dislike of small orders.



## Present Limitation and Future Projections: Food Insecurity, Housing Insecurity, and Optimism Among College Students

Amber Obermaier

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**Abstract.** Within the last decade, research has identified wide-ranging disparities in access to basic needs among university students. These differences, such as a lack of adequate food and housing during university, provide a negative environmental experience with potential to limit one's optimism or hope for the future. This research explores how basic needs insecurity and social vulnerabilities among college students are related to subjective assessments of their prospects for the future. The present study utilizes survey data from a random sample of college students (n=300) enrolled at an urban university in the Midwest region of the United States of America. Logistic regression examines the multivariate relationships among social vulnerabilities, insecurities, educational achievement and their role in determining the odds of being optimistic vs. non-optimistic. The analysis finds that among this sample of students, unmet basic needs are related to higher chances of being non-optimistic for the future. The findings underscore the importance of personal stability in food and shelter reflecting not only current physical and mental capabilities, but also projections of one's future.



## Is Local Food More Sustainable? Comparing Local Food Production to Conventional Centralized Agriculture in the Contiguous United States Through Life Cycle Assessment

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**Abstract.** In recent years, local food production has seen growing interest as a sustainability measure. A variety of systems can enable local produce, however, with varying sustainability impacts. Previous research indicates year-round Controlled Environment Agriculture (CEA) like greenhouses can have high environmental impacts due to significant energy intensity. Such studies focus on experimental performance or simulations in particular locations. Expanding beyond these case studies to capture regional variations would enable better stakeholder understanding of sustainability impacts and trade-offs. Our research presents a geographically resolved cradle-to-store life cycle comparison of four lettuce production systems: indoor plant factories, greenhouses, local outdoor cultivation, and centralized cultivation. Combining U.S. DOE EnergyPlus modeling with geographic resolution in climate, grid generation mix, and water scarcity, we estimate the global warming and water impacts of CEA lettuce production across the contiguous United States. Further, utilizing the Food and Agriculture Organization's AquaCrop model, we simulate seasonal soil cultivation of lettuce in the same locations. We compare these results to conventional cultivation and transportation from California, where most US lettuce is grown. Results indicate that CEA production always has higher greenhouse gas impact than conventional production, on average eight times higher. However, an 85% reduction in water footprints suggests energy-water tradeoffs. In contrast, local soil production reduces global warming impacts except where soil conditions greatly reduce yields. Variations in yields and precipitation lead to a range of water footprints for local outdoor cultivation, with most impacts lower than conventional usage. The high climate impacts of CEA systems indicate conventional production is more sustainable; CEA systems would need to improve energy efficiency and decarbonize energy sources before greenhouse gas impacts break even with the conventional system. Local seasonal cultivation, meanwhile, can be more sustainable than conventional systems with the right growing conditions. All local production results suggest trade-offs at the water-energy nexus, as the water intensity of the conventional system could incentivize technologies with lower water requirements and locations with less water scarcity. Our results provide geographically resolved comparisons of local vs. centralized food production and can facilitate food-energy-water decision-making on emerging food production systems.