Regional food freight:
Lessons from the Chicago region

Miller, M., Holloway, W., Perry, E., Zietlow, B., Kokjohn, S., Lukszys, P., Chachula, N. Reynolds, A., and Morales, A.

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CENTER *for* INTEGRATED AGRICULTURAL SYSTEMS

Author Contact:
Michelle Miller, Center for Integrated Agricultural Systems, University of Wisconsin-Madison, mmmille6@wisc.edu, 608-262-7135

USDA Contact: Bruce Blanton, USDA-AMS, Transportation Division

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Regional food freight – lessons from the Chicago region

Executive summary

Entrepreneurial farmers who are filling the demand for local and sustainable food report difficulty getting their product to market, and are looking for transportation options that align with their interest in sustainability and local economic development. Concurrently, processors, restaurants and retailers struggle to source these products in an efficient and cost-effective way. Why the market disconnect?

Food distribution is insufficiently organized to meet these needs. Moving food within a region, especially as population settlement shifts from rural to urban, raises a number of issues about the structure of our current food supply. Food freight transportation links production and consumption regions into a complex web of relationships. To understand the complexity, a growing community of researchers and policy makers think the food sector is best considered in a systems context. Our food system is made up of complex interactions between the natural world, and human systems such as communities, transportation and markets. Taking a systems approach enables us to identify potential solutions to transportation-specific challenges, such as safety, congestion, and inadequate public resources for transportation infrastructure, maintenance and development, that otherwise may be easily overlooked. We began our inquiry into regional food freight by exploring how to optimize food system resilience and identifying opportunities for efficiency and diversity. To do this, we applied lessons on diagnostics from systems dynamics literature and considered the regional food supply chain in an historical context. We gained a deeper understanding of how national and regional food systems work today by using these multiple methodologies. We are better positioned to understand how food shipment trends influence current and future food production and markets.

We convened a multidisciplinary team in 2014 and, with the help of practitioner-advisors, explored the field through literature review, data analysis and practitioner workshops. Our investigation identified two distinct segments of regional food supply chain businesses, defined by scale – diversified farm businesses that are scaling up from direct markets to wholesale markets, and businesses that have a decade or more experience in wholesale markets that are looking for ways to make their supply chains more sustainable, through certification and branding local and environmentally conscious product, or through distinct organic supply chains. Some companies are seeking supply chain partners who invest in alternative energy innovations so that the entire supply chain is more sustainable. These supply chain segments are the connective tissue of our regional food framework. Those businesses that are scaling up to realize necessary efficiencies and those seeking a higher degree of sustainability each face unique and shared challenges to move food freight regionally. They also share some important opportunities.

To meet public goals of sustainability and food security, each of these business segments may benefit from targeted public support and partnerships to reshape the way their activities are integrated across markets in the region and beyond. Farmers and distributors function across the rural-to-urban gradient of our region, and face transportation bottlenecks and market opportunities associated with large urban areas.

We organized the project to address regional shipper concerns when accessing the Chicago market, and learned that system failures were occurring all along the supply chain. We identified a number of innovative private sector efforts to improve freight transportation in city regions.

One of these was to split trucking options into rural and urban segments. Another was to address aggregation and supply chain scale challenges. The research process identified a host of key leverage points in the regional food freight system. Optimizing both efficiency and diversity is a high-leverage approach to improving food distribution. Critical thresholds are also leverage points. These included cropping systems diversity, distance to market, truck size, contracts, terminals and trip segments, settlement patterns and engineering innovations.

We identified and explored three ways to reorganize food systems in such a way that encouraged regional food supply chains, each paired with proof of concept examples:

- Support the emergence of smaller, regional supply chains through not-for-profit terminals;
- Develop collaborative, not-for-profit drop yards for urban freight in megaregions; and
- Extend federal support for regional food trucking companies that serve metro regions so that they may adopt engineering innovations for regional shipments.

Introduction and methods

On a cold January day in 2016, sixty people gathered to discuss regional food freight challenges at the offices of the Chicago Metropolitan Agency for Planning, in the city's Willis Tower. The workshop convened supply chain businesses to discuss innovations in and challenges to regional food distribution to wholesale markets. Participants shared their supply chain experience and considered ways to improve the wholesale market environment for regional businesses. This meeting was the culmination of a three-year exploration into questions raised by local and regional food practitioners –farmers, distributors, and wholesale buyers -- in 2013 (Day-Farnsworth and Miller 2014).

- How can we distribute local, sustainably grown food more efficiently, especially to larger urban markets like Chicago?
- How can we make food freight more sustainable?
- In other words, **how can we make our food system more resilient by undergirding national and global food supply chains with robust regional food supply chains?**

Shippers struggled to find trucking companies to move their product at a cost they could afford and expressed a need for cold storage nearer their markets to improve logistics. Larger, more experienced regional shippers were struggling since the cost of diesel had skyrocketed to over four dollars a gallon. One large shipper was toying with the idea of exiting the Chicago market because of high fuel costs and congestion. Trucking companies, too, were facing challenges with fuel costs and congestion. In addition, they expressed concern that labor costs and driver turnover hampered business. Then-new regulations limiting the number of hours a driver could work (hours of service) was intended to improve highway safety, but it also complicated logistics and added cost to deliveries, especially in metro areas. Wholesale buyers wanted to see better product aggregation and more consistency. Institutional buyers (such as schools and hospitals) needed better pricing and aggregation. We agreed that addressing transportation concerns could lower the cost of freight services to shippers, improve business conditions for the trucking sector, and ultimately increase market share for regionally produced foods.

To explore these questions regarding the interlocking systems that make up regional food systems, the Center for Integrated Agricultural Systems at the University of Wisconsin –

Madison organized a multi-disciplinary team of researchers that were then guided by a diverse group of practitioners in food and freight systems (Appendix A). Inquiry through regular conference calls, participatory workshops, practitioner interviews, literature review and data analysis provided insight into ways to increase food system resilience while realizing efficiencies with the potential to contain costs.

How can we make our food system more resilient by undergirding national and global food supply chains with robust regional food supply chains?

Our process was iterative. As the team evolved, so too did the advisors and our mutual understanding of complex systems in play. For instance, we originally proposed to analyze scrubbed logistics data from private sector shippers to better understand food flow if infrastructure was added. People left companies, fuel costs dropped, and private logistics companies were in upheaval, so our team was left with insufficient data to analyze. With inadequate data, we turned to Plan B – assess logistics issues generally, and add new partners to the project. This required us to convene an additional meeting to ensure we learned together as a team, and resulted in more ideas about ways to improve the distribution system.

Because production and market regions are unique, we focused on truck freight shipments that link the Chicago metro region with food producers in Wisconsin and Illinois. To ensure that the research had immediate practical applicability, we focused on truck freight because most food for North American markets is currently moved by truck, and for most markets it is the only mode available (Casavant et al. 2010). While other modes of transportation may be more fuel efficient, they cannot compete with truck movements for time to market and ability to ship products between specific locations. Even though there was considerable interest in exploring food movement by rail to take advantage of fuel efficiencies, it was deemed outside our scope of work for this project due to its limited applicability for the shipment of refrigerated product.

Three one-day meetings allowed our team and community partners to engage and explore issues face-to-face. Meetings were intended to bring business entrepreneurs representing food production, aggregation, trucking, logistics, infrastructure and purchasing together with researchers from multiple disciplines and government representatives to learn from one another. The first workshop convened July 2014, was part of a campus process to develop new approaches to climate change (Appendix B). Our team used this day to better articulate our project goals and expected outcomes, which resulted in an early concept paper (Appendix B). The second workshop, June 2015, engaged 19 participants, ten of whom were new to the project and unfamiliar with the scope of work, and brought relevant expertise (state transportation infrastructure, regional economic development, logistics) to the on-going discussion (Appendix C). Using scenario-building methods, the team focused the day's discussion on four groups of trends that shape food systems.

- public health and food access;
- climate change and population growth;
- fuel and labor costs; and
- traffic congestion and public infrastructure.

Ways to address these trends emerged from our discussions. We then grouped potential solutions into four approaches: policy and regulation, data and information technology, private/public sector engagement and opportunity, and infrastructure and other innovations. These reflections were then used to develop the agenda for the final meeting.

Our final workshop in Chicago brought together a diverse group of participants, primarily from the Chicago region (Appendix D). The workshop ran seven hours, including a working lunch for networking. Three hours were devoted to hearing the experiences of people in the field working on improving transportation and supply chains from rural farming areas to urban markets. Equal time was given for practitioners to meet in small groups, discuss their concerns and respond to ideas and questions posed by guest speakers. Topics covered included:

- Regional shipper concerns when accessing the Chicago market;
- Private sector efforts to improve freight transportation in the Los Angeles megaregion;
- Efficiencies to be gained from splitting trucking options into rural and urban modes; and
- Market issues for accessing regional food and last mile delivery

Throughout the process we had the good fortune to engage two teams of professionals in the project as part of their degree programs on the UW-Madison campus. Nancy Chachula and Julia Schilling from the Department of Landscape Architecture worked with us for more than a year to grapple with land use challenges. Their participation in the project resulted in two reports with extensive graphics that are used in this report. A group of five supply chain professionals in the second year of their MBA program with the Grainger Center for Supply Chain Management worked with our project for a semester. They helped us think through supply chain challenges and pulled together data on transportation logistics, also used in this report.

The importance of system-based diagnostics for food and agriculture

Freight transportation via truck is reliant on public investment in roads. In the recent past, food freight was also reliant on public investment in warehousing infrastructure. As settlement and food production patterns have shifted, infrastructure for food freight has privatized, and systemic distribution failures are occurring in very rural and very urban areas. Public investment has tended to focus on highway infrastructure – in particular, the strategy of building more lanes to accommodate more trucks and cars moving into the city, even though adding lanes is expensive and increasingly ineffective at addressing congestion over the long term. Consequently, we explored whether or not there were new strategies to address these system failures.

Food systems involve a complex array of interactions between people and our natural environment. A recent publication by the Institute of Medicine and the National Research Council describes the food system as a complex adaptive system embedded within a broader and ever-changing economic, biophysical and social context. The authors introduce a guiding framework for food system assessment that illuminates the interconnectedness of its health, environmental, economic, and social dimensions, and that enable a full set of impacts to be analyzed (Nesheim, et al., 2015). The authors urge investigators to undertake food system research that comprehends “systems dynamics and complexities” and assesses systems effects, such as sustainability and resilience. This directive indicates a need for conceptual and applied research on food systems that crosses disciplinary lines and generates multifunctional solutions (Cahill, 2001). Systemic action research requires that we look for repeating patterns in the interplay between three domains of complexity: the natural world – what is, the underlying

truth; the social domain – what ought to be, what is right; and the subjective domain – what an individual thinks, intends and feels (Midgley 2016).

System Dynamics. Europe is at the forefront of applying system dynamics methods to understanding agriculture and food as a complex system. In July 2015, the first Mediterranean Conference on Food Supply and Distribution Systems in Urban Environments convened in Rome to bring together scholars and decision makers in the field of complex systems and system dynamics, to develop practical tools to improve food systems (Armendariz et al. 2015). System dynamics analysis involves the use of diagnostic tools, such as stock and flow diagramming, that provide a way to think about the underlying structure of a system, and reveal structural weaknesses that lead to unintended consequences. In the case of our food system, we see structural conditions result in problems that present as symptoms, including environmental degradation, poor economic returns to farmers, labor disparities, market consolidation, lack of access to food in impoverished communities, and traffic congestion.

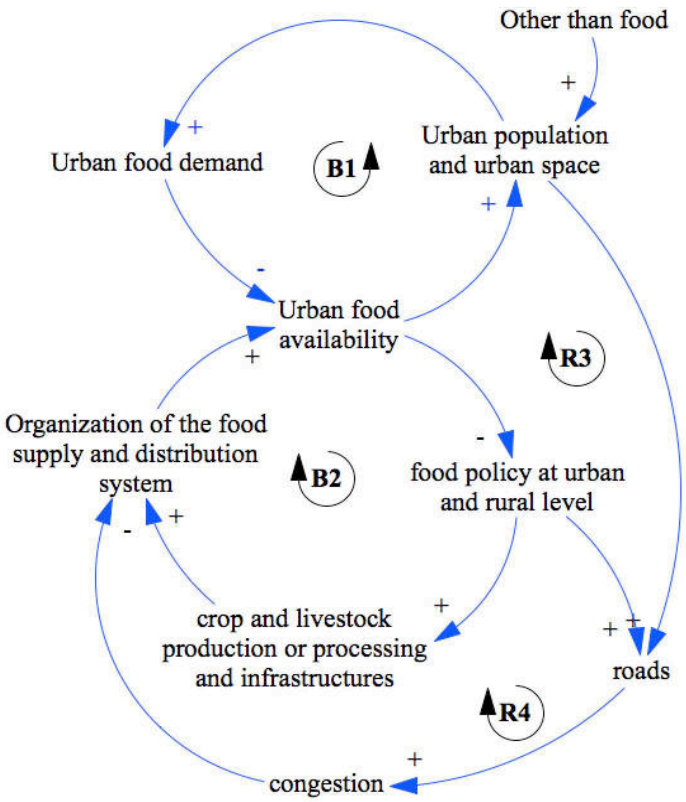


Figure 1. Stock and flow diagram for food supply and distribution systems. Armendariz, et al. (2015)

The simple stock and flow diagram (Figure 1), applicable to any urban/rural food system today, shows systemic flaws arising from the relationship between urban food demand and food production. Systems, and the relationships between and within them, are non-linear, delayed, discontinuous, and give inaccurate and untimely feedback (Meadows, 2008). The non-linear nature of systems means that they hinge on critical thresholds that, when identified, can be leverage points for change. There are multiple critical thresholds in the food system that warrant examination, some of which are natural thresholds, such as soil type, weather patterns, and growing season length, and others which are human-constructed, such as farm size, road capacity, and truck specifications.

System archetypes are common feedback or interaction patterns that arise from the structure of the system. Identifying archetypal system patterns helps practitioners and policy makers understand that our food system, like any system, is imperfect AND can be improved. This understanding empowered our research and practitioner team to consider systemic redesign options with the potential to address system-wide market and food access failures, as well as environmental challenges inherent to the current system.

Leverage points. Identifying system archetypes helps us to identify leverage points for change. In the case of food systems, slowing a growth cycle in a positive feedback loop is a powerful leverage point to explore. Armendariz et al. (2015) explain the stock and flow diagram, as shown in Figure 1, as a growth cycle. The balancing loops (B1 and B2) are examples of the system archetype of "eroding goals" in positive feedback loops. In this archetype, long-term goals are not met because the underlying causes of system failure are not addressed. Instead, harmful unintended consequences are managed with short-term solutions that tend to address the symptoms of system failure rather than the root causes. Here, more food is produced to feed more people while cities are sprawling over farmland, farmers are not adequately paid for their labor and can make more money by taking other jobs in the cities, and rural and urban poor don't have access to healthy food.

The reinforcing loops (R) also tell important stories. R3 is an example of the "shifting the burden" archetype characterized by solutions that address symptoms and overlook the underlying cause of the problem. In this example, building roads as a short-term solution to meet distribution and economic goals creates greater congestion and traffic, and most importantly does not address the fundamental problem – that the distribution system is insufficiently organized to meet changing rural and urban needs. R4 is an example of a "fix that fails", that is, a fix that not only detracts from solving the underlying cause, it also creates unintended consequences that make matters worse. For example, this may refer to public policy that maximizes agricultural yield with little attention to food distribution, and which simultaneously exacerbates environmental degradation, fuels an exodus of rural people to cities and undermines food system sustainability.

The distribution system is insufficiently organized to meet changing rural and urban needs.

Most supply chain literature emphasizes negative feedback, such as regulation and top-down intervention to control a system and slow growth, but others observe that emergent patterns in complex adaptive supply networks can be better managed with positive feedback through reward systems that allow for autonomy of supply chain businesses (Choi et al. 2001). Rather than focusing on what we do not want and controlling it, the focus shifts to articulating a shared vision, such as sustainability, and articulating the steps necessary to create it.

An example of rewards for regional businesses in smaller wholesale supply chains could be public support for collaborative entrepreneurial business development. Examples of collaborative efforts include beginning farmer networks and apprenticeships, community kitchens, and a place for shippers and locally-owned restaurants and grocers to do business. Positive interaction for improved transportation systems may be support for infrastructure redesign in response to population shifts, for both goods distribution and public transportation. Positive interaction in sustainable agriculture policies would encourage regional crop diversification, which then may provide a supply of local food for entrepreneurial food processing businesses.

Efficiency and diversity paradigms. Identifying the paradigms from which the system arises allows us to identify the most powerful leverage points of all (Meadows, 2008). In Figure 1,

building roads as a short-term solution to meet distribution and economic goals does not address the fundamental problem – that the food distribution system is insufficiently organized to meet changing rural and urban needs. Greater regional production diversity that results from increased farm-level sustainability requires infrastructure, as do population shifts to urban regions.

Efficiency and diversity paradigms, when considered in relationship to one another, may help us to take actions that optimize both. Goerner et al. (2009) describes this challenge in Figure 2. Emerging from quantitative work in South Florida's Cypress wetland ecological system, researchers engaged in ecological network analysis and found that the most efficient food network supported the most life (ie: largest carbon flows), but was not resilient (Ulanowicz et al., 1996). Simply maximizing diversity in the system reduced carbon transfer and efficiency. Optimizing both efficiency and diversity resulted in slightly more carbon transfer (ie: organisms in the system) and a more stable system overall (Figure 3). Goerner, Ulanowicz **off in carbon transfer in the cypress ecosystem of South Florida. Ulanowicz, et al. (1996)** and their colleagues continue to explore the relationship between diversity, efficiency and resilience. Resilience is quantified as the balance between the efficiency and redundancy of resource flow through the network (Fath, 2015). System level indices such as these highlight the relationship between internal processes and whole system performance. They identify a sweet spot between diversity and efficiency.

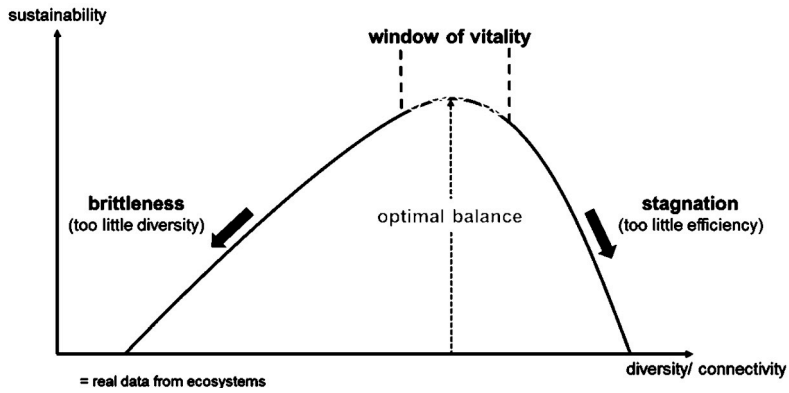


Figure 3. Sustainability as a function of efficiency, diversity and resilience. Goerner, et al. (2009)

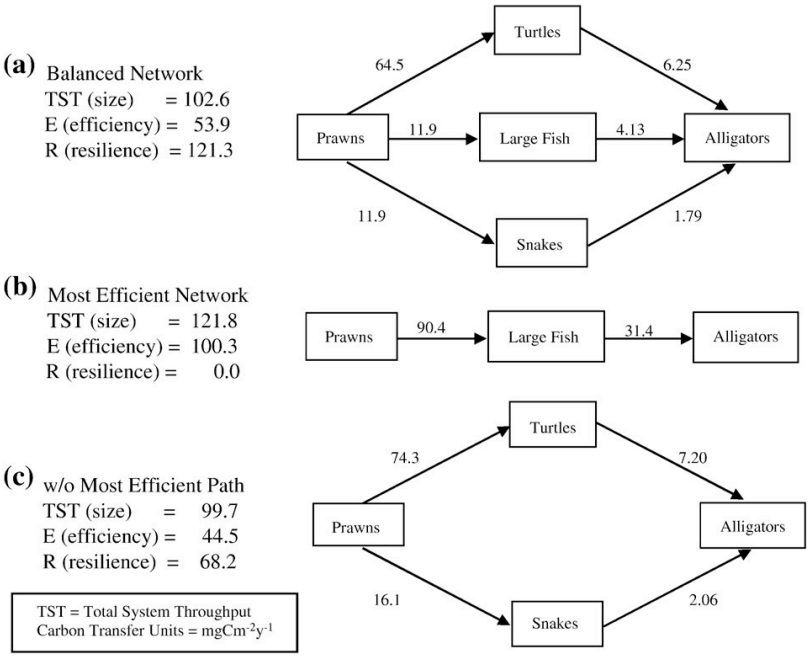


Figure 2. (a,b,c) Size, efficiency, and resilience trade-

Increasing regional diversity at commodity production scale for regional markets is one approach to improving system resilience. Another approach is to improve regional food supply chain efficiency. Both approaches to increase resilience offer new market opportunities, while they also

introduce a myriad of organizational and infrastructural challenges (Day-Farnsworth et al., 2009). As supply chains lengthen, smaller farmer-shippers need to build coalitions and improve negotiation, or they find themselves in the position of "price-takers" rather than "price-makers" (Stevenson & Pirog, 2008, Banterle et al., 2013).They also need to employ efficiency strategies for food freight so that they can be profitable.

Differentiated regional supply chains will emerge from national chains when farmers systemically improve resilience through sustainable agriculture practices, including diversification (Lengnick, 2014), and when businesses invest in equipment for specific products and in infrastructure for aggregation (Rogoff, 2014; Tropp, 2014). Over the past decade, the USDA research initiative on Agriculture of the Middle (NC1198) and other sustainable food supply chain research have conducted a number of empirical studies identifying governance, pricing, marketing and branding characteristics of intermediated regional food supply chains that enable food businesses to realize social, ecological, and economic goals more commonly associated with direct-marketing (Lerman, 2012; Lyson & Stevenson, 2008).

Food flows. While global food flows are relatively well studied (for example Garlaschelli et al. 2005; Fasolo et al. 2008; Barigozzi et al. 2010), there is a lack of modeling on how food flows through our national food system, and even less research on regional food flows. Lin and colleagues in a 2014 US study gave us a snapshot of how food moved between states and to international ports, using 2007 data. The authors note that free trade policies between the states result in food flow patterns that may be indicative of international free trade arrangements. At the regional level, researchers have struggled with defining the system boundaries. Nicholson et al. (2015) used people-centered definitions, such as state boundaries and miles from market, in their study on localizing dairy supply chains in the Northeastern states. Given the limits of this approach, the authors suggested using a systems-oriented approach that takes into account regional economic flow – the flow of land, labor and existing infrastructure. Following their advice, our regional exploration better defined system elements or the lack thereof in regional food flow.

Thinking about regional food systems from a national perspective

The movement toward national and global food markets has eroded lower scale food system networks, an autocatalysis, as Goerner et al. (2009) describe. It has created a bifurcation in the system, where very small and very large companies and their supply chains dominate, and leave little opportunity for midscale businesses to participate. Concentration and consolidation in the food system increases the potential for volatility, supply bottlenecks and inconsistent access. Long-term trends such as urbanization and the rising cost of fuel are driving concentration throughout the economy, and climate change puts additional pressure on these brittle systems.

Early research suggests that relinking cities with adjacent production regions shows promise for realizing system efficiencies while promoting socioeconomic and agro-ecological resilience (Lengnick et al., 2015). Encouraging cities to look beyond their administrative boundaries when it comes to food supply allows cities to address fundamental barriers to food access, labor issues, and environmental health (FAO & RUAF 2016). If regional food systems are optimized for logistics and fuel-efficiency, shorter distance food movements may have the potential to successfully "compete on proximity" with large-scale growers at great distance to markets.

Ultimately, innovative supply chain governance and collaboration may expand regional producers' access to urban markets and urban residents' access to affordable, regionally-sourced products (King et. al, 2010.) A reintroduction of a public vision and public participation in food distribution may offset food system consolidation in the private sector. Lengnick et al. (2015) suggest that enhancing the modularity and diversity of regional food production and distribution in tandem with system efficiencies is crucial to fostering more socio-economically sustainable and climate resilient food systems nation-wide.

Regional economies are shaped by their cities through the power of city markets, city jobs, technology, and capital (Jacobs, 1983). Rural areas may be perceived to lack autonomy and cultural significance of their own and to exist primarily to serve urban needs. Over the last twenty-five years, however, local food and farming movements in metropolitan regions have begun to demonstrate ways to reverse this tendency through symbiotic enterprises in food supply chains. They are restructuring the relationship between urban and non-urban communities in ways that enhance the well being of both (Jennings, et al. 2015). Using network flow analysis to understand economic sustainability, Goerner et al. (2009) found that small and mid-scale enterprises are crucial to cultivating the balance between diversity and efficiency needed to sustain regional economic flows in the face of disturbances. Such a balance likely exists in all network flow systems, including food systems.

The regional scale has advantages over the local scale for sustainable food systems development (Clancy & Ruhf, 2010). For example, a regional land base has greater potential to produce a larger percentage of its own food supply and a wider array of products than a local food system. Secondly, due to both landscape and jurisdictional factors, cropping systems often exhibit regional patterns and natural resource management decisions frequently occur at the supra-local level. Finally, the regional scale can help realize economic benefits such as rural-urban trade and greater efficiencies in food storage, processing and distribution than hyper local systems permit (Clancy & Ruhf, 2010).

Unfortunately, businesses engaged in local food supply chains experience inefficiencies associated with short hauls. These "create market disincentives for local food, either in high transportation costs to shippers or in high cost of goods to wholesale buyers" (Lengnick et al., 2015). Grigsby and Hellwinckel (2016), in their study of threshold distances of competitive advantage found that small truck deliveries longer than 44 miles to markets in Tennessee could not compete with longer hauls from California on transportation cost. Scaling up production to fill 53' trucks is a hurdle for individual midscale growers unless there is a place for product aggregation to occur.

Food system history – production, transportation, markets

How did we move from regional to predominantly national food economies? Our team found that understanding the historical context of the food system was helpful to identifying patterns at the regional or landscape level. Over the last seventy-five years, our national food system has evolved from one based on regional food flows between cities and proximate arable lands, into a system largely reliant on national and global food flows. Change came quickly to the food sector after World War II, with the infusion of considerable public investment. Interstate highways, irrigation, refrigeration breakthroughs, labor availability (especially from Mexico), and urbanization, converged to support system reorganization toward consolidation and away from fragmentation. Small regional chains that had emerged to serve specific regional markets grew into large national and global private supply chains, or collapsed.

Food system history - production

Who grows our food? Migration from farms to towns and cities changed farm labor dynamics, replacing family farm labor with a hired workforce and machines. Federal policy supported the increase and expansion of agriculture production, especially through price support mechanisms. Production efficiency and maximum yield were the goals. As a result, crop diversity, an indicator of ecological resilience, was reduced. A reduction in diversity at the farm scale allowed for greater mechanization and simplified farm management. Furthermore, a reduction in diversity at the landscape level meant that entire regions shifted to specific cropping and livestock production patterns, such as "the corn belt", the "dairy state", and the "Central Valley". More recently, regions known for the production of high value food products are emerging and are recognized by geographic indications such as Vidalia onions, Sonoma wines, and Driftless cheeses. "Taste of Place" recognition is nurtured in regional markets, and then product recognition radiates to more distant markets. The US Department of Treasury maintains a list of more than 3,000 recognized Appellations of Origin for wine made in the US, and commonly other products adopt these regional brands to differentiate products, especially for global markets.

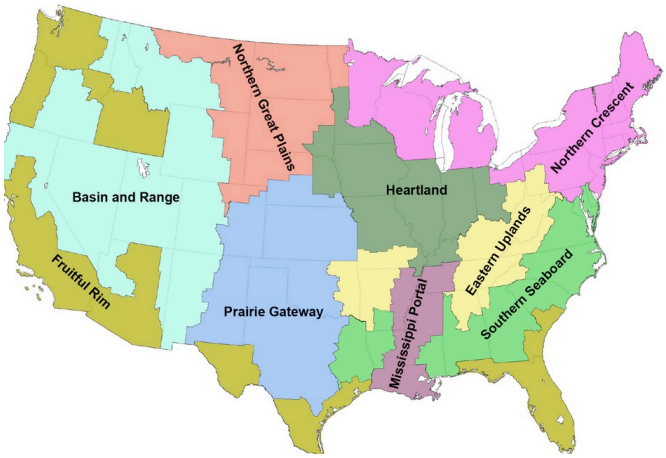


Figure 4. USDA resource regions. Aguilar et al. (2015)

The shift from regional to national and global scale food systems has had a profound and disparate impact on regions throughout North America. As Aguilar et al. (2015) documented in their study on cropping diversity in the US, diversity has declined since the 1970s. Counties are clustering as either low or high diversity with most shifting toward lower diversity, another example of bifurcation. At the resource region level (Figure 4.), diversity in the Heartland region has plummeted, while the cotton-growing Mississippi Portal region is the only region with a noticeable increase in diversity, due to the collapse of the cotton economy.

The Fruitful Rim and Northern Crescent resource regions show a relatively high level of agricultural diversity at the landscape scale because these regions grow much of our fruits and vegetables. The Northern Crescent, a region roughly equivalent to the Great Lakes states extending from Maine to Minnesota, is historically where midscale farmers grew much of the fresh food for cities in the region. Innovations in refrigeration and farming methods, investments in public infrastructure (such as water delivery and freeways), and population shifts from rural to urban settlement (due in part to higher paying jobs in the city), made desert agriculture west of the Rocky Mountains competitive with regional food production. This reshaped the US national food system (Bowman & Zimmerman, 2013). The increased scale of production and specialization made possible by these changes resulted in fruit and vegetable production regions, especially in the Fruitful Rim along the west and southern coasts (Aguilar et al. 2015). Today we see a hot spot of crop diversity in the Fruitful Rim regions at a mega-scale, and lessened diversity throughout most of the rest of the country, even though there is considerable capacity for fruit and vegetable production in most other regions (Aguilar et al. 2015).

Fruit and vegetable production in the Northern Crescent region continues, although it does so at a much-reduced scale than it did decades ago. Fruits and vegetables from Wisconsin and Minnesota are mostly destined for regional processing and distant fresh markets, despite the fact that this is home to more than 20 million people in the Chicago–Milwaukee--Twin Cities region. The same is true in other parts of the region as megacities form in the Northeast states, Michigan and Ohio. Farmers in the Northern Crescent face seasonal constraints, and are not able to attain the scale of production possible in western desert farming. The seasonal timing factor results in a difficult national market that pits regions against each other. Farmers in regions limited by seasonal production struggle to receive fair prices, while growers from distant regions who are less impacted by seasonality may adjust their prices to make up for seasonal losses. With the recent precarious water situation in Western growing regions, grocers saw their brittle supply chains collapse, because the system has minimized redundancy by decreasing diversified regional food production.

Food system history - transportation

Transportation systems respond to and influence crop diversification. Refrigerated trucks and the federal highway system made long-distance food transport reliable and economical. As fuel prices began their steady increase in the 1970s, shippers and carriers managed their businesses to improve fuel efficiency by maximizing distribution efficiency.

The story of CR England, North America's largest wholesale cold chain trucking company, follows the food system's trajectory. Founded in 1920, the company began as a regional food carrier in Utah. They bought their first refrigerated trailer ("reefer") in 1950 and by 1960 the company was operating regular cross-country runs from Western producers to a public terminal market on the East Coast. In 1978, the company opened its first private distribution center in New Jersey, and now operates three more terminals in California, Indiana, and Texas (CR England, 2015). As the largest cold chain company, CR England is at the forefront of logistics innovation. EPA's Smart Way program has honored CR England for its high environmental performance multiple times and most recently in 2015(EPA, 2015). The company serves as a beacon for innovation in food supply chain logistics. Its business trajectory demonstrates the importance of public food terminals to smaller businesses in realizing efficiencies and increasing regional resilience.

The public goal to feed urban populations at the neighborhood level eroded as the private sector maximized distribution efficiency (Tangires,1997). Distributors and grocery chains invested in private terminals, in part to increase fuel efficiency. Cities that once supported pubic food terminals relinquished that function to private distribution centers in the 1970s. By the 1990s, big box stores located at the periphery of cities saved shippers and storeowners fuel costs by shortening their delivery routes. Consumers now incurred the costs of driving to stores, including the costs of car ownership. The expectation of car ownership was furthered by suburban settlement patterns. Managing for maximum fuel efficiency to contain freight costs has created a "self-amplifying circuit", a positive feedback loop, that contributes to altered food distribution patterns, and limited food access, once addressed by smaller, locally-owned businesses (Georner, et al. 2009).

Transportation links products to market. It is a non-linear system with critical thresholds. Certain minimums must be reached for the system to operate efficiently. Sustainable agricultural production involves managing within natural system limits and not exceeding the maximum carrying capacity for specific environmental

conditions. Optimizing diversity at the farm level is a cornerstone of sustainable production. Many crops once grown in the Northern Crescent for wholesale fresh market fell below critical production levels necessary for efficient transportation to regional markets. Attaining transportation efficiencies requires that individual crop production minimums be met for markets of varying sizes. Optimization at the food systems level requires tradeoffs between production diversity and transportation efficiency.

Food system history – urban markets

The need to methodically consider food system organization as a public service is not a new one (Morales, 2000). In the early 1900s, city planners with an eye toward beautification sought to organize cities around market districts and advocated for public investment in food markets, especially for wholesale trade. Walter Hedden, Chief of the Commerce Bureau of the Port of New York Authority, is credited with the first use of the term "food shed" in his 1929 book, "How Great Cities Are Fed," a comprehensive assessment of the New York City food supply. Hedden conducted the assessment after a threatened nationwide railway strike in 1921 made food shortages in New York City a real possibility and he could not find the food system information needed for emergency planning.

During this historical period, cities large and small invested in pubic terminal markets for food. These are markets where shippers – farmers and processors – could unload their trucks and sell their product to buyers at a wholesale price. A terminal market is also called a cross-dock, since the product is unloaded from one truck onto another when ownership of the product is conveyed from one party to the next. The public cross-dock system accommodated shippers and buyers of any size, as long as it was wholesale.

Food businesses depended on public distribution infrastructure to grow and develop. As national supply chains grew, they were able to outcompete smaller regional chains. They could carry products out of season, realize efficiencies of scale, and could privatize the business functions of cross-docks. The public terminal markets had provided access to wholesale trade regardless of the size of the business. This meant that smaller and emerging businesses had access to markets. The privatization of terminal functions required businesses all along the food supply chain to operate at a minimum scale to participate. Smaller businesses were either squeezed out of the market or were forced to grow larger to participate. It is unclear why public investment in wholesale facilities dwindled and if anyone forecasted the consequences of privatization. The lack of wholesale market access led to limited market access for farmers and food processing entrepreneurs, and higher prices for consumers. For more on consolidation in the grocery industry and it disparate geographical and price impacts, see Harrison and Baffoe, 2016; OECD, 2013; Martins, et al. 2010; Howard, 2016.

The evolution of our food system during the last century has left a lasting legacy. Population growth and shifts from rural to urban settlement, labor market dynamics, even the way we measure economic success has contributed to shaping our current transportation system and the transportation challenges we face.

Food transportation trends

Two long-term trends continue to have profound impacts on the food transportation system. They are the cost volatility for fuel and labor, and the on-going shift in population settlement that

increases food distribution costs. A third trend, extreme weather from climate change, is now in play.

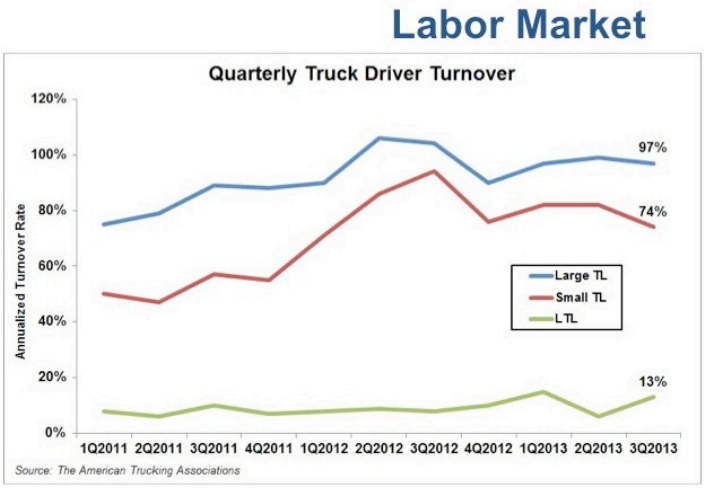


Figure 5. Driver turn-over 2011-2013. Source: American Trucking Associations.

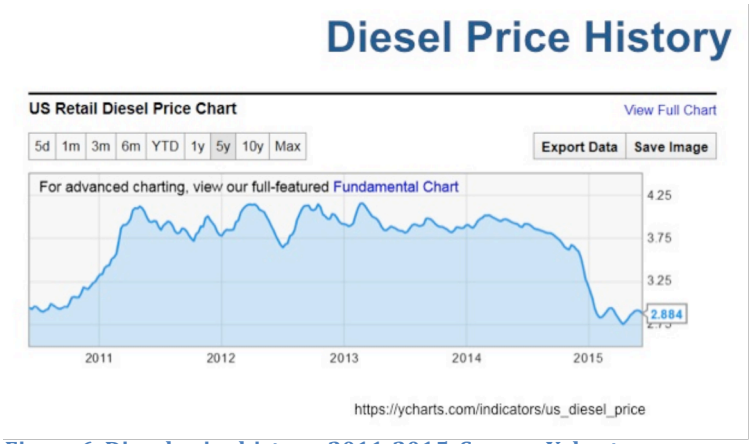


Figure 6. Diesel price history, 2011-2015. Source: Ycharts. com

When food supply chains nationalized in the 1960s, diesel was cheap and readily available. Since the Oil Crisis in the 1970s, businesses began to tightly manage fuel costs, estimate fuel price volatility, and look for innovations that would improve fuel efficiencies. For transportation businesses, predictability in their costs to move food from shipper to market helps managers organize their assets, such as tractors and trailers, to full advantage. Cost volatility is especially difficult for transportation businesses when attempting to predict volatile costs over the term of a contract with a shipper, or over the useful life of a tractor, trailer, truck yard or other asset. Figure 5 shows the diesel price history for the five years between 2011 and 2015. Prices skyrocketed from under three dollars a gallon to over $4 per gallon, and then dropped back down after three years of high prices. Labor trends are also of concern. Truck driver turnover, especially for full-load, 53' trucks, has varied between 70—97% in that same five-year period (Figure 6).

Underlying these trends in cost volatility is the shift in population. Urbanization and population growth are global trends that profoundly impact food systems. We see the impact from this population shift expressed as increased traffic congestion around cities like Los Angeles, New York and Chicago. By 2050, it is anticipated that much of the US population will reside within eleven megaregions (Figure 7). Concentrating people into megaregions increases traffic congestion within regions and acts as

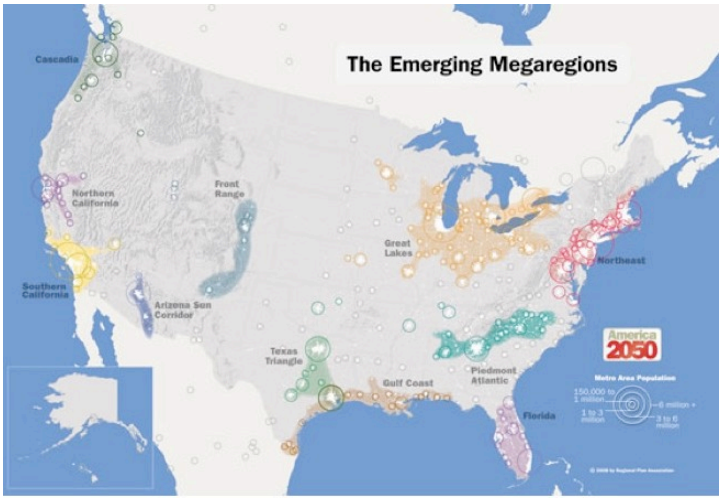


Figure 7. Megaregions 2050. Source: America 2050.

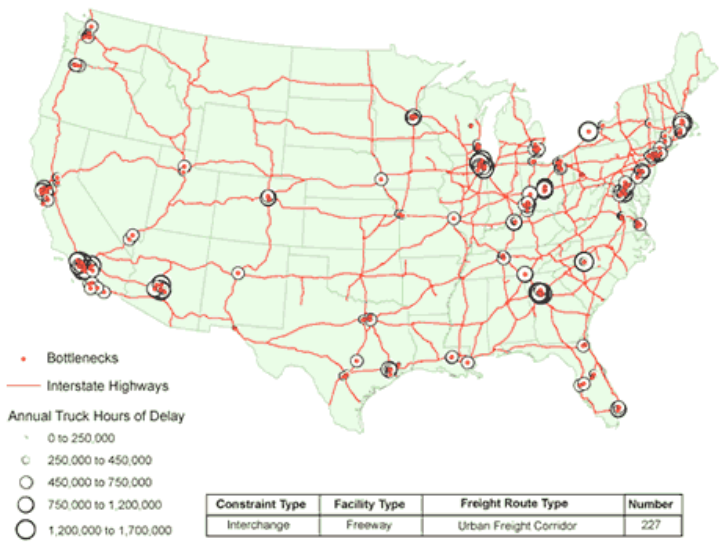


Figure 8. Major highway interchange bottlenecks for trucks. US DOT Federal Highway Administration. https://www.fhwa.dot.gov/policy/otps/bottlenecks/execsum.cfm

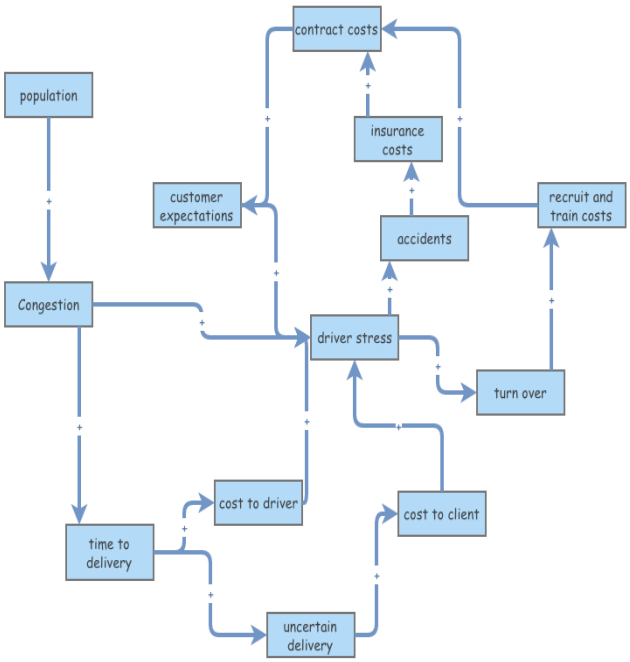


Figure 9. Reinforcing relationship between congestion and labor costs.

a barrier to entry on the outskirts of the region (Figure 8). The overall flow of food within the US contributes to congestion. Lin and colleagues *(2014) mapped US food flow,* identifying nine core nodes out of a total of 123 nodes nationwide. Of those, international shipping ports are critically important, as are three in the Upper Midwest. The US food flow is vulnerable to disruption at these key nodes. Their research indicated that the US is the most central country in the global food trade network, and the movement of food from Illinois to Louisiana is the largest flow within the country.

The trucking industry bears a heavy cost for congestion. Congestion dramatically reduces fuel efficiency for freight trucks, since they are designed to be most efficient when traveling over long distances at steady speeds. Stop and start traffic, common on congested roads, wastes fuel and results in unnecessarily high GHG emissions. Refrigeration on trailers typically runs on diesel, so slower traffic increases the likelihood that a driver will need to stop for a rest and leave the engine running to power the refrigerated trailer (commonly termed “reefer”). Most trucks on the road today are engineered to handle both urban and interstate driving, making them relatively inefficient in both settings.

Perhaps more challenging for supply chain managers of all sizes is the reinforcing relationship between labor costs and congestion (Figure 9). Congestion increases driver stress and accidents, and increases the cost to insure drivers, while slowing delivery and increasing the uncertainty in delivery schedules that costs clients and which ultimately increases driver stress. Companies typically pay drivers by the mile, so as traffic slows, the driver

compensation rate falls. Drivers would commonly work extra-long days to compensate for congestion and to improve delivery times. In an effort to make congested roads safer, the Department of Transportation implemented a reporting system for truck drivers to limit and document their hours of service on the road, but with the reliance on driver logbooks, ensuring honest reporting of hours has been difficult. As of 2016, many fleets are implementing electronic reporting so that driver logs are automatically sent to the company. This makes driving beyond the allowable hours much less likely.

The difficulty of finding locations to take legally required breaks is another concern. Drivers approaching congested road segments near the end of their shift must find a place to stop their rig, and take their mandatory rest period. Drivers have reported spending significant time on the outskirts of cities, searching for an appropriate place to rest. All of these factors increase driver turnover, which increases company costs to recruit, train, insure and retain new drivers.

Agricultural labor is also negatively impacted by urbanization. Urbanization concentrates people in megacities, and it drains rural regions of a labor force for agriculture because rural labor markets cannot compete on wages with the greater opportunity for higher paid work in cities. This profoundly impacts rural communities and their economies, especially those towns reliant on midscale farms selling into wholesale markets. The pressure is to bifurcate – get bigger, and hire low-paid workers, or get smaller and sell into direct markets. The USDA Economic Research Service documents that in 2012, hired farmworkers (including agricultural service workers) now make up 62% of those working on farms; the rest are self-employed farm operators and their family members. The majority of hired farmworkers are found on the nation's largest farms, with sales over $500,000 per year. Almost three-quarters of hired crop farmworkers are not migrants, but are considered settled, meaning they work at a single location within 75 miles of their home. This number is up from 42 percent in 1996-98 (USDA ERS 2015).

As the migration from rural to urban areas has accelerated, rural towns that once supported the daily needs of community agricultural labor, migrant labor as well as part-time seasonal labor, have lost resources generated by small and medium sized businesses and the incomes they provided. According to the USDA-ERS summary of the Current Population Survey, a joint effort by the U.S. Census Bureau and the U.S. Bureau of Labor Statistics, about 56 percent of hired agricultural workers are in crop agriculture, and the remaining 44 percent work in livestock. Roughly 37 percent of all hired farmworkers live in the Southwest (defined to include California), and 25 percent live in the Midwest. Two States--California and Texas--account for more than one-third of all farmworkers. For the Upper Midwest, the demise of "follow the crop" migrant farm workers, who move from state to state working on different crops as the seasons advance, may be an indicator of the loss of mid-scale farms and a subsequent move to year-round hired labor. Part-time seasonal workers supplement family labor on midscale farms, while full-time workers are more common on large farms.

Climate change, extreme weather, and policies directed to mitigate greenhouse gas emissions have important implications for the linked food and transportation sectors (Bohringer et al., 2016, DOT 2015). Extreme weather is disrupting transportation systems and damaging infrastructure. As much as twenty four percent of total global greenhouse gas emissions come from agriculture (IPCC 2014) while the US transportation sector accounts for another 28% (DOT 2015, Figure 10). Cars and light duty trucks account for 61% of this segment, medium and heavy-duty trucks account for 23% of transportation sector GHG emissions. The report stresses

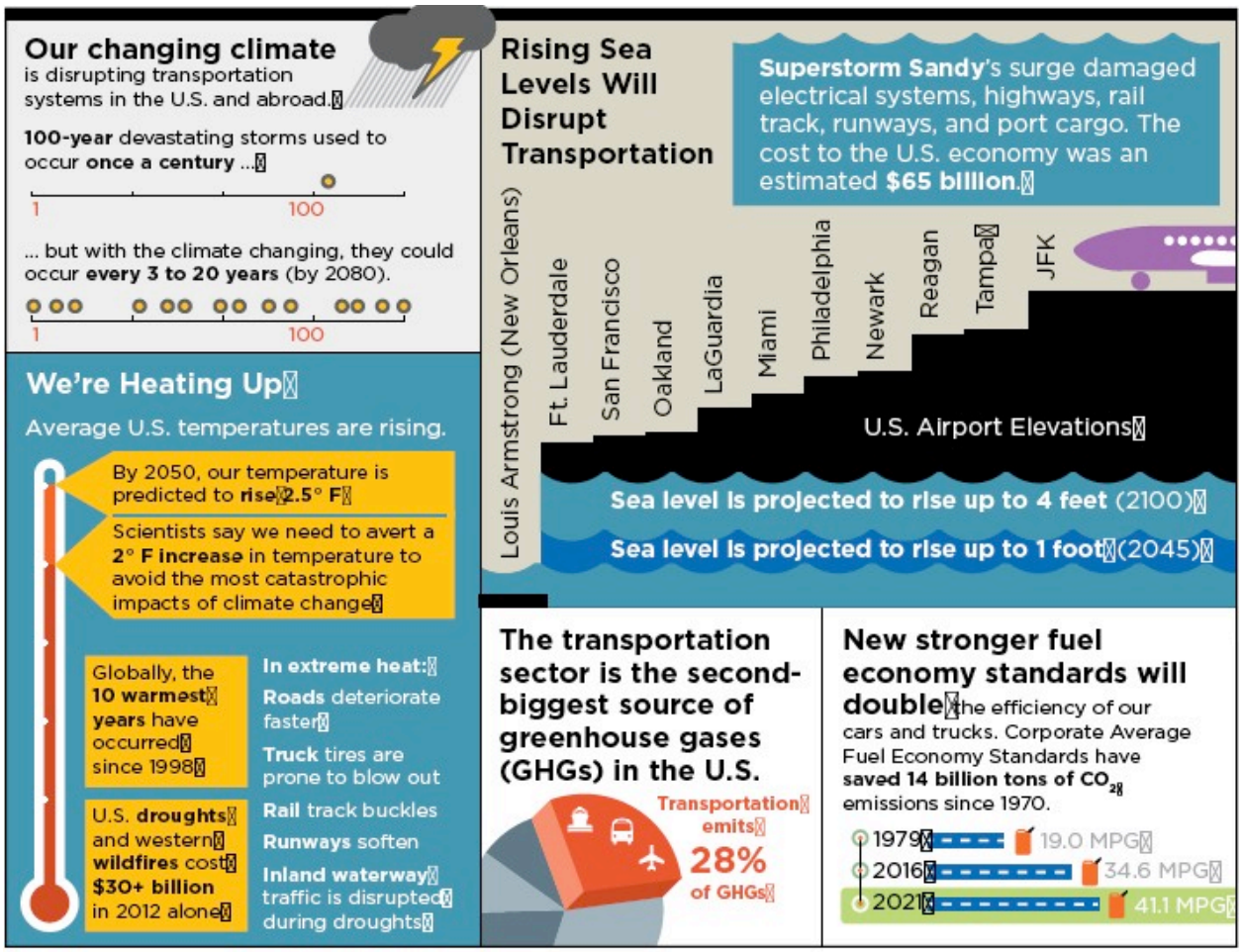


Figure 10. Climate change adaptation. US DOT (2015)

the fact that from 1990 to 2014, GHG emissions in the transportation sector increased more in absolute terms than any other sector analyzed (i.e. electricity generation, industry, agriculture, residential, or commercial)(EPA 2016).

Choosing where to grow crops, where to process them and how to deliver them to consumers may be an integral part of adapting to climate change. Rain-fed and irrigated farming across the country will be affected by climate-induced changes in precipitation. The competitiveness of fruits and vegetables from California rests on the assumption that we should grow crops in the desert and that water will be available. As cropping patterns change, food flows and freight movements will change, too. Restrictions on the carbon emissions in diesel fuel will also change transport costs of produce from different locations. West Coast fruits and vegetables sold in megaregions in the Eastern US generate carbon associated with the fuel used to haul them over the Rocky Mountains.

Rising population and urbanization, increasing fuel and labor costs, extreme weather and volatility are global trends. These challenges demand that we think strategically about food production and distribution, not simply in the context of scale, but in a systems context. In that way, we will be better able to meet multiple goals such as environmental protection, decent and equitable work, access to good food, and resilient regional economies.

A closer look at the Upper Midwest

We directed our focus on a particular production / market region: the Upper Midwest. Here, a constellation of cities has developed a unique food flow, one that supports regional food production while serving as a hub for national and global food flows. Regional production is relatively diverse, with commodity dairy and grain production, as well as remnants of a once-vigorous specialty crop economy around fruits and vegetables. Each city in the region has played a unique role in the Upper Midwest food economy: Minneapolis/St. Paul and Madison drive direct marketing through farmers markets, CSAs and grocery cooperatives. Chicago/Milwaukee work in tandem to create a hub for food produced in Western states moving east.

Wholesale markets for regionally produced food are built on the success farmers have had in direct markets. Supermarkets see local and regional food offerings as a potential competitive advantage in a highly competitive market (Lyson et al. 2008). The Dane County Farmers Market in Madison, WI began in 1972 with a handful of vendors and now ranks as the nation's premier producers-only farmers market with 275 vendors over the season (120 -180 vendors each Saturday). An estimated 20,000 visitors attend the Saturday market each week. In addition to the Saturday market, twelve neighborhood farmers markets in Madison and 9 markets in surrounding Dane county cities and villages create an opportunity for local farmers to truck fresh food to consumers.

Madison is also home to the first association of CSA farmers, Fair Share CSA Coalition, organized in 1992. In 2015, thirty-three CSA farms delivered food to 179 neighborhood locations throughout Madison on a weekly basis during the growing season (Miller, 2016). Restaurants in the region support local farmers through farm-to-restaurant sourcing, some purchasing food direct from farmers since the start of the Dane County Farmers Market. These direct markets improve the quality of life for residents and draw tourists to the city, but they are highly inefficient food movements. Small trucks, many not fully loaded, and some from more than one hundred miles away, participate in the direct market. Because residents purchase local food from city farmers markets and CSAs, they increasingly demand local food from groceries and institutions.

The region has a storied history of cooperatives, beginning with farmer coops organized to sell crops, crop inputs, and process farm products. The coop scene shifted to consumer coops, especially in the early 1970s. Stockinger and Gutknecht (2014, also Lengnick et al. 2015) document the vibrant Minneapolis/St. Paul grocery coop scene. Seventeen retail food stores serve about 140,000 consumers in the metro area of almost three million inhabitants. They estimate nearly a third of total retail sales were regionally produced. The stores rely on the active participation from their 91,000 co-op member-owners who connect the businesses to the community. The coops have a legacy of long-standing business relationships with more than 300 farmers in the region who serve the stores and sell product through a cooperatively owned distribution center. Farmers direct-deliver about 60% of the stores' local product, while the local distributor—Co-op Partners Warehouse (CPW)—moves about 20% of the local product sold at the groceries in one of two ways. CPW purchases product like a traditional distributor, but also provides space for farmer-directed distribution services. Smaller farmers who sell to co-op stores aggregate their product for shipment on farm and then share direct-to-store delivery tasks. The Twin Cities cluster of retail cooperatives, farmers, and the cooperative distribution center is closely aligned with similar co-op clusters in smaller cities and towns in the Upper Midwest, which also have overlapping and unique relationships with sustainable farmers, food supply chain businesses, and the communities they serve. Citizens and businesses in towns in

the Upper Midwest, with the Twin Cities as the urban core, are creating and sustaining viable regional supply chains built to scale with sustainable regional farms.

Grocery and distribution cooperatives are only part of the region's co-op story for food supply chains. Organic Valley is a cooperative owned by organic dairy producers based in Wisconsin's Driftless region, and was a partner in developing the Twin Cities consumer co-op scene. It provides marketing, processing, and supply chain services to its farmer-owners (CIAS, 2013). Many of the farms supplying direct and regional wholesale markets are located in the Driftless region, the unglaciated landscape along the Upper Mississippi River. This production region is famous for organic milk production, raw milk cheeses, grass-fed beef, micro-cideries and breweries, and regionally unique wine grapes and apples.

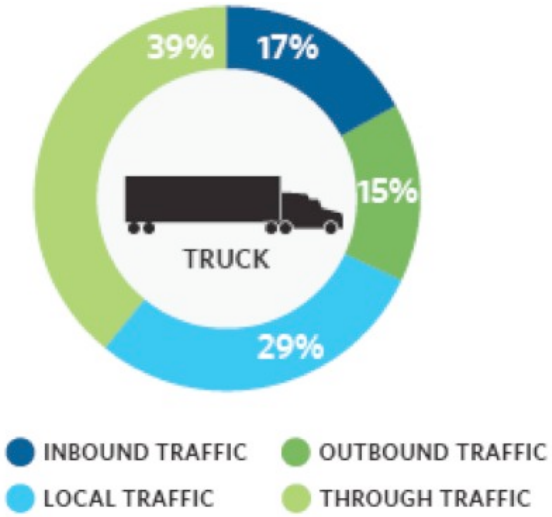


Figure 11. Percent of regional truck freight volume by trip type in 2007 for the seven-county Chicago region. CMAP (2012)

During the period that the Twin Cities and Madison were building a farmer-centric food system, the Chicago-Milwaukee urban corridor was taking its place as a gateway for national and global food freight. Over a quarter of all US freight originates, terminates or passes through the Chicago region. Over a billion tons of freight worth over $3 trillion moved through the Chicago region in 2007, though volumes naturally fluctuate year to year with economic ebbs and flows. Of that, food freight accounts for $232 billion dollars annually. Although rail and barge account for significant portion of freight movement, especially of non-perishable products, 67% of all food freight is moved by truck whether it is in the over-the-road (OTR) or last mile segments. (CMAP 2012). Freight moves vary by trip type, and "through traffic" — which initiates and terminates elsewhere — is the largest component of truck freight because the region serves as a midway point for continental moves. Trucking also has a high volume of movement within the seven-county region (Figure 11). Lin and colleagues (2014) work on food flow indicates Illinois' importance within the national food supply chain. In 2010, the largest square footage of food warehousing was located in the Chicago region, according to industry sources (MWPVL 2010). A 2010 analysis by the Texas Transportation Institute indicated that the Chicago region had the worst traffic congestion of any urban area in the nation – resulting in over 31 million annual hours of truck delay and a congestion cost of over $2.3 billion (Eisele et al. 2013). This cost includes only wasted time and fuel due to congestion and excludes costs or penalties for late shipments or any other extra costs to shippers and carriers for changes to their business practices or investments necessitated by serious congestion.

The emerging edge of regional food systems

An early insight from our inquiry is that businesses engaged in local food supply chains generally fall into one of two categories. The first category is made up of businesses that are scaling up, that is, moving from direct to wholesale markets. These entrepreneurial shippers are typically grounded in sustainable agriculture practices and are searching for ways to move food

more efficiently to market in an effort to save transportation costs so that they can grow their business. They are new to the world of wholesale freight movements and struggle to find a way to enter existing, usually large volume, supply chains or create new wholesale chains.

The second category consists of shippers who have been wholesaling food for a decade or more, and their supply chain partners. Generally, the scale of these businesses is larger. Often multiple farmers are working together through a packinghouse or other processor to ship product jointly. Many shippers at this scale have been around for decades, and survived upheavals in regional supply chains as national supply chains have grown. The market is ferociously competitive between regional and national shippers, especially between the Fruitful Rim and Northern Crescent shippers. The competition has also increased between shippers in different states within the Northern Crescent region, for instance between apple growers in New York, Michigan and Minnesota.

To stay in business, mid-scale shippers had to be innovative and hyper-attentive to market trends, including environmental and social trends. They are already linked with freight companies who are facing transportation challenges such as traffic congestion in metro areas, additional regulations implemented to improve safety conditions on federal freeways, and volatile fuel and labor costs. Furthermore smaller shippers have typically relied on smaller trucking companies, especially for shorter movements to near-by markets and for "first mile" movements from farm field to packinghouse, processor or other aggregation point. Many of the owners of smaller trucking companies are aging out of the business with no plan to transition their businesses to young entrepreneurs.

Both of these categories of shippers – those that are scaling up operations from direct to wholesale and those that are currently competing in the national arena - are looking for ways to make freight movements more sustainable, so that the supply chain reflects the shipper's environmental commitments and community values. Both want to find the sweet spot between diversity and efficiency to build system resiliency.

Diversifying food production to better serve regional markets is an important strategy for increasing resilience throughout the food supply chain. At the farm management level, diversifying crops can help to hold the soil in place, reduce or eliminate the need for expensive and sometimes toxic off-farm inputs, and build a stronger rural economy for midsize agriculture, also referred to as "agriculture of the middle". Regional supply chains made up of a greater diversity of products can supplement and stabilize national supply chains, especially in times of extreme weather and economic turbulence. As metro regions continue to grow, so too will the need for regional food supply chains organized from midsize businesses and start-up food entrepreneurs. But balancing diversity and efficiency comes at a price. Optimizing both goals – efficiency and diversity - is the challenge for businesses that make up sustainable food supply chains.

Because there are two very different categories of shippers selling into regional wholesale markets, there are two very different but aligned conversations in play that pertain to food freight transportation. These two types of businesses have much to learn and gain from one another, as well. Our research team and practitioner-advisors represented both categories. This required us to better understand each other's language, perspective and worldview. We explored the history of food supply chains through the lens of business development. History pointed to some potential "missing pieces" in food system infrastructure. In the process, we identified "proof of

concept" businesses that systemically alleviate transportation barriers to regional food supply chains for midscale businesses. By employing a systems approach, these businesses were able to successfully address other failures in the overall food system.

Optimizing both goals – efficiency and diversity - is the challenge for businesses that make up sustainable food supply chains.

Improving the regional organization of food flow, based on an understanding of the nonlinear constraints in regional food movements, may allow private sector entrepreneurs to seize opportunities to optimize fuel use without sacrificing food access. These dimensions of regional food distribution have significant ecological and economic implications that remain underexplored.

Farms that aggregate products for shipment use multi-firm collaboration. Forward-thinking businesses and the public sector could organize and support similar efforts within food supply chains to improve collaboration between shippers, trucking firms and wholesale buyers. Business investment in multi-firm collaboration puts innovative entrepreneurs in the lead as investors in developing societal assets (Miles et al. 2005). This is possible when a core group of firms have a shared vision, common set of values, competence in collaboration, and interest in continuous innovation, as we see with farms committed to sustainable agriculture. For continuous innovation and collaboration to emerge, supply chains need redesigned reward and control systems. As noted earlier, Choi and colleagues (2001) support the idea that positive interaction through rewards is more effective at managing complex adaptive systems. Protocols are needed for when and how decisions would be made and disputes resolved to support self-governance and timely action.

The conversation around scaling up.

Entrepreneurs in newly emerging regional supply chains have a steep learning curve to become volume shippers, a step that is necessary to enter wholesale markets. To better understand the freight transportation system our team and advisors needed to clarify terms and better understand system nuances.

How does food move? Trucking companies and wholesale buyers need consistency and volume from shippers in order to best utilize their equipment and storage or shelf space. Like any business that has invested in equipment, they strive to use tractors, trailers, loading docks, and refrigeration to its fullest extent. A truck that is not on the road or a store that lacks inventory is a financial drain.

Businesses that are scaling up from direct sales to wholesale markets may be learning how food moves to market. Figure 13 depicts food movement from a production region to a city. Food produced on a farm may be moved directly from the farm to a wholesale buyer, in which case the farmer acts as the primary shipper. If the farm is smaller in scale, the food may first move to an aggregation facility, such as a packing-house for fresh fruits and vegetables, or a processor such as a dairy or product manufacturer. The movement to the aggregation point is known as a "first mile" movement. In this scenario, the aggregator is the primary shipper that is responsible for moving food to the wholesale buyer.

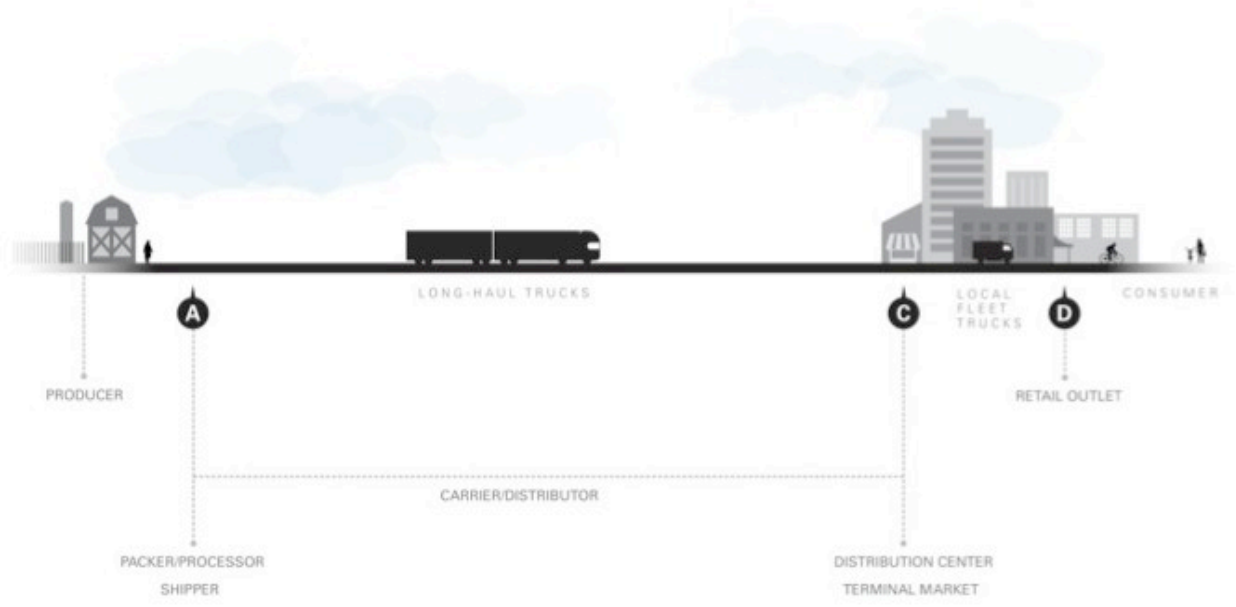


Figure 12. Food freight movement. Image by Julia Schilling.

The next movement segment is called "over the road" (OTR) or long haul. Generally this is a long-distance movement of at least 150 miles, where trucks are moving on federal and state highways at a steady speed. In trucking parlance, it is associated with trucking companies that move products throughout the lower 48 states, while regional trucking consists of freight movements limited to a group of states in a region, such as the Northeast or West Coast. Efficient OTR movements are accomplished by filling 48' or 53' trailers, and sometimes include hooking two trailers together in tandem. Trailers must be full, either by volume or weight, and intended for delivery to one buyer or **one terminal** for efficiencies to be realized. Consistent delivery is highly valued since it allows trucking companies to anticipate asset utilization. There must be "enough trucks running on enough days with enough product" for the shipper to move product with a trucking company efficiently, as one project advisor said at the Chicago meeting.

This is a challenge for agriculture in general, and diversified agriculture, in particular. Weather patterns are increasingly unpredictable and influence what food can be grown, when it is harvested and available for sale. When food production is overly fragmented, it costs more to ship it because it is harder to aggregate sufficient seasonal product to fill trucks and anticipate timing. Too little regional crop diversity means that there are not enough farmers who are growing sufficient acreage to meet shipping minimums for specific products at harvest. Too much product diversity at the farm level increases the complexity in aggregation and shipping minimums can't be met consistently. Volatile and extreme weather exacerbate inconsistency.

Shippers, their brokers, and trucking companies manage these complexities when selling food to wholesale buyers, who also put a premium on consistency. Shippers typically contract with buyers a season ahead, by assessing needed acreage of crops and estimating harvest. Store buyers are anticipating seasonal customer demand, and then allocate store space and purchase advertising in sync with product availability. When a crop is harvested or delivered early, late, or is of insufficient quantity or quality to meet the contracts between shipper and

hauler and buyer, a complex set of negotiations must successfully occur between actors in the supply chain in order to maintain the business relationship. Ultimately, the supply chain is a set of relationships that rest on trust.

Smaller shippers tend to use spot markets to move their product. Spot markets are short-term contracts that are executed immediately. Most refrigerated trucking companies need between $600 and $750 of revenue per truck per day in order to be profitable. Inconsistent shipments result in poor asset utilization for carriers, making spot market prices higher for shippers. Trucking companies consider the number of years of doing business with a client as an important factor in setting any contract terms. In addition, carriers prefer to schedule pickups and deliveries according to their own schedules and prioritize their customers accordingly.

Shippers contract with trucking companies to pick up food at a loading dock, and then move it to a terminal point, or cross-dock where goods are unloaded from the trailer and transferred to a new owner. Today, terminal points are most likely a food distribution center that is privately owned by a distributor, restaurant chain, or grocery chain. The “last mile” delivery takes products from the distribution center or terminal into restaurants, groceries, and other institutions where end consumers commonly drive to the store or restaurant and purchase products at a retail price.

Building a nested network: regional food terminals serving wholesale markets

As towns develop into cities and then evolve into metro regions and megaregions, shipping terminals are an important piece of infrastructure to match midscale farm production to regional markets. The non-profit distribution systems developed to serve food banks, pantries and other emergency food needs are examples where charity organizations have stepped in to address a public need for better food distribution. This same model, targeting the needs of small businesses, has potential to grow local and regional economies.

Proximity to a significant supply region and to a strong market allow terminals to both aggregate product from farmers and to disaggregate product to retail outlets. Terminals that are distant from farms, such as is the case with Chicago terminals, will support primarily disaggregation, while terminals that are distant from cities will support aggregation and be a net “exporter” from their area. Terminals in small and midsize cities are in a position to serve both aggregation and disaggregation functions.

By providing a space where many smaller businesses may do business collaboratively, public terminals with a mission to support smaller-scale supply chains create efficiencies, especially in transportation to market. A wholesale market that accommodates various scales of wholesale trade, from an occasional truck load or seasonal offering, to mid-scale distribution where product is available daily and year-round, provides a public good in supporting smaller supply chains, the entrepreneurs that create them, the people they employ, and the communities they serve. Public investment in creating these types of facilities for midscale businesses to utilize can pay off, as has been the experience at the Ontario Food Terminal.

Proof of concept: The Ontario Food Terminal

The Ontario Food Terminal, just outside of Toronto, is the third largest food terminal in North America. In addition to renting warehouse space to about twenty larger distributors, the facility serves about four hundred farmers who sell wholesale at lesser volumes and seasonally. About 5,000 wholesale buyers are registered to do business at the Ontario Food Terminal, ranging from large volume buyers who purchase for chain stores to independent caterers who seek smaller volumes. The Terminal provides a cross dock for small and midsize shippers that creates a marketplace for independent businesses operating at a scale too small for large North American supply chains. Farmers from a two-hundred mile radius bring product to the terminal, and buyers come from much further away. The Ontario Food Terminal (Figure 13) is an anchor for the regional food economy, with an estimated 100,000 direct and indirect jobs attributed to the terminal in the Great Lakes region (Lengnick et al. 2015). In operation since 1954, the OFT is unique in that it is governed by a board appointed by the provincial Secretary of Agriculture. Ontario provided the original investment for the land and building, which was paid off in full in the first years of operation. The terminal functions as an independent, self-sufficient non-profit business. It generates income from rental fees from tenants, including a bank, grower associations and cafes, and charges a nominal buyer membership fee. Electricity, maintenance and improvements, and labor costs for the terminal's thirty-six employees are the core of the budget. The terminal has undergone a number of improvements since its inception, including expanded cold storage, shelter for wholesale farmers, and parking for business clients.

Figure 13. Ontario Food Terminal cross dock. Tenants rent warehouse space on the left. Trucks pull in to load on the right. Photo by M. Miller

The conversation around efficient regional midscale food movements

Farmer-shippers interested in serving the Chicago region are not able to efficiently ship product into the city due to traffic congestion on area highways and a lack of supply chain infrastructure to serve the needs of smaller shippers and wholesale buyers. In response to their need, our team researched options for improving access to Chicago markets for regional shippers.

We investigated two approaches to optimizing regional food freight for megacities. First, metropolitan regions could create infrastructure that splits rural and urban routes, essentially paving the way for trucks to become, in a sense, multimodal –splitting the OTR and urban segments to enable higher efficiency vehicles and operational strategies in each setting. This

innovation is not specific to truck fleets moving food regionally, as it could benefit shipments of any product into major cities. Chicago is a special case-in-point since it serves as a gateway for food moving west to east. Improving food movements in the Chicago region could have a significant impact on all congestion at both the local and national levels by helping to alleviate a chokepoint for through-freight.

Second, metropolitan regions would benefit from providing incentives for regional food shipment. In addition to supporting diverse cropping systems in farming communities around the city and strategically locating food terminals to support smaller supply chains, agencies may also want to consider extending federal clean air incentive programs. These programs target companies headquartered within the region with air quality concerns. By making them available to company fleets based outside the region of concern, but with dedicated shipping contracts into the region, it is more likely that air quality improvement targets will be met.

These strategies have the potential to achieve a high level of systems improvement at a significantly lower cost than expanding highway infrastructure. They are strategies that reward behavior rather than giving negative feedback through new regulations. They also promise to reinvigorate neighborhood food economies, both rural and urban, by stimulating small business development.

Supporting the transformation of truck fleets to multimodal

An underlying barrier to optimal freight movements is the "jack of all trades" truck (Figure 14), whose routes may fluctuate between very short to long haul routes, transitioning between rural and urban environments. Engineers have developed multiple improvements to tractors and trailers, but many of them are specific to vehicles traveling in rural or in urban environments, not both (Figure 15). The technologies are there, but companies have been slow to adopt.

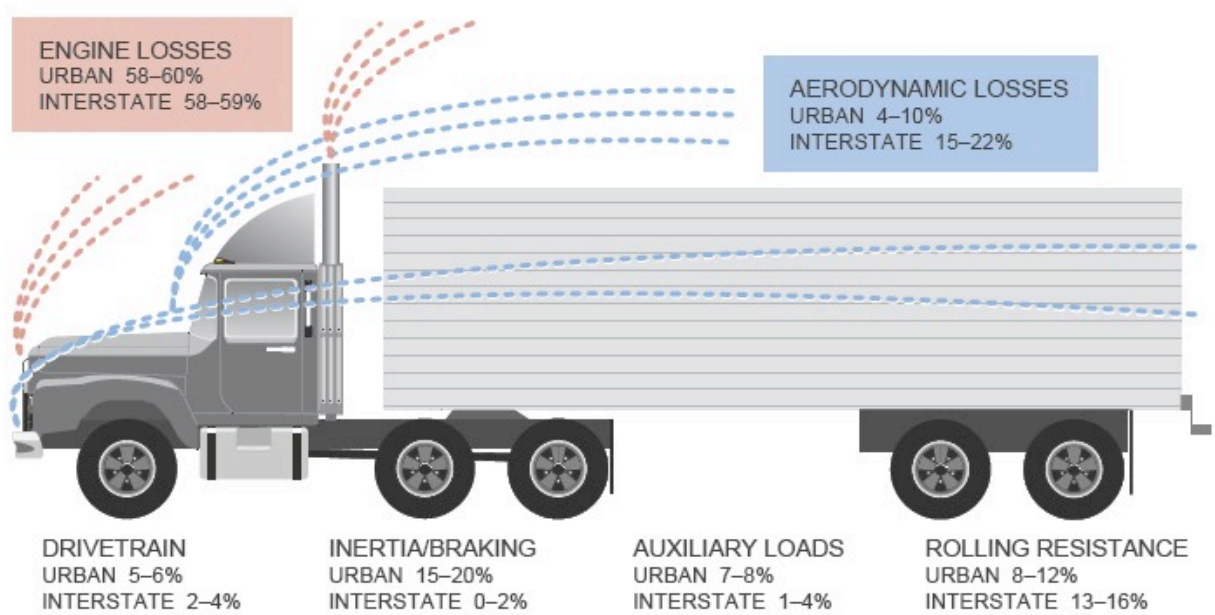


Figure 14. A "Jack-of-All-Trades" tractor-trailer. Energy loss range of vehicle attributes for a Class 8 truck as impacted by duty cycle on a level road. NAS 2010, NPC 2012.

	Long Haul (Rural)	Intra-City (Urban)
Route	65 mph, 500 miles/day	Start/Stop, Pickup & Delivery
Equipment	Optimized for Long Haul	Maneuverable, Low Emission
Technologies	Aerodynamics, powertrain, LRR tires, idle reduction	Alternative fuels, high level of telematics, safety systems
Drivers	Out two weeks sleeping in truck	Home every night, tenured
Future	Platooning, Long Combination Vehicles, Autonomous and even self driving for 24/7 operation	Traffic jam operation, scheduled deliveries, kitting, zero emission
Examples	Autonomous SuperTruck	Electric, City automated trucks

Figure 15. Comparison of rural and urban shipping segments. Roeth (2016)

Infrastructure such as drop yards (Figure 16) allows truck fleets to specialize their vehicles to serve rural and urban segments. Drop yards strategically positioned outside the congestion zone surrounding megacities provide trucking companies a way to improve their operational efficiencies. Drop yards are a place for drivers to drop their trailer and switch loads to tractors optimized for either rural or urban routes. Drop yards also allow drivers to take their rest breaks and access services outside the congestion zone. One energy-saving service could be power outlets intended for reefers so that they may run on electricity rather than diesel, further reducing costs and air emissions.

Truck companies could pay drivers differently too – by the mile on OTR and based on time for the urban segment. Unlike moving freight over great distances at a steady speed, driving metro routes requires shippers to contract for a relatively short distance at an uneven pace. To accommodate this, companies using drop yard infrastructure could contract to pay drivers by the hour instead of by the mile for the urban segment. Carriers could then charge shippers by the asset instead of the mile for route services. Trucking companies might be more likely to retain experienced drivers to cover more challenging routes. Because drivers would be more productive making deliveries during less-congested evening and weekend hours, shipping rates could be lower during these off-peak times, which would improve congestion. Cities interested in shifting freight traffic to off-peak hours could provide additional incentives to regional companies to ensure fair wages for their drivers and a robust regional food economy.

Siting and installing accessible drop yards for trucks to swap trailers will require public and private investment and coordination. The drop yard concept was of particular interest to trucking companies that participated in our workshops. For instance, Schneider trucking maintains two private drop yards in the Chicago region. Access to additional yards at different city access points would be desirable for logistical reasons, but their shipping volume doesn't warrant the private investment. Similar to the non-profit terminal concept for shippers, a place for trucking companies to share logistical opportunities outside large urban areas would improve logistics, save fuel and meet other efficiency goals.

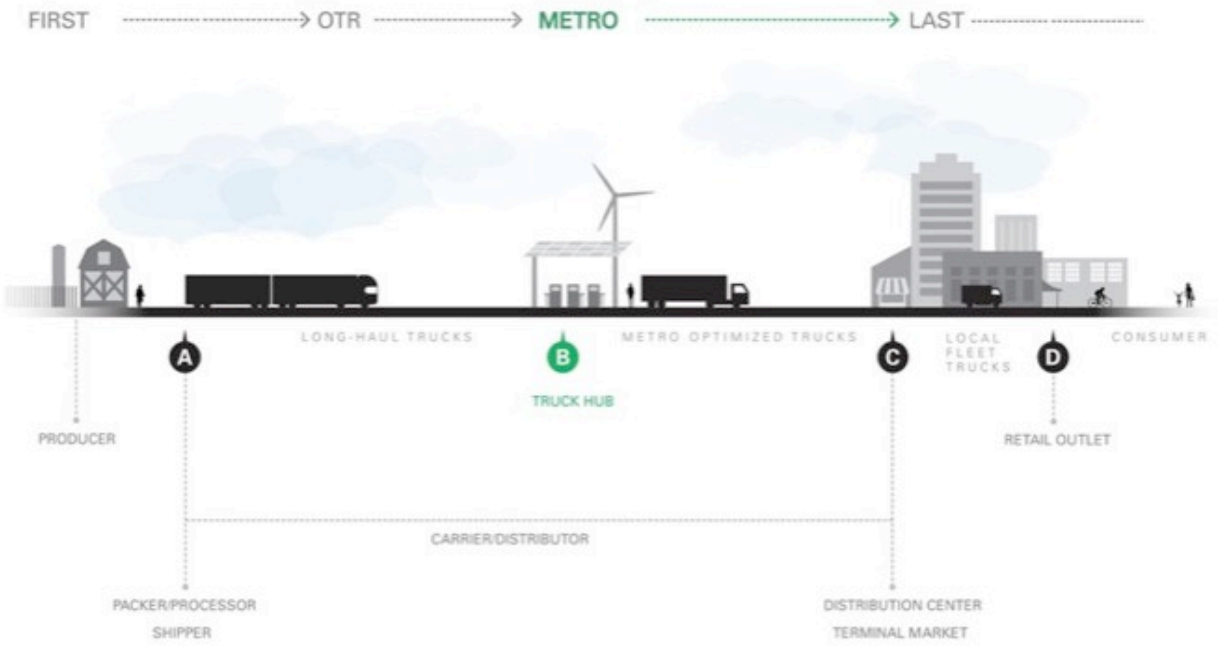


Figure 16. Freight infrastructure innovation: adding a truck hub or drop yard to accommodate "green" shipping into metro regions. Image by Julia Schilling.

Issues around supply chain governance and ownership, especially trailer ownership and security, are of immediate concern. Dedicated carriers may find it easier to use a public drop yard than independent companies working in the spot market. However, dedicated carriers are not commonly operating at the smaller scale of regional grower-shippers. Support for non-profit terminals and for greater crop diversification may increase the production scale that would make drop yards an important part of regional food shipments of many commodities.

Proof of concept: CR England

In 2015, CR England invested in drop yard infrastructure just fifty-six miles outside of Los Angeles. As a dedicated contract carrier – that is, a trucking company that contracts with a specific shipper to move product along regular routes —it is relatively straightforward to swap a truck tractor designed for long-distance hauling with another tractor for the urban segment of a trip. This practice has allowed the company to power some of its urban trucks with more efficient alternative fuels, adopt technologies to improve long-haul efficiency on other tractors, and improve overall fleet efficiency.

The Southern California facility includes a maintenance shop, Driver Resource Center, and parking for more than 250 tractors and 350 trailers. The new facility made it possible to expand their local fleet with Liquefied Natural Gas (LNG) tractors. The company credits collaboration with vendors and shippers–positive freight market dynamics-as critical to the success of converting to LNG tractors (CR England 2014). A contracted rate structure allowed for greater efficiencies between the urban and rural segments of the trip. Now, the OTR fleet moving product from the shipper to the drop yard can move continuously, while the local fleet can drive the shorter distance inside the urban area with LNG vehicles. This reduces fuel costs, and air pollution that is released while trucks wait in queues at congested delivery points, such as the Port of Los Angeles. It also allows the company to make better use of drivers and their skills,

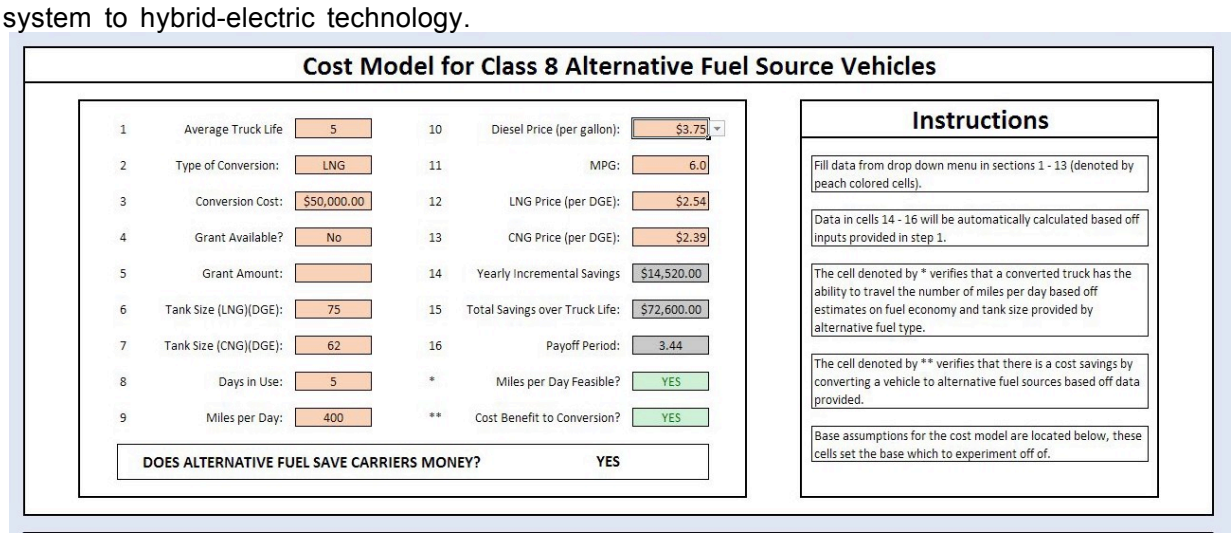
where newer drivers can take OTR routes and more experienced drivers can handle urban routes.

Regional freight fleet incentives

Shippers moving food to markets less than four hundred miles are in a unique position to encourage the development of a regional freight industry based on alternative fuels and other efficiency-boosting innovations. This could impact intra-regional food movements and some intra-regional food movements. For instance, some shippers have first-mile shipping arrangements with other shippers in different climate zones, particularly north/south. This allows shippers to extend the seasonal availability of specific foods, sometimes as long as 12 months for storage crops such as potatoes. That way, they can provide products to their wholesale buyers out-of-season. These first-mile intra-regional movements may be less than four hundred miles, depending on where the point of sale is located. Regional fleets could employ alternatives to diesel fuel much easier than could national fleets, given similar incentives.

Diesel prices must meet or exceed a break-even point for a company to invest in the technology. Using conservative assumptions about the costs to convert a fleet to alternate fuel, average truck life, miles per day and price per gallon for alternate fuels, diesel needs to be priced around $3.75/gal or higher in order for a transition to alternative fuel such as LNG to result in savings for the company and pencil out as an economical investment. Diesel price volatility has made the costs and benefits of such a change much less certain and is a barrier to fleets considering a switch to LNG. As prices have fluctuated above and below $3.75, some early adopters have made the investment, while most companies have been reticent to change (Figure 17).

Dedicated urban freight transport using hybrid-electric technology shows real promise for improving engine performance. Long-term, engine research is focused on enabling renewable fuel usage in compression ignition engines. Advanced combustion engines that mix diesel-like fuels with gasoline-like fuels demonstrate near zero NOx and soot, with a peak efficiency of 56%, while conventional diesel shows 49% efficiency, with much higher NOx and soot (Kokjohn, et al. 2011). Challenges to advanced combustion engines include load limitations and combustion stability and control. One way to overcome these limitations is to link the advanced combustion system to hybrid-electric technology.



Cost Model for Class 8 Alternative Fuel Source Vehicles

1	Average Truck Life	5	10	Diesel Price (per gallon):	$3.75
2	Type of Conversion:	LNG	11	MPG:	6.0
3	Conversion Cost:	$50,000.00	12	LNG Price (per DGE):	$2.54
4	Grant Available?	No	13	CNG Price (per DGE):	$2.39
5	Grant Amount:		14	Yearly Incremental Savings	$14,520.00
6	Tank Size (LNG)(DGE):	75	15	Total Savings over Truck Life:	$72,600.00
7	Tank Size (CNG)(DGE):	62	16	Payoff Period:	3.44
8	Days in Use:	5	*	Miles per Day Feasible?	YES
9	Miles per Day:	400	**	Cost Benefit to Conversion?	YES

DOES ALTERNATIVE FUEL SAVE CARRIERS MONEY? YES

Instructions

Fill data from drop down menu in sections 1 - 13 (denoted by peach colored cells).

Data in cells 14 - 16 will be automatically calculated based off inputs provided in step 1.

The cell denoted by * verifies that a converted truck has the ability to travel the number of miles per day based off estimates on fuel economy and tank size provided by alternative fuel type.

The cell denoted by ** verifies that there is a cost savings by converting a vehicle to alternative fuel sources based off data provided.

Base assumptions for the cost model are located below, these cells set the base which to experiment off of.

Figure 17. Cost model for Class 8 Alternative Fuel Source Vehicles. Miller (2016)

Smaller, regional trucking companies may benefit immediately from upgrading their fleet with urban optimized trucks, especially if regular routes can be established between aggregation facilities and markets. Extending federal fleet improvement incentive programs, beyond metro areas to rural companies that move food regionally or between regions, could result in multiple benefits. Such incentives are currently available to businesses with fleets based in urban areas only, since the programs target regions with poor air quality. Support for state-of-the art fleets, based in rural regions may support food systems resilience and help metro areas meet their air quality targets. This requires cities to think outside their traditional administrative boundaries, and for federal agencies to consider the underlying cause for poor air quality.

Proof of concept: Testa Produce

Testa Produce has been delivering produce throughout the Chicago region since 1912, and currently transports refrigerated produce to their Chicago warehouse from as far away as Door County, WI, 200 miles north of the city. The company has a long-term commitment to green innovation, and invested in building a LEED Platinum warehouse in 2011, wind energy and local food procurement. In 2015 Testa was named Chicago Area Clean Cities "Clean Fuel Champion" for their commitment to fleet innovation. The company initially invested in biodiesel technology, but with support from Clean Cities, started to convert their 24- and 26 foot refrigerated fleet to Compressed Natural Gas (CNG). They have twenty CNG vehicles in 2016 and intend to convert their entire fleet–about sixty vehicles-by 2019.

Testa worked with Clean Cities Green Fleet federal grant program to offset costs associated with upgrading their fleet to CNG. The program is limited to the six Chicago air quality nonattainment counties and some adjoining townships. A major focus of this funding is medium- and heavy-duty vehicles, such as trucks and buses, operated by government or public sector fleets as well as some private fleets whose vehicles serve the public. The Chicago Department of Transportation is administering a similar grant program for electric trucks in the Chicago area and federal agencies are offering grants for similar programs across the country.

Other considerations

Participants in the research team and workshops were interested in exploring a number of issues related to regional food freight that were beyond the scope of this project. These included rail and barge freight transportation as sustainable alternatives to truck shipment; autonomous vehicles and their potential contribution to improved food freight logistics; the structure of the labor market for the entire food supply system, and the perceived intensification of random, unforeseen disruptions to the food supply. These issues warrant a closer look as part of future research into food transportation.

Conclusion

By considering the Upper Midwest regional food system as a whole, we were able to see patterns in how food could move more efficiently and support a more resilient, diversified agriculture. Food freight transportation links production and consumption regions into a complex web that has outgrown its ability to meet public and private objectives. Simple, targeted public and private investments in transportation and distribution infrastructure specifically to support small and medium supply chains could improve this.

Using systems tools, we identified potential solutions to food transportation-specific challenges, such as safety, congestion, and inadequate public resources for transportation infrastructure maintenance and development. All these potential solutions currently lay outside the traditional

boundaries of the transportation system. By improving the food distribution system, they improve the transportation system, especially in a region critically important to national food flow, like Chicago. By using multiple methodologies, we gained a deeper understanding of how national and regional food systems work today, and how long-term food shipment trends impact current and future food production and markets.

Efficiency and diversity paradigms are fundamental leverage points in the food system. When we successfully optimize for both, we realize a more resilient food system that has the potential to elegantly address multiple business and public sector goals. Other paradigms that characterize the quality of system relationships, such as predation, competition, collaboration and cooperation, deserve a closer look, especially from a governance perspective. Identifying mutually advantageous ways to correct system failures through incentives is likely to improve supply chain dynamics more effectively than applying controls such as regulation.

Food systems have a number of critical thresholds that can be leverage points for improved food system organization. Sustainable agriculture practitioners are identifying bio-physical critical thresholds for food production, specific to the agricultural production region. In turn, they seek supply chain partners in transportation and markets that share their commitment to sustainability. Our investigation identified a number of transportation efficiency thresholds that shape the system and may serve as leverage for sustainability. Some are common knowledge within freight transportation and sustainable agriculture circles, while others may require additional research, especially region-specific research. They are:

- **Cropping systems diversity**: There is a need for greater farming diversification at the landscape scale, especially near megaregions, to hit the sweet spot between diversity and efficiency in food systems. The Chicago megaregion is a case in point, where Illinois farmers are less diverse than farmers in Wisconsin and Michigan. Restoring agricultural diversification throughout the Corn Belt is important to regional resiliency, especially within the four hundred mile regional radius of large urban markets.
- **Distance to market**: Limited research suggests that farmers selling into direct markets realize a transportation efficiency when they are no further than 45-55 miles from point of sale while regional transportation efficiencies may be gained at about 400 miles or less because of engineering advances applicable to shorter hauls. To use hours of service regulations to best advantage, less than 200 miles is a round trip to market in an eight-hour day, if traffic congestion isn't an issue. These critical thresholds can help identify appropriate locations for regional distribution infrastructure. Farmers interested in pooling product for regional wholesale markets may want to limit their aggregation within the 45-55 mile radius, and limit their markets to about 400 miles. To boost their access to significant local wholesale markets, shippers may want to partner with mid-size cities in developing combination facilities that both aggregate products and weave together multiple smaller supply chains so that they may also sell to wholesale buyers (such as groceries, institutions and restaurants) within about fifty miles to the terminal. Large cities that invest in distribution infrastructure may want to prioritize service to smaller, community-owned supply chains that are unable to invest in their own private warehouses necessary to receive shipments, and target shippers no further than four hundred miles.

Distribution infrastructure that is proximate to large cities and natural features such as the Great Lakes or mountains may change these mileage calculations.

- **Truck size**: 53' trucks must be fully loaded for shippers to realize efficiency. This means shippers must be able to load 30 pallet footprints or a maximum combined weight of 80,000 pounds (tractor, fuel, gear, and loaded trailer). Farmers must aggregate their product for shipment at this scale to efficiently reach regional markets. It then follows that there must be sufficient production of various foods within a region for wholesale marketing to be efficient.
- **Contracts**: Regular contracts along the supply chain are more efficient than erratic, irregular relationships. The seasonal nature of production in the Upper Midwest, and extreme weather impacts on food production mean that shippers and trucking companies will either loose efficiencies in this part of the business or must find creative ways to overcome volatile conditions and associated uncertainty. Regular professional meetings for small supply chain businesses may improve communication and build trust. Another approach may be rewarding north-south collaborative intra-regional supply chains.
- **Terminals and trip segments**: For regional wholesale food shippers to gain efficiency, they need one point to transfer ownership of product. Combining regional trucking with last mile deliveries is inefficient. Terminals that operate with an explicit goal to serve small wholesale supply chains are increasingly necessary as national supply chains continue to consolidate even while extreme weather threatens those supply chains.
- **Settlement patterns and city scale**: Congestion barriers to free flowing traffic in urban and suburban regions create significant barriers to efficiency and associated costs that are shouldered by trucking companies and shippers. This leads to limited food access in poorer regions of cities. Rural regions lack food access when there is a lack of regional food production diversity and where supply chains are too large to efficiently serve them. Are there ways to more equitably share the costs of congestion and support smaller supply chains? There is a need to identify scalar sweet spots for transportation systems and other infrastructure that serve supply chains into urban centers and rural towns.
- **Engine and fuel efficiencies**: Considerable research on engine efficiencies is underway and can shape how we invest in food infrastructure to create positive incentives to adopt these engineering innovations. For instance, we know that OTR vehicles operate best at constant, higher speeds. We know that the price of diesel must reach about $3.75 before it is economically prudent for companies to invest in alternate fuel vehicles unless there are other economic incentives. Advances in hybrid technology may alter existing critical thresholds, as may other engineering innovations. Engineers are setting the pace for change so there is opportunity in anticipating and matching this pace.

Our investigation identified two distinct categories of regional food supply chain practitioners, defined by scale – the businesses that are scaling up from direct markets to wholesale markets, and the businesses that have a decade or more experience in wholesale markets and are looking for ways to make their supply chains more sustainable. These supply chain categories

face unique and shared challenges and opportunities to move food freight regionally. To meet public sustainability and food security goals, each of these business categories may benefit from targeted public intervention to reshape the way food markets are currently organized, especially in light of urbanization. Our project identified three ways to reorganize food systems, each paired with proof of concept examples:

- supporting smaller, regional supply chains through collaborative, not-for-profit shipping terminals, as operated in Ontario;
- developing collaborative, not-for-profit drop yards to serve multiple midsize supply chains for urban freight moving through megaregions, similar to one developed by a large private company for a very large supply chain; and
- extending federal and metro-region support to regional food supply chains so that they may better serve regional markets, as in the Chicago example. Another example that logically follows is to promote federal farming support programs that encourage food production for regional markets.

Entire food supply chains are poised to emerge that are made up of farms and other firms that share a commitment to sustainability and local economic development. Improving the regional organization of food flow, if it is based on an understanding of the relationships that create system constraints in regional food movements, will allow private sector entrepreneurs to seize opportunities to optimize fuel use without sacrificing food access or sustainable farming practices. First mile, OTR regional, and last mile transportation businesses; product aggregation intended for regional wholesale markets; and regional supply chain aggregation in megaregions are just a few opportunities that could improve the climate for small business development in food production and retailing. Business investment in multi-firm collaboration puts innovative entrepreneurs in the lead as primary investors in developing societal assets. Midsize farms that aggregate products for shipment currently practice multi-firm collaboration. Forward-thinking businesses, with encouragement from the public sector, could organize and support similar efforts within regional food supply chains to improve collaboration between shippers, trucking firms and wholesale buyers. Given the unique nature of food in a healthy society, improving the organization of the food supply chain so that it meets public goals is a civic responsibility.

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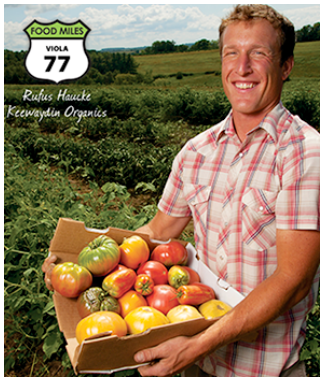
Truck Hubs for Food Freight Advisory Committee Biographies (alphabetical)
A project of the University of Wisconsin – Madison, Center for Integrated Agricultural Systems

Irv Cernauskas founded Irv & Shelly's Fresh Picks in 2006 with his wife Shelly Herman, to provide new market opportunities for farmers and to help stimulate the re-growth of Chicago's local food system. Fresh Picks' home delivery service brings great food to thousands of area households, has developed farm based food aggregation hubs to drive down shipping costs, and adds several hundred thousand dollars to the incomes of local farmers each year. Irv earned an MA in Economics, an MBA from MIT, and worked for 20 years as a corporate executive and running his own IT consulting practice. Several years of service on the boards of Seven Generations Ahead and The Land Connection helped forge friendships with local farmers. This convinced Irv of the importance of local agriculture to health, the environment and rural communities, and was the inspiration for starting Fresh Picks.

Kathleen Dickhut, Deputy Commissioner of the Sustainability and Open Space Division of the City of Chicago Department of Planning and Economic Development. The division implements the CitySpace and Chicago River plans, and led the development and assists with the implementation of: the Calumet plans; *Logan Square Open Space Plan; Chicago Eat Local Live Healthy; A Recipe for Healthy Places; Adding Green to Urban Design; Chicago Sustainable Industries* and the *Green Healthy Neighborhood* land use strategy for five City neighborhoods which have undergone large population loss. Kathleen Dickhut has a Master's of Science in Landscape Architecture from the University of Wisconsin, Madison and a Bachelor's degree in psychology and anthropology.

Andy Dierks, Coloma Farms. Andy is a fourth generation potato grower in Coloma, located 60 miles north of Madison. With his father, Steve they operate Coloma Farms, Inc., growing about 850 acres of potatoes, and 400-700 acres each of corn and soybeans. They recently upgraded to a new packing facility where they started packaging new potatoes each season around the 1st of August. Both are very active within the Wisconsin Potato and Vegetable Growers Association (WPVGA) and serve on several committees related to marketing, research, and government relations. Coloma Farms and the WPVGA work pro-actively with researchers and leadership within the UW system to address issues in the vegetable industry. Andy received a BS from UW-Madison in Agricultural Engineering and currently serves on the DATCP board, the WPVGA Promotions Committee, the WPVGA Water Task Force, the Discovery Farms Advisory Council, and is also Chairman of the USPB Chip Committee.

Rufus Haucke, Keewaydin Farms and Just Local Foods. After 10 years of farming dirtying up his



overalls, Rufus Haucke has transformed the family farm, purchased by his parents for use as a dairy farm back in 1976, into a thriving provider of organic goodness. Located at the end of Haucke Lane in the Driftless Region of Southwestern Wisconsin, Keewaydin Farms raises 20 acres of garden produce for local CSAs and wholesale markets. Rufus has embarked on an even larger project - launching Just Local Foods, an organic produce distribution warehouse based in Viroqua, WI. Just Local Foods works with many organic farms in the Viroqua Region to provide a wide offering of organic, seasonal, wholesale produce. Through these efforts, they've been able to expand the market available to organic farmers - now delivering twice a week to Madison, Milwaukee, and the Twin Cities.

Pete Huff, Director of Food Systems at Institute for Agriculture and Trade Policy (IATP) has been involved with food systems for the past ten years, working on a variety of levels spanning from organic production to policy development. His work has primarily been in the nonprofit and local government sectors of the United States and Australia. While in the United States, his work focused on organic market gardening and agroecology apprenticeship program development in California. In Australia, he focused on school garden programs, food waste reduction programs and urban agriculture policy on the local and state level. He has a B.S. in environmental management and a B.A. in history from Indiana University-Bloomington. He is an avid gardener, bee keeper and cook.

Karen Lehman directs Fresh Taste, a funder initiative dedicated to relocalizing the food system in the Chicago foodshed and improving equity of access to good food. Karen's food system work spans three decades, beginning with an award-winning PBS documentary on women's leadership in farm movements. Karen directed the local food and regional economy programs at The Minnesota Project; co-founded Youth Farm, located in Minneapolis and St. Paul; and directed the Institute for Agriculture and Trade Policy's Food and Agriculture Program. Karen also held an endowed chair in Agricultural Systems at the University of Minnesota, consulted with the Ford Foundation on rural development in Mexico, and received a Master's of Public Administration from Harvard University's John F. Kennedy School of Government as a Bush Foundation Leadership Fellow. Prior to her work with Fresh Taste, Karen was a Senior Associate with Cambridge Leadership Associates.

Sarah Lloyd is the Special Projects and Regional Membership Coordinator for the Wisconsin Farmers Union. In this position she organizes the biennial Midwest CSA Conference and has assisted the launch of the farmer-led Wisconsin Food Hub Cooperative. She also facilitates farm succession planning workshops for Farmers Union members. Sarah assists her husband Nels Nelson on the Nelson family dairy farm. Sarah represents the dairy farmers of her area on the Wisconsin Milk Marketing Board, the state dairy check-off organization. Sarah has a PhD in Rural Sociology from the UW-Madison, a Masters in Rural Development from the Swedish University of Agricultural Sciences, and a B.A. in Environmental Studies from Brown University.

Tom Murtha is a Senior Planner for the Chicago Metropolitan Agency for Planning, responsible for CMAP's transportation system performance measurement project. Previously, Tom was responsible for the agency's freight system planning and congestion management processes. At the Chicago Area Transportation Study, CMAP's predecessor, Tom was the Chief Transportation Planner, and assisted in developing the 2030 Regional Transportation Plan for Northeastern Illinois. Prior to joining CATS in 1993, Tom held various transportation- and planning-related positions in Wausau and Madison, Wisconsin. He received his B.A. in Economics and his M.S. in Urban and Regional Planning, both from the University of Wisconsin at Madison.

Mike Roeth, North American Council for Freight Efficiency. Mike has worked in the commercial vehicle industry for nearly 30 years, most recently as the Executive Director of the North American Council for Freight Efficiency. Mike is also leading the Trucking Efficiency Operations for the Carbon War Room. Mike's specialty is brokering green truck collaborative technologies into the real world at scale. He has a BS in Engineering from the Ohio State University and a Masters in Organizational Leadership from the Indiana Institute of Technology. Mike served as Chairman of the Board for the Truck Manufacturers Association, Board member of the Automotive Industry Action Group and currently serves on the second National Academy of Sciences Committee on Technologies and Approaches for Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles and has held various positions in engineering, quality, sales and plant management with Navistar and Behr/Cummins.

Steve Viscelli, concept originator. (PhD, Indiana University; MA, Syracuse University; BA, Colgate University) is an economic sociologist who studies the trucking industry. In 2010 he began working with COWS as a National Science Foundation fellow. His work focused on developing alternative ways to move freight by truck that reduce fuel consumption and shipping costs, improve working conditions for truckers, and relieve traffic congestion. He engaged industry and government stakeholders to

evaluate the benefits and feasibility of what he calls "urban truck ports" that allow truckers to coordinate the of use super-efficient trucks designed for urban or rural hauling. Since 2013, Steve has been a Visiting Assistant Professor at Swarthmore College. He is currently completing a book about how deregulation transformed labor markets and work in long-haul trucking and thus fostered a revolution in logistics, based on six months of fieldwork as a long-haul trucker, more than 120 interviews with truckers, and survey data.

Research Team Biographies (alphabetical)

Bill Holloway, State Smart Transportation Initiative, lead on modeling. Bill Holloway (MS in Urban and Regional Planning, UW-Madison; BA Colorado College) is a Transportation Policy Analyst at the State Smart Transportation Initiative. Since joining SSTI, he has worked on wide variety of projects involving transportation finance, transportation demand management, stakeholder communication, scenario analysis, school site selection, and other issues. Previously, he worked as a transportation analyst in the Austin, Texas office of Cambridge Systematics, Inc. At Cambridge Systematics, Bill worked on a regional and statewide plans and studies dealing with multimodal freight transportation and associated issues. Prior to attending graduate school, he served as a Peace Corps Volunteer in the Kingdom of Tonga.

Sage Kokjohn, Engine Research Center, lead on engineering efficiencies. Sage Kokjohn is an Assistant Professor in the Department of Mechanical Engineering at the University of Wisconsin – Madison. His research interests include engine modeling and experiments focused on explaining the mechanisms controlling high-efficiency combustion systems and developing pathways to achieve robust, high-efficiency energy conversion. He received his Ph.D in Mechanical Engineering from the University of Wisconsin – Madison in 2012. Professor Kokjohn was a visiting researcher at the Combustion Research Facility at Sandia National Labs where he used optical engine experiments to investigate low temperature, premixed combustion. He has over 40 publications related to high efficiency engine combustion.

Peter Lukszys, guidance and oversight of student researches from the Wisconsin School of Business. Pete teaches supply chain management courses as a senior lecturer at the University of Wisconsin-Madison School of Business. He is Director of Applied Learning in the Grainger Center for Supply Chain Management and an academic affiliate in the Kohl's Center for Retailing Excellence. Pete teaches courses in the Wisconsin undergraduate, MBA and executive education programs. He developed courses in Enterprise Resource Planning (ERP) and Logistics Management, which he teaches as part of the core supply chain management curriculum. Pete is the SAP University Alliance faculty liaison. He led an initiative to implement SAP enterprise software at the School of Business for educational use. His areas of expertise are supply chain management, business

logistics, ERP system implementation, and inventory management. He began teaching at the School of Business in 2004.

Prior to his move to academia, Pete worked at Abbott Laboratories and EMD Chemicals, the North American affiliate of MERCK, KGaA where he held the positions of senior director supply chain management, director of global logistics, and SAP project leader. In his role as SAP project leader, he led a team of over 100 employees in a successful business transformation where ten SAP modules were implemented at six U.S. sites. At Abbott Laboratories he completed a two-year management development program and held positions in inventory planning, plant supervision, and financial analysis. He has consulted, advised, and served as an expert witness to companies in the automotive, life science, defense and transportation industries. Pete is APICS certified in production and inventory control. He received an MBA in supply chain management and a BS in industrial engineering from the University of Wisconsin-Madison.

Kelly Maynard, UW Center for Integrated Agricultural Systems, project assistant, lead on human organization. Kelly currently provides support to the Wisconsin Food Hub Cooperative in the areas of producer development, food safety and launching a value-added products line. From 2010-2014 she worked as the Technical Assistance Facilitator and General Manager of the Spring Rose Growers Cooperative in Madison, to design and provide technical assistance to underserved agricultural producers. Kelly served as an agro-forestry volunteer with the Peace Corps in Paraguay from 2003-2005 and managed a forestry project in Indonesia for Conservation International from 2006-2008. She earned her Master's degree in Agroecology from UW-Madison in 2010. Her local food system development work is rounded out by a position at the WI Department of Natural Resources where she helps to expand hunter education and resources for adults and families.

Michelle Miller, UW Center for Integrated Agricultural Systems, project manager, lead on process. Michelle is Associate Director at the Center for Integrated Agricultural Systems, UW-Madison, where she manages a number of projects related to food systems sustainability. Her expertise is in human organization, participatory research and leadership, sustainable agriculture, systems thinking and restoration ecology. Michelle also serves on the Wisconsin Farmers Union Foundation board of directors.

Dr. Alfonso Morales Alfonso is a professor of Urban and Regional Planning at the University of Wisconsin-Madison. He studies public marketplaces and street vendors, and the role and function that they serve in economic development. Using an innovative blend of the disciplines of sociology and urban planning, Morales has created a body of books, articles, book chapters, and other writing that provides practical insight into the ways that street-level economies and social interactions

contribute to and influence community and economic development. He is among a small number of researchers who employ ethnographic field research methods to help inform contemporary theoretical debates about community food systems, public markets, space use, and street vending businesses. His primary dissertation research on Chicago's Maxwell Street Market established the foundation for what has become a wider range of studies of the social, cultural, and economic factors that involved in the interactions between public marketplaces and the areas where they are established. His new research on community and regional food systems expands his intellectual and policy agenda through the $5 million dollar USDA-AFRI grant of which he is Project Co-Director and Research coordinator.

Ernie Perry Ernie is the Program Administrator and Facilitator of the Mid-America Freight Coalition. Before joining the National Center for Freight and Infrastructure Research and Education, Perry was the Administrator of Freight Development at the Missouri Department of Transportation. During his seventeen-year tenure at MoDOT, he served as research administrator, organizational results administrator, senior environmental specialist, and socioeconomic specialist. Perry has worked closely with freight leadership at AASHTO, FHWA, and MARAD, served on NCFRP panels, and participated in the Scan of European Union Freight Corridors. Perry holds a BS in animal science, an MS in rural sociology, and a PhD in rural sociology from the University of Missouri–Columbia.

Anne Reynolds, Center for Cooperatives, lead on governance. Anne Reynolds is a Faculty Associate and Assistant Director of the University of Wisconsin Center for Cooperatives. She teaches a course on cooperatives (AAE 323), and develops courses, conferences and educational programs at the Center. She has led numerous workshops on board leadership, board roles and responsibilities, and strategic planning. Anne is currently researching cooperative governance, behavior and performance, as part of the Center's Cooperative Business Study. Her areas of interest include governance, member loyalty, business structure and innovative uses of the cooperative model. She has worked with cooperatives in all sectors, including agriculture, food, energy, purchasing and worker-owned. Anne serves on several boards, including The Cooperative Foundation. Before joining the Center for Cooperatives, she worked at the Credit Union National Association (CUNA).

Ben Zeitlow, Center for Freight Research and Education, lead on GIS. Ben Zietlow recently joined CFIRE as a geoeconomist. He will focus on both CFIRE and MAFC research activities. Before joining CFIRE, Zietlow worked as a surveyor for La Crosse Engineering and Surveying Co., Inc., as a GIS intern at Gunderson Lutheran Health System, and a traders' assistant at Robert W. Baird & Co. He holds a BS in Economics and Philosophy from University of Wisconsin-La Crosse and a MS in Geographic Information Science from Saint Mary's University.

Student Research Team Biographies (alphabetical)

Nancy Chachula, Department of Landscape Architecture, lead on envisioning Chicago metro. Nancy Chachula started her business in 1999 as Verde Terra gardens, a small backyard grower of ornamental and annual plant stock. Applying her passion for business, plants, and design, she began creating planting designs for residential customers shortly after. Today, Nancy offers design services and landscape managerial services to residential and business customers. Nancy recently completed her Landscape Architecture degree at the University of Wisconsin-Madison.

Justin Johnson is pursuing his Master of Business Administration with a focus in supply chain management at the Wisconsin School of Business. He graduated from the University of California, San Diego in 2007 with a Bachelor of Arts in economics. After graduation, Justin worked for the UC San Diego Health System, where he was first exposed to supply chain management and began to develop an appreciation for the profound impact it can have on an organization. Throughout his inventory storehouse experiences, Justin was able to implement policies and modify procedures that addressed points of failure and increased operational efficiency. He also planned and executed inventory-related aspects of projects ranging in scope from $6K to $1.5M for the project management team.

Ryan Kildow is earning a Master of Business Administration, specializing in supply chain management, from the Wisconsin School of Business. He graduated from the University of Wisconsin-Milwaukee with a Bachelor's degree in economics. Upon graduation, he joined the United States Army as an Infantry Officer and served at Joint Base Lewis-McChord in Washington. He has spent the past three years in a variety of direct leadership roles including Forward Logistics Element Platoon Leader, Mortar Platoon Leader, and Reconnaissance Platoon Leader. In these roles, he has focused his efforts on job specialization proficiency, professional development, team building, and resource allocation and management. While serving as a Forward Logistics Element Platoon Leader in Afghanistan, he was introduced to supply chain complexity as he led a cross-functional team engaged in on-demand distribution of key sustainment supplies for a Task Force Headquarters and seven off-site operation centers. In this role, he worked alongside industry leaders such as Oshkosh Corporation, Lockheed Martin, Raytheon and ManTech International, as well as host nation commercial transportation assets.

Stephen Larsen is pursuing his Master of Business Administration at the Wisconsin School of Business. He graduated from Brigham Young University in 2011 with a bachelor's degree in business management with an emphasis in supply chain management. After graduation, he joined the transportation company C.R. England as a logistics analyst where he led the design and pricing of new business opportunities within the company's dedicated fleet services division. In this role, Stephen worked on numerous projects including

transportation network design, financial modeling, contract and rate negotiations, and continuous improvement projects. His involvement in these projects helped give him a unique perspective on many different supply chains ranging from Fortune 100 companies to local grocery chains.

Dawn Luo is completing her Master of Business Administration in supply chain management at the Wisconsin School of Business. She graduated from National Chengchi University in Taiwan in 2010 with a bachelor's degree in management information systems. Upon graduation, she joined an integrated circuit design house, Silicon Touch Technology, National Hsinchu Science Park of Taiwan, as sales personnel responsible for managing 20 accounts over five product lines and introducing parts into new products' supply chains. After spending a year and a half in her sales role, she joined Foxconn, Shenzhen, China, where she was responsible for equipment purchasing for the iPad production line. She purchased and scheduled equipment arrivals for iPad repair lines and directed quantity and pricing confirmation of reimbursement items.

Julia Schilling, Department of Landscape Architecture, lead on envisioning Milwaukee metro. Julia graduated from the Milwaukee Institute of Art and Design (MIAD) in 2008 with a focus in sculpture and completed a design certificate in Landscape Architecture in 2015.

Adam Zachary is earning a Master of Business Administration from the Wisconsin School of Business, focusing on system dynamics, efficiency, and environmental impact. He graduated from the University of Colorado at Boulder in 2004 with a Bachelor of Arts in economics. After graduation, he moved to Japan for three years to teach English through The Japan Exchange and Teaching Program, Adam then worked for Whole Foods Market, an upscale U.S.-based grocery chain specializing in natural and organic foods and it was there, as a retail seafood buyer, that he discovered his passion for sustainable business. Working closely with suppliers who prioritized sustainability, Adam recognized the impact that "green" supply chains could have if effectively integrated into the operations of a company.

Workshop One

Climate Quest
PRACTICAL SOLUTIONS. BIG IMPACT.

Climate Quest Solutions Workshop
June 12, 2014 10am – 4pm
WID - DeLuca Forum
Agenda Outline

Time	Topic/Exercise
10:00	Welcome and introductions
10:10	Warm-Up Exercise
10:20	Introduce the Purpose of Today List What They Will Have at the End of the Day ▪ What their project is/is/not ▪ Project reframe (at the start of the day it was this; now we see it is that) ▪ Assessed what they know and what they still need to learn ▪ A punch list of what to do next
10:25	Introduce Design Concepts
10:30	Introduce Design Thinking
10:40	Get Smart - Understanding the Concrete
10:50	**Exercise #1** **Considering Stakeholders** **Capturing Assumptions**
11:45	**Lunch**
12:30	Making Sense – Analyzing the Data
12:45	**Exercise #2** **Creating an Experience Map and Value Chain**
2:00	**Break**
2:15	Frame it Up- Refining the Opportunity
2:30	**Exercise #3** **Reframe** **Drafting a Value Proposition**
3:30	Wrap it up
4:00	Next Steps

Team: Nick Lichter, Ben Zeitlow, Sarah Lloyd, Bill Holloway, Ernie Perry, Michelle Miller

Climate Quest concept paper: Transportation innovations in food freight
M. Miller, W. Holloway, E. Perry, A. Reynolds

Executive summary

This high-risk, high-impact proposal seeks to transform food freight transportation systems to realize substantial reductions in greenhouse gases (GHG). In addition to mitigating climate change, we are proposing a multi-system redesign for adaptation to climate change rooted in regional food sustainability and social justice. The interface between sustainable food production, freight distribution, and market demand is poised for change, a change that promises to meet the mounting needs of multiple stakeholders in food and transportation systems, while dramatically reducing GHG, and adapting our food system to extreme weather events.

We see this game-changing work as taking place in multiple, iterative phases. A carefully calculated transition to a more regional food system will improve our chances of success. The first phase is to address large-scale food shipments and tackle logistical barriers to moving food produced regionally to regional markets. We have a small federal grant to begin a modeling process and hold one stakeholder meeting on this topic, as next small step in this first phase. The second phase is to address smaller scale food movements that are necessary to healthy and fair commerce between rural production areas, rural communities and urban markets. This builds on stakeholder work in 2013, and a completed project on food access. The third phase is to articulate fair trade standards, governance innovations, and work with cities and other public interest organizations to support regional food systems. This phase is a logical next step from a number of smaller initiatives, including the proposed Madison Public Market and work with the UWEX Community Food Systems team and the Wisconsin Local Food Network.

Our proposed supply chain modeling research and stakeholder meetings are geared toward the Upper Midwest, with an emphasis on the production regions within the ―Circle City‖ market. Circle City is the region that includes Chicago, Milwaukee, Green Bay, Eau Claire, Minneapolis / St. Paul, and then back through smaller cities in Minnesota and Iowa to Chicago. Our region includes about 21 million people, and encircles four distinct food production regions – the 4-state Driftless region, the Central Sands, the Central plains, and the rich prairie plains in SE Wisconsin. Other food production regions that feed into Chicago include southern Illinois, Michigan, Indiana and Ohio.

This proposal outlines a different way to look at a wicked problem, which then suggests elegant solutions. It has a high likelihood of success because it addresses multiple needs of different stakeholders by changing how we organize food distribution. It is:

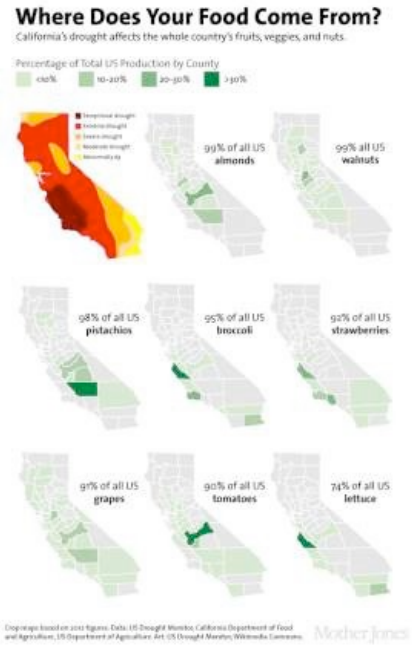
- Cost-effective, in that the proposed changes will save farmers, shippers, carriers, wholesalers, traffic engineers and taxpayers money;
- A catalyst for business innovation, in that it opens up regional markets to regional farmers, unleashes the market for new fuels and more fuel efficient trucks, and creates conditions for new businesses to flourish;
- Good for cities, in that it improves food access, supports small business development, improves air quality, and reduces highway congestion for all motorists;
- Good for rural communities, in that it improves food access, supports small business development, and improves urban / rural relationships;
- Good for labor, in that it helps farmers realize a fair price for their products, improves working conditions for truck drivers, and creates jobs;

We propose to build on decades of work rooted in the Wisconsin Idea from the UW Center for Integrated Agricultural Systems. With farmers and other partners engaged in participatory action research, the Center supports the development of efficient, values-based food supply chains. Farmers and their strategic supply chain partners are looking for ways to bring ―good food‖ to our tables. This means that the food must be produced sustainably – that agriculture is environmentally sound, profitable, and socially just. As more and more farmers engage in sustainable production and market demand grows, there is a need to grapple with supply chain issues, especially transportation, or how our food is distributed. The entire supply chain needs to be sustainable, not simply the farm.

The Center initiated this discussion in 2013 as co-hosts with the United States Department of Agriculture – Agricultural Marketing Service, Transportation Division where we brought together more than 100 stakeholders in regional food transportation to better understand issues facing them. This meeting is documented in the USDA report ―Networking Across the Supply Chain: Transportation Innovations in Local and Regional Food‖ (Day-Farnsworth & Miller 2014). USDA recognizes the catalytic promise of this work, and continues to partner with us. We are also partnering with three campus centers engaged in aligned work on freight efficiencies and business governance.

Challenge statement

Farmers producing food for regional wholesale markets face a number of transportation challenges. Whether delivering full truck loads (TL) or less-than-full truck loads (LTL), farmers and their supply chain partners are struggling to find transportation efficiencies. They are unable to meet a growing market demand for differentiated food products that are ―local‖, artisanal, sustainable, or organic because of transportation failures (Day-Farnsworth & Miller 2014). Transportation system failures do not simply impact regional farmers, shippers and carriers, but also the national freight supply chains for food and other goods.



Regional food production is a key component of food system resiliency, especially as extreme weather impacts agriculture. Over the last thirty years, metro areas have become dependent on foods produced as commodity products. This means that agricultural regions of the US have specialized in products that are particularly well-suited to large scale, industrial farming practices to produce cheap food for growing populations. As an example, 95% of the nation's broccoli comes from just ten counties in California, most of which are experiencing exceptional drought conditions this growing season (Park & Lurie 2014). Much of the nation's fresh produce comes from farms located in arid regions that rely on irrigation for production. Extreme weather is disrupting food supply chains in other crops, too. Grocery chain buyers are encouraging each other to find multiple suppliers for products should extreme weather result in crop failure in any one part of the

country (Major 2013). Investing in regional food production, then, is an adaptation response to extreme weather (Miller et al 2013).

Food system redesign to adapt to our changing climate may also address other imbalances caused by the current food system, especially food access and labor problems. The current food distribution system is optimizing fuel costs in a system that wasn't designed to optimize fuel efficiency. This makes it very expensive to bring food into inner city markets, as well as into rural communities. Rural out-migration has changed the nature of farm labor, so that we now rely on agricultural workers (of which there is a shortage) in industrialized farming systems to fill our shopping baskets. Increasing regional food production and the way it moves to market has the potential to change the dynamic between urban and rural for the better.

Food freight transportation challenges, especially in the Chicago region, are sobering. According to a 2010 USDA report, ―agriculture is the largest user of freight transportation in the United States, claiming 31 percent of all ton-miles transported in the United Stated in 2007 (Casavant et al 2010).‖ Trucks carry 46 percent of total agricultural ton-miles and 70 percent of the total tonnage of agricultural products. With over 80 percent of the nation's cities and communities served solely by trucks, highway freight infrastructure plays an important role in delivering a stable food supply to the US population. In addition, because of the limited extent and inflexible nature of railroad tracks and domestic waterways suitable for barge traffic, most freight moved by train or barge must be hauled by truck on the first and last trip segments, on the way to and from ports and rail yards. Their much poorer fuel economy than barges and trains, and the fact that they often travel on heavily trafficked urban routes make freight trucks a disproportionately large contributor to roadway congestion and air pollution.

In 2011, Chicago tied for 7th place in annual delay to drivers, up from a rank of 28 in 2000. System performance measures indicate congestion is a serious problem for the Chicago urban area - in 2011, the region ranked 3rd in excess CO2 due to congestion, at 2.3 billion pounds of CO2, and estimated to cost $1.7 billion (Texas A&M 2014).[1] And after decades of food industry consolidation, the Chicago region now hosts the largest concentration of food warehouse square footage in the US (MWPVL 2013).

One of the most vexing challenges of the current truck freight model is that trucks must both navigate congested urban areas for pick-up and delivery and travel long distances between cities. The different operational requirements—speeds, braking, acceleration, and maneuverability—in these different settings has led the typical long-haul tractor-trailer to be a jack of all trades and a master of none. While there are a variety of available vehicle and fuel technologies, as well as operational changes, that could dramatically increase the efficiency of trucks in urban areas and on long haul trips, in many cases, changes made to improve efficiency in one setting, degrade it or have little value in the other. Strategic public investment in the urban-rural transition to allow for specialization—long-haul trucks for long-haul trips and short-haul trucks for short-haul trips—could dramatically improve adoption of efficient technology and operations, cutting the costs, emissions, and congestion impacts of trucking (Miller & Viscelli, forthcoming).

We believe there are substantial efficiency gains to be had by separating the urban and rural trip segments to enable the use of the most efficient vehicles for each part of the trip. A fundamental shift from undifferentiated freight transportation to a differentiated system like this

[1] It is interesting to note that the value of travel delay for 2011 is estimated at $86.81 per hour of truck time, substantially more than the $16.79 estimated per hour of person travel.

will require the buy-in from a range of supply chain professionals, transportation professionals, and shippers. They will need a risk assessment to get a sense of costs as well as savings. We think that, overall, the savings will far exceed costs. It will be important to understand where savings and costs will occur in the supply chain and have explicit discussions about how to share risks and rewards across the full gamut of partners (Clancy 2014).

Separating the urban and rural portions, or ―duty cycles,‖ of truck trips to boost overall systems efficiency is an idea that resonates with logistics and freight professionals, and meets the needs of regional farmers and their shippers. In talking with industry leaders, there has been general agreement that the food freight sector would be a good place to start.

Our understanding of the challenge is based on research, professional experience and public meetings where businesses committed to sustainable food supply chains openly discussed transportation difficulties and work-arounds. Wisconsin shippers, such as Organic Valley and the Wisconsin Local Food Hub Cooperative, are looking for TL carriers who can move their produce into Chicago more efficiently and in a way that better aligns with their sustainability values. Similarly, farmers who move their produce into Chicago, Milwaukee, Madison, and smaller cities and towns in LTL shipments are also looking for ways to get their goods to retailers in a more efficient and sustainable way (Nelson et al 2013, Miller 2014). The carriers who serve these farmers are looking for solutions to highway congestion as well as driver shortages caused by poor working conditions.

The benefits of bridging the urban and rural duty cycles to lower costs and boost efficiency will accrue to more than food shippers and carriers. Reducing peak-period truck traffic carries the added benefits of reducing congestion for all road users, lessening the need for infrastructure expansion, and lowering total emissions. Urban communities struggling with limited access to fresh produce and rural communities struggling with limited access to urban markets and to product also stand to benefit from stronger connections between urban areas and the farmers in their rural communities.

Solution and impact

To take this elegant, multi-systems innovation to the next step, our team proposes to model practical, technical solutions that address logistical functions and that serve both TL and LTL freight movements. We would then bring models to people with a stake in the supply chains for vetting.

In **Phase One**, we intend to bridge the urban-rural transition by modeling and proposing a series of truck hubs located outside of Chicago and other major urban areas in the upper Midwest. These truck hubs would help to alleviate the inefficiencies of the current freight model by allowing high efficiency long-haul trucks, which due to their length or aerodynamic body features would be less suited to congested urban travel, to pick up and drop off their loads without entering areas of heavy traffic congestion. Smaller, alternative fuel trucks built for use on congested highways and downtown could then ferry goods to their final destinations. Because different drivers would perform the long-haul and short-haul portions of the trip, more freight could be delivered during off-peak hours, when the trucks would not be contributing to or suffering from heavy traffic congestion. These hubs could also spur the use of new fuels and technologies by acting as a central source for fuel and maintenance for the short-haul trucks cycling between them and delivery points throughout the urban area. By helping long-haul drivers, who are usually paid by the mile, avoid congestion, truck hubs could also improve driver retention—a major problem for carriers. Finally, by removing large trucks from the traffic stream

during peak travel periods, these truck hubs can help to reduce emissions and the need for costly roadway expansion projects.

Although we envision this project eventually expanding to other types of freight movements and other freight sectors, the initial phase will focus on full truckload (TL) movements of agricultural goods because it strategically engages critical actors. Medium-sized farmers are aggregating their product to ship TL, and they face high costs to get their product to market, even in nearby urban markets. A network of urban truck hubs for food shipments could help to solve both of these problems, and provide other freight sectors with a new paradigm for high-efficiency goods movement. Separating rural and urban freight movements for TL could be accomplished through truck hubs outside major metropolitan areas that would allow for easy load swapping for trucks with different driving technology.

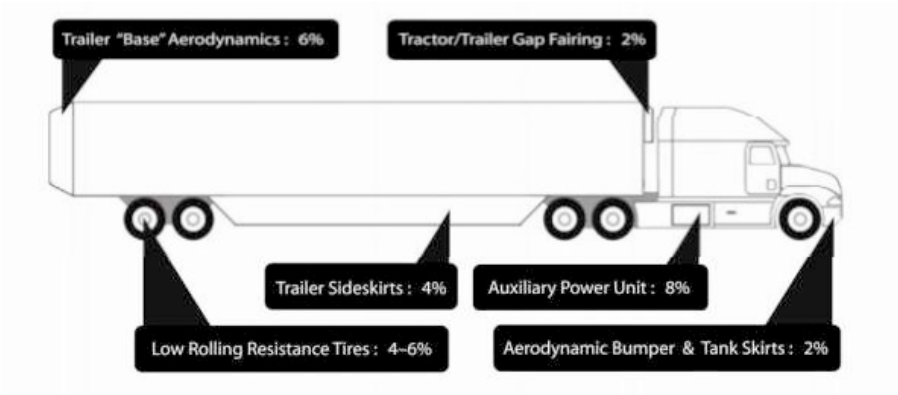
So, for instance, a long-haul tractor-trailer could pull into a truck hub outside Chicago, leave its container, and pick up a new one to be delivered on its return trip. The container dropped off by the long-haul would be picked up by a truck designed for shorter trips in stop-start traffic, for delivery to privately-owned distribution centers and warehouses. These short-haul trucks could be powered by electricity, natural gas, or other alternative fuel. The use of alternative fuels by these short-haul trucks would be facilitated by maintaining fueling facilities at the truck hub where they pick up and drop off their containers. Efficiency of the short-haul delivery trips could be further increased by conducting as many of them as possible during off-peak hours. Currently, drivers who carry goods from rural areas to their final destinations inside urban areas are often compelled by federal hours-of-service rules to enter the city during peak period congestion. However, under our proposed truck hub scenario, long-haul drivers could drop their cargo and begin their return trip, leaving the final delivery to be made by a different driver, during less congested hours. These truck hubs would also enable regional farmer-shippers to save money on shipping, making their produce more affordable for urban retailers and consumers. Together these new supply chain efficiencies would dramatically reduce GHG emissions, improve working conditions for drivers, increase the use of alternative fuel vehicles, reduce highway congestion, stimulate small business development, and improve access to fresh, local produce in cities.

In the course of exploring options, it has become clear that addressing the needs of TL shippers and carriers first would help us build momentum for later work. In preparation, our team has been reaching out to potential partners engaged in aligned work on freight efficiencies. Our campus team is made up of four UW-Madison research centers - the Center for Integrated Agricultural Systems, the Center on Wisconsin Strategy, the Center for Coops and the Center for Freight Infrastructure Research and Education. We are meeting with the UW Center for Engine Research at the end of August to explore alternative fuel aspects of the proposed work. In addition to a number of supply chain businesses interested in partnering, we are also working with the North American Freight Efficiency Council, a spin-off from the Rocky Mountain Institute, the Chicago Metropolitan Agency for Planning, and Fresh Taste, a Chicago-based non-profit that supports food systems work in the region.

We just learned that USDA-Agricultural Marketing Service's Transportation Division will support our team to do a small study of the urban truck hub concept. A stakeholder committee to assist with modeling and meeting planning is forming and will be responsible for shaping the study and developing a meeting agenda that interests our participating food transportation professionals and harnesses their creative insight. This fall we will be working with Breakthrough Fuel in Green Bay, which works many major shippers to improve supply

chain efficiency, to model the benefits of transportation enhancements for TL food freight. We will use actual food freight movement data (scrubbed of proprietary information) to understand how truck hubs could improve the efficiency of shipments into the Chicago metro area and reduce some of the negative externalities associated with truck freight. We expect to find that the benefits of using urban truck hubs will substantially outweigh the costs. However, we also expect there to be some challenging supply chain governance issues arising from this new model. How is risk across the supply chain managed? How would the truck hubs be managed?

The study results will be vetted at a meeting next May in Chicago, where food logistics and transportation specialists will share their take on urban truck hubs and other potential technical solutions for TL freight in the region. The agenda will showcase speakers who are leaders in the field and can help create a dialogue for change. Supply chain managers will need to know what the proposed changes will look like and how they can help reduce risk in the supply chain before they will support such a change. They look to industry leaders who have earned their trust and who can articulate the change process.



Aerodynamics and other improvements with associated fuel savings. Source: Ogburn & Ramroth 2007

We currently lack a complete understanding of the potential benefits from new truck technologies or operational changes made economically feasible by truck hubs. New prototype tractor-trailers, developed as part of the Department of Energy's SuperTruck initiative, are already able to achieve nearly twice the fuel efficiency of the average truck on the road (Shea, 2014a). Several manufacturers involved with the program will be offering trucks that are 50 percent more efficient than baseline levels for the 2015 model year (Shea, 2014b). A Union of Concerned Scientists report estimates that, by 2030, the average heavy duty truck could improve its fuel efficiency by about 60% and would reduce GHG per truck by more than 36%, by improving tires, aerodynamics, and improved mechanics. Similarly, the average medium-duty truck, using a combination of conventional and hybrid technologies, could raise its fuel economy by more than 80%, and reduce carbon emissions per truck by 44% (Cleetus et al 2009).

Our small preliminary study on truck hubs funded by USDA is just the start of the work ahead to realize change in food freight transportation. Ideally, the TL modeling study would be extended to include Milwaukee, Stevens Point, Green Bay, Madison, Janesville, LaCrosse, and the Twin Cities. We know that farmers in Michigan, Iowa and Illinois are also interested in improving the efficiency of food freight flowing into and through the Chicago area. Our first

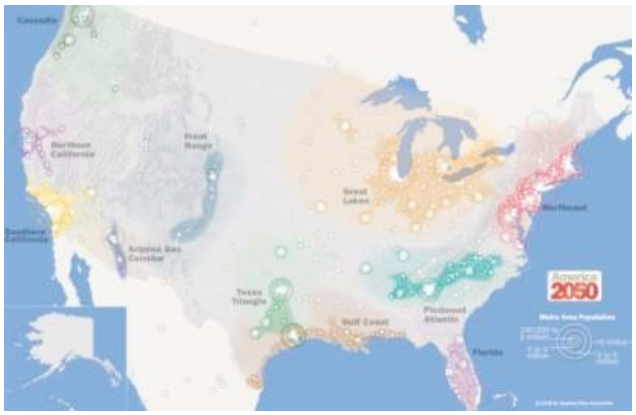
efforts to map out the benefits and costs will necessarily be limited to a few parameters. Closer examination will be necessary and must be followed up with a review of the impact on various supply chain functions. We expect the Chicago meeting will generate considerable interest and push-back, and will give us a chance to gauge response and continue with an iterative design process. Further down the line we would like to explore how trains, barges and other modes of transportation could supplement trucks in the food freight supply chain to further improve efficiency. In meetings to date, multi-modal options come up in the conversation frequently as options and we need to recognize their appeal and address them up-front.

Phase Two focuses on LTL and requires a process similar to that proposed for TL. We need to research logistics models and host follow-up meetings for invested supply chain businesses. A related and sometimes different set of stakeholders maintain these supply chains and many convened in 2013, LaCrosse (Day-Farnsworth & Miller, 2014). Thinking about where terminal markets could be placed, how they would be governed, and what resources – public and private – are needed to support them is critical. Terminal market history is another key research need and may help us better understand how to recreate a structure to launch them successfully.

Phase Three – fair trade and food access issues are of utmost importance to a large segment of people and businesses working on food supply chains and addresses a critical component of systems failure. Articulating a working definition for regional fair trade is an important next step to creating a more resilient food system and it will involve supply chain governance discussions. Food access discussions will involve meeting with and learning from local food policy councils, sustainability staff in mayoral offices in the region, regional economic development staff, food bank managers and others about public investment in food freight commerce, especially for LTL. Large metro regions and Departments of Transportation will need to commit to TL solutions. We expect that public investments will play an important role in improving the efficiency of food freight transportation, so the sooner we can begin a dialog with these stakeholders, the better.

Ability to scale-up solution

We envision this project scaling up in two primary ways – regionally and sectorially. The regional opportunity will revolve around food production paired with 11 mega region markets, depicted below. Each has its own mix of sustainable, wholesale food production businesses and its own set of opportunities and challenges around supply chains and transportation into urban areas. Each region would need to enter into conversations with key players to read the field and develop TL and LTL solutions in a site-specific way. For instance, we are in conversation with a team at MIT working on wholesale transportation issues for farmers in Appalachia. Farmers are proximate to both the Northeast and Piedmont



population clusters and are raising food crops in a warmer climate than the Upper Midwest and so have a different array of products to sell. We are working with similar teams partnered with farmers across the country near different population centers. We are also involved in projects focused on urban sustainability and transportation that could help drive innovation from food access and small business development perspectives. Although the food access, economic development, and sustainability goals of the nation's mega regions are similar, what every region is missing is the integration of carriers and supply chain managers into the discussion. We are the vanguard.

We expect these solutions to scale up from a sectorial perspective, as well. The project we propose focuses on food distribution, but could also be applied to any kind of freight movements. From a resilience perspective, food is a key freight item, but freight transportation is critical to provisioning cities and rural communities in all production and consumption sectors. Even the waste and recycling streams could potentially be improved by using many of the technological and operational innovations that our project envisions for the TL food freight sector. For example, using smaller alternative fuel trucks to pick up refuse in cities during off-peak hours and deliver it to staging areas on the urban fringe to be transferred onto larger fuel-efficient long-haul trucks for the final stage of its journey could substantially reduce congestion and emissions.

Readiness of solution / Time to Impact

Our team expects to make first impact with our small USDA grant deliverables, forthcoming journal articles, and conference presentations as early as this September (Exeter: Innovations in Sustainable Agriculture and Food Supply Chain research conference) and October (USDA Agriculture of the Middle annual meeting and guest lectures from Peter Hurst, United Nations International Labor Organization on the Madison campus). Every conversation builds interest in and support for these ideas. As this support grows, people start to act in their individual spheres to make change happen. In this way, we believe it will become a largely self-organizing innovation.

We expect it will take a **minimum** of two years, from our first sector conference where we discuss urban truck hubs with supply chain and transportation professionals, until the first functioning hub is available for use. This allows for two annual shipping cycles to take place, two annual meetings of supply chain management professionals and transportation planners to convene, and time to get key city players and shippers on board. Because this specific innovation is relatively low-cost, especially when compared to the astronomical cost of adding lanes to existing urban highways, piloting the urban truck hubs in one region using DOT funding may be especially attractive.

For the truck hubs to have maximum impact on reducing GHG, it will be important for alternative fuel and high-efficiency conventional vehicles to replace the existing fleet. This benefit may take longer to realize, since companies will need to invest in alternative fuel fleets after the truck hubs are in place. If use of these ports allowed a significant portion of the long-haul tractor-trailer fleet to adopt currently available technologies the benefits to the public and the economy would be enormous. A host of studies over the last few years by government and non-profit organizations have all concluded that, not only is the potential to decrease the fuel consumption and thus the emissions of long-haul trucks significant, but over the lifetime of these vehicles they can substantially reduce transportation costs.

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Workshop Two

Agenda: Optimizing regional food freight movements
Objective: To investigate regional food freight movements for 2050

Wednesday, June 17, 2015 9am – 4pm
The Pyle Center, 702 Langdon Street, University of Wisconsin-Madison

9am	Welcome and introductions
9:15	Presentation: Trends for multi-modal strategies for regional food freight
9:45	Presentation: Intervening factors in moving freight
10:15	Discussion: Early thinking about food freight opportunities in the Upper Midwest – SWOT analysis and situation assessment
10:45	Group work: 2050 scenarios for food transportation in our region • Extreme weather and population growth scenario • Fuel and labor cost scenario • Congestion, and public / private infrastructure investments scenario • Public health scenario
Noon	Lunch – continue small group discussions
1pm	Presentations from the four scenario groups – narrative / SWOT
2pm	Break
2:30	Discussion: Synthesizing scenario insights • How do we get from here to there? • What is the path of least resistance? • What questions arise from thinking about future scenarios? • Who are the key actors to involve at the autumn conference? • Who can champion key aspects of our conversation? (Potential speakers for the conference?)
4:00	Conclude

Meeting Summary
Food Freight 2050 Scenarios, June 17, 2015

In Attendance:
Advisory: Sarah Lloyd, Irv Cernauskas, Steve Viscelli
Guests (see bios from meeting packet): Theresa Feiner, Ty Rohloff, Kathy Heady, Rebecca Kemble, Steve Ventura, Sheri Walz, Jesse Patchak, Craig Kettleson, Lindsey Day Farnsworth, Rebecca Jollay
Staff: Michelle Miller, Kelly Maynard, Bill Holloway, Ernie Perry, Anne Reynolds, Ben Zeitlow

Next Steps:
1. Collect and review shipper data (WI Food Hub Cooperative, Keewaydin Farms, Driftless Organics, Organic Valley, Wescott apples, Wisconsin Meadows beef, Dierks potatoes, Coop Partners Warehouse, Alsum's, others?
2. Work with the Business school to involve student volunteers for logistics analysis.
3. Chicago meeting in November – prioritize participation from shippers and carriers, logistics providers, planners. Organize as a working meeting, not talking heads.
4. Need help to identify a local host and compelling speakers.
5. Present analysis at Chicago meeting.

Presentations on:
- Trends for multi-modal strategies for regional food freight
- Intervening factors in moving freight
- Early thinking about food freight opportunities in the Upper Midwest

Breakouts -- 2050 scenarios for regional food transportation:

Climate Change and Population Growth (combined with public health and food access)
- Predicted climate changes and population growth are opportunity for Upper Midwest
- Need increased public investment in aggregation and distribution infrastructure so farmers can focus on farming
- Opportunity with rail for food and people; aligning food movement with commuter movement
- Intermodal hubs that connect rail w/ last/metro mile on trucks – reefer boxes that go between rail and trucks – modular design
- Shortline rail vs Class One issues -50% of the infrastructure today compared to 1920
- Aggregation food hubs to create shipper scale
- Cooperative logistics companies
- Less congestion = less driver turnover (with current payment structure), but should change how drivers are paid and organized
- Some off-peak delivery – what are the ramifications?
- Fewer food miles overall
- Nationalize rail-roads – **critical** to making this work for freight. BUT HOW??? Pie in the sky??
- Policy: Farm Bill – broaden crop insurance protections to include produce; metro regions – what are the incentives for off-peak delivery
- Changing water levels pose risk for barge/ship movement
- Railroads are resilient to climate changes, but private ownership creates complications

Fuel and Labor Costs

Fuel:

- Volatility in price is increasing; artificially low right now
- Fuel market dictates investment in alternative logistics – investments in natural gas and alternative fuels more attractive when fuel prices high, but less "room" for change when transportation costs are high
- Insufficient fuel efficiency now – we can do better – trucks now better engineered, but system not conducive to using them
- Fuel use increases when prices are low and leads to greater congestion
- Aerodynamic improvements – OTR efficiency
- Batteries – increases ROI in metro transportation, can improve GHG depending on charge source
- Federal standards for emissions and biofuels are shifting this cost center
- Target public or private investment in infrastructure. First mile road conditions, coop logistics and aggregation – OTR road improvements – truck port / drop yard at metro regions – last mile congestion pricing?
- Bridge weights (OTR) and road geometries (first, metro and last mile)

Labor -trucking

- 6mo 100% turnover
- Different situations in different companies
- Takes driver 6mos to learn job to realize fuel efficiencies, but then they quit.
- Insurance issues – self-insured w/ bond vs. 1-2 years experience
- Baby boom demographics – who will take these jobs?
- Veterans as ready workforce – training through national guard?
- Consolidation and deregulation
    - LTL was dominant 90% teamster but ag wasn't regulated so that it could compete w/ rail
    - "carriers of the middle" largely replaced by vertically integrated companies and very small companies

Labor – agriculture, supply chain

- similar issues to trucking
- labor shortages, low wages, ownership consolidation, vertical integration
- supply chain of the middle

Congestion and Public Infrastructure

- Multifaceted solution for land management and people: urban agriculture; tax incentives to preserve farmland; improved land quality; improved water quantity and quality; higher density of farms; strategic plan for crops; zoning
- Increased water and rail – more efficient than trucks: containerize freight for intermodal transfer; develop intermodal infrastructure; increased funding and P3; tie urban and rural interests to transportation and federal funding programs and federal environmental policy
- Rail issues complex and run deep – shortline vs Class 1 rail. Private investment in infrastructure. Federal vs. state oversite.
- Increase truck efficiency: duty cycles; containers/pods; truck ports / drop yards
- Logistics to combine/meet needs of buyers and sellers regionally
- Data gathering – connect food to tech sector
- Land zoning to encourage farming and limit urban sprawl
- Internalize cost of ag/transportation – transportation tax, structured like sales tax?

Themes in Common - Synthesis:

Policy and Regulation

- Federal vs state vs local government & private vs public: complex interagency and scaler issues especially around midscale independent supply chains and transportation. Federal oversight for regional food freight spread between different agencies (FDA, USDA, DOT, EPA). Very hard for any one person to get their head around the whole thing.
- Support off-peak delivery to reduce congestion **-** How much incentive is needed to change behavior? Will investment in truck ports / drop yards reduce congestion and / or make it easier to provide incentives?
- Need adjustments to food, transport, regulatory, environmental, etc. policy
    - Coordinated approach is needed
    - Regional focus seems more practical than national focus – production region to regional market?
    - Food a subset of freight transportation – does truck port / drop yard idea work with carriers who aren't dedicated? Backhaul logistics?
- Incentivize local and regional supply chains (fresh produce) to meet regional demand
- Non-profit DCs/cross docks/terminals to kickstart independent supply chains and support existing midscale shippers

Data and Information Technology –

- Need more granular data on food transportation (avoid skewing by high dollar value/heavy weight foods)
- Design logistics structures to serve midscale supply chains
- Untapped potential in linking tech industry to food
- Need better data on rail opportunities – pilot ship from Waupaca to processor in Oconomowoc – shortline with sweet corn and squash? Hook and haul two containers twice a week?
- How much wait time to unload (dock wait costs), or move through congestion? Big companies get first priority at docks – waiting as power indicator in the system
- What is the sweet spot for trucking? 300-500 miles most profitable?
- Transparency on labor costs
- What is the cost per mile for customer shippers?
- What would a business plan look like for a company that wanted to serve the metro OTR segment (truck port to DC)?

Private Sector Engagement and Opportunity –

- Rethink logistics to optimize more than fuel costs - improving labor conditions a high priority. Also GHG emissions.
- Are there companies currently running refrigerated trucks that could accommodate seasonal produce? Dedicated vs independent.
- Reefer trailer co-op for smaller shippers? Organize independent regional carriers into co-ops? Has this been done before?
- Who, how and if to engage the railroads, especially in pilot project? Complex and resource intensive. Not a next step, but futuristic?
- Uber system for freight? Untapped opportunity with hi teck and younger labor force

Infrastructure and Other Innovation –

- Modular/standardized shipping units (for intermodal)
- Chasie / trailor components?
- Truck ports / drop yards at fringe of large metro areas – governance issues yet to be addressed. Spot market opportunity?
- Investigate opportunity for shortline seasonal rail shipments of ag produce – pilot on state-owned track?
- More cooperation between shippers and carriers is needed, targeting refrigerated carriers. What is the incentive to do this?
- Truckers' wasted time at destination loading docks is a major problem with current system (not talking about last mile delivery to retails, but OTR deliveries to Distribution Centers)
- Need to identify our market better – volume and value of the market (food needing delivery)
    - How much business would be required to make truck ports / drop yards work?

Precedents to explore

- Eco-vida, Brazil food logistics
- Short-line food shipments
- Local food starter pack
- Kwik Trip alternative fuel trucking
- Igl farm backhaul arrangement with Roundy's to Antigo
- Pickle Train

Workshop Three

Freight innovations to optimize regional food resiliency

Tuesday January 5, 2016, Chicago Metropolitan Agency for Planning

Andrew Lutsey, Chicago Local Food

Moving food from rural areas into large metropolitan regions is an expensive proposition. Regional shippers are looking for ways to reduce labor costs and improve fuel efficiency. Distribution centers are interested in securing more regionally-produced food to meet consumer demand and differentiate their stores. Planners are looking for ways to reduce traffic congestion and improve air quality. Food activists want to see food businesses owned by community members bloom in their neighborhoods. This workshop provided an opportunity to consider systemic improvements to how food is moved from rural to urban areas and in such a way that potentially can meet the needs of all stakeholders. The Chicago Metropolitan Agency for Planning (CMAP) hosted the workshop. Sixty-one participants spent the day thinking through issues related to food freight movement.

Format:

The workshop ran seven hours, including a working lunch for networking. Three hours were devoted to hearing the experiences of people in the field working on improving transportation and supply chains from rural farming areas to urban markets. Equal time was given for practitioners to discuss in small groups about their concerns and to respond to ideas and questions posed by guest speakers.

Topics:

- Regional shipper concerns when accessing the Chicago market
- Private sector efforts to improve freight transportation in the Los Angeles megaregion
- Efficiencies to be gained from splitting trucking options into rural and urban modes
- Market issues for accessing regional food and last mile delivery

Steve Viscelli leading the workshop

Agenda:

9:00 – Welcome

Ernest Perry – Center for Freight Infrastructure Research and Education

Steve Viscelli – Swathmore College

Irv Cernasukas – Irv and Shelly's Fresh Picks

Tom Murtha – Chicago Metropolitan Agency for Planning

Mr. Gregory Grajewski – USDA-Agricultural Marketing Service

Michelle Miller – UW Center for Integrated Agricultural Systems

9:30 – Session one: Shipping food regionally, efficiently

Larry Alsum , Alsum Farms & Produce, Alsum Trucking , Friesland, WI Alsum – Regional Food Freight Workshop Presentation 1.5.16 FINAL

Rob Reich, Schneider Trucking, Green Bay, WI

Michelle Miller, reporting on the UW Grainger School of Supply Chain Management MBA student project regional food freight presentation

Table talk: **What is your experience with regional food shipment – what are the challenges and opportunities?**

11:00 – Get your lunch! Arbor is feeding us

11:30 – Session two: Unleashing engineering efficiencies

Michael Roeth, North American Council for Freight Efficiency NACFE Chicago Reg Food Freight 010516

Sage Kokjohn, University of Wisconsin – Engine Research Center_Kokjohn Regional Food Freight

Table talk: **What do private sector supply chain actors need to make this switch?**

1:15 – Break

1:30 – Session three: Meeting the market demand for regional food

Barbara Daly – Testa Produce, Chicago Testa Trucks

Cynthia Haskins – IL Farm Bureau Jan. 5

Lee Strom – FARM Illinois FARM Illinois IPPA

Table talk: **How can we better connect Chicago to our regional food economy?**

3:15 – Synthesis: Irv Cernauskas and Steve Viscelli, with participants

3:45 – Concluding Remarks: Ernest Perry

Download the rff meeting packet.

Download the Meeting Evaluation_CMAP results

Overall, the meeting was well-received (N=32/60). Where five rated high on an agreement scale and one rated low, most of the questions rated higher than a four, indicating high satisfaction with the workshop overall. Participants found the speakers engaging and the discussions productive. People felt that the knowledge they gained from the workshop was useful to them, they appreciated the networking opportunities, and most indicated an interest in further involvement with local and regional food systems work. Lower scores are noted for workshop timing and location, although the location enhanced the meeting. There was interest in engaging many more farmers, truck drivers, retailers and others in regional supply chains. Please see the evaluation results for more detailed feedback.

Speakers:

Mr. Rob Reich – Senior Vice President, Equipment, Maintenance & Driver Recruiting, Schneider National, Inc. Schneider was established in 1935 and is one of the nation's leading trucking companies. With an extensive history of commitment to the environment, Schneider is regularly awarded by EPA's Smart Way program for its initiatives to reduce emissions and improve fuel efficiency.

Mr. Larry Alsum -Alsum Farms & Produce & Alsum Trucking, Freisland, WI. Larry starting farming and packing potatoes and onions in 1981. Today his company is packing and marketing over 1.8 million cwt of potatoes, including russets, reds, golds, whites, and fingerlings from a number of farms in the Midwest. In addition to growing and selling potatoes, Alsum Farms & Produce also buys onions, sweet potatoes and pumpkins and markets them under the Alsum label as well as private labels. The company wholesales 300 different kinds of fresh fruits and vegetables including locally grown apples, onions, hard squash, peppers, cabbage, zucchini, celery, sweet corn and asparagus during the season.

Mr. Mike Roeth – North American Council for Freight Efficiency. Mike has worked in the commercial vehicle industry for nearly 30 years, most recently as the Executive Director of the North American Council for Freight

Efficiency. Mike is also leading the Trucking Efficiency Operations for the Carbon War Room. Mike's specialty is brokering green truck collaborative technologies into the real world at scale. He has a BS in Engineering from the Ohio State University and a Masters in Organizational Leadership from the Indiana Institute of Technology. Mike served as Chairman of the Board for the Truck Manufacturers Association, Board member of the Automotive Industry Action Group and currently serves on the second National Academy of Sciences Committee on Technologies and Approaches for Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles and has held various positions in engineering, quality, sales and plant management with Navistar and Behr/Cummins.

Mr. Sage Kokjohn – University of WI-Madison, Engine Research Center. Sage is an Assistant Professor in the Department of Mechanical Engineering at the University of Wisconsin – Madison. His research interests include engine modeling and experiments focused on explaining the mechanisms controlling high-efficiency combustion systems and developing pathways to achieve robust, high-efficiency energy conversion. He received his Ph.D in Mechanical Engineering from the University of Wisconsin – Madison in 2012. Professor Kokjohn was a visiting researcher at the Combustion Research Facility at Sandia National Labs where he used optical engine experiments to investigate low temperature, premixed combustion. He has over 40 publications related to high efficiency engine combustion.

Ms. Barbara Daly - Testa Produce has provided produce to Chicago wholesalers for more than 100 years. With a strong commitment to sustainability and sourcing local product, Testa Produce makes regular runs to farms in the Upper Midwest to fill its orders. Barbara Daly, facilities manager, is building a CNG fleet for deliveries and was recognized by Chicago Area Clean Cities for the effort.

Ms. Cynthia Haskins – Illinois Farm Bureau. Cynthia is the Manager of Business Development and Compliance for the Illinois Farm Bureau. Haskins is responsible for creating and implementing programs to assist with local business development; including the expansion of marketing and distribution networks for local food and products as well as keeping informed on food safety issues, labeling requirements and nutrition programs. She has coordinated over 20 Meet the Buyer events, of which link farmers with potential grocery and foodservice buyers. In addition, she has coordinated the Local and Regional Food Summit, an event that has attracted over 300 industry and Illinois Farm Bureau members. Haskins has been in the industry for more than 33 years. As president of the Northern Plains Potato Growers Association, she worked on legislative, environmental, and marketing initiatives for the grower-member association. Other experience includes working for marketing organizations such as David Oppenheimer Group, an international fruit and vegetable brokerage, where she served as a marketing brand manager representing New Zealand apple, pear, and kiwifruit growers. Haskins was a regional manager for the Washington Apple Commission, a grower nonprofit representing apple growers. She was a general manager for Continental Food Service/Sysco, a multi-million dollar produce foodservice organization. Other organizations she has worked for include Dole, an international fruit and vegetable marketing company, Sunkist, a grower cooperative, and the Missouri Department of Agriculture.

Mr. Lee Strom – FARM Illinois. Mr. Strom is Executive Director for Food and Agriculture RoadMap (FARM) Illinois and is involved with creating the Illinois Council for Food and Agriculture. FARM Illinois recently completed an extensive public process to set a way forward that strengthens the roles played by the Chicago region and Illinois as a whole in local and regional food systems. Mr. Strom also serves as a principal of Open Prairie and its Rural Opportunity Fund, an Illinois-based private equity company with focus on agriculture and food companies.

Mr. Gregory Grajewski – USDA-Agricultural Marketing Service, Marketing Services Division. Mr. Grajewski currently works on the Local Foods Promotion Program and previously worked on terminal market analysis and wholesale food issues for USDA. He graduated from Politechnika Poznanska in Poznan, Poland with a masters degree in construction project management and received an MBA from Southeastern University in Washington, DC. Prior to his employment in USDA he worked in private industry both in Poland and US managing various construction projects.

Mr. Stephen Larsen – University of Wisconsin Grainger School of Business, Center for Supply Chain Management. With a degree from Brigham Young University in supply chain management, he joined the transportation company C.R. England. He worked as a logistics analyst, designed and priced new business opportunities within the

company's dedicated fleet services division. In this role, he worked on numerous projects including transportation network design, financial modeling, contract and rate negotiations, and continuous improvement projects.

Conveners:

Mr. Irv Cernauskas - Irv & Shelly's Fresh Picks. Irv and his wife founded Fresh Picks in 2006 to provide new market opportunities for farmers and to help stimulate the re-growth of Chicago's local food system. Fresh Picks' home delivery service brings great food to thousands of area households, has developed farm based food aggregation hubs to drive down shipping costs, and adds several hundred thousand dollars to the incomes of local farmers each year. Irv earned an MA in Economics, an MBA from MIT, and worked for 20 years as a corporate executive and running his own IT consulting practice. Several years of service on the boards of Seven Generations Ahead and The Land Connection helped forge friendships with local farmers. This convinced Irv of the importance of local agriculture to health, the environment and rural communities, and was the inspiration for starting Fresh Picks.

Dr. Steve Viscelli – truck hub concept originator. (PhD, Indiana University; MA, Syracuse University; BA, Colgate University) is an economic sociologist who studies the trucking industry. In 2010 he began working with the University of WI -Center On Wisconsin Strategy as a National Science Foundation fellow. His work focused on developing alternative ways to move freight by truck that reduce fuel consumption and shipping costs, improve working conditions for truckers, and relieve traffic congestion. He engaged industry and government stakeholders to evaluate the benefits and feasibility of what he calls "urban truck ports" that allow truckers to coordinate the of use super-efficient trucks designed for urban or rural hauling. Urban Truck Ports white paper Since 2013, Steve has been a Visiting Assistant Professor at Swarthmore College. He is currently completing a book about how deregulation transformed labor markets and work in long-haul trucking and thus fostered a revolution in logistics, based on six months of fieldwork as a long-haul trucker, more than 120 interviews with truckers, and survey data.

Lead facilitator:

Ernie Perry – Ernie is the Program Administrator and Facilitator of the Mid-America Freight Coalition. Before joining the National Center for Freight and Infrastructure Research and Education (CFIRE), Perry was the Administrator of Freight Development at the Missouri Department of Transportation. During his seventeen-year tenure at MoDOT, he also served as research administrator, organizational results administrator, senior environmental specialist, and socioeconomic specialist. Perry has worked closely with freight leadership at AASHTO, FHWA, and MARAD, served on NCFRP panels, and participated in the Scan of European Union Freight Corridors. Perry holds a BS in animal science, an MS in rural sociology, and a PhD in rural sociology from the University of Missouri–Columbia.

Participants:

Alonzo, Joe CDOT
Alsum, Larry Alsum Farms & Produce, Alsum Trucking
Arias, Lauro Arias Agribusiness Consulting
Bigelow, Mark Local Foods Chicago
Bingham, Samantha Chicago Dept of Transportation
Block, Daniel Chicago State University
Bosso, Max Elwood International Port
Boxer, Greg Coyote Logistics
Broadnax, Jane Chicago Department of Transportation
Cernauskas, Irv Irv & Shelly's Fresh Picks
Chachula, Nancy Consultant
Daly, Barbara Testa Produce, Inc.
Doetch, Ronald SITL
Eby, Ben Fifth Season Coop

Frankel, Noam Optimal Freight
Gollnik, Bob Cambridge Systematics
Grajewski, Gregory USDA AMS TM
Haney, Harry Logistics consultant
Haskins, Cynthia Illinois Farm Bureau
Haucke, Rufus Just Local Foods
Heiderscheidt, John AgroBuild, LLC
Holloway, Bill SSTI
Jones, Danielle WI Economic Development Corp.
Kemble, Rebecca City of Madison
Kettleson, Craig MadREP
Kessler, Grant Chicago Market – a Community Co-Op
King, Warren WellSpring Ltd
Knobel, Zachary Coyote Logistics
Kokjohn, Sage University of Wisconsin – Madison
Larsen, Kelly Windy City Harvest
Lawless, Greg University of Wisconsin Extension
Lehman, Karen Fresh Taste
Liu, Caitlyn WI Department of Transportation
Lloyd, Sarah Wisconsin Food Hub Cooperative
Lutsey, Andrew Chicago Local Foods
Maietta, Anthony US EPA Region 5
Maldonado, Rosario Chicago Botanic Gardens
Maynard, Kelly UW CIAS
Miller, Michelle UW-CIAS
Morales, Alfonso UW-Madison
Murtha, Thomas CMAP
Perry, Ernie MAFC/CFIRE – UW Madison
Reich, Rob Schneider National, Inc.
Roback, Bradley City of Chicago
Roeth, Michael NACFE
Scaman, Robert Goodness Greeness
Schone, Ryan UW-Extension
Siegel, Sidney Natural Direct
Small, Cathy FamilyFarmed
Smith, Bradley People's Food Co-Op
Jennifer Spitz Consultant
Strom, Lee FARM Illinois
Szwak, Andrew Openlands
Tansley, Matthew Kane County
Viscelli, Steve Swarthmore College
Wilborn, Pat PortFish, Ltd.
Zietlow, Benjamin CFIRE Center

Hosts:

The meeting is part of a project organized by the University of Wisconsin – Madison, Center for Integrated Agricultural Systems. The project is supported by the USDA Agricultural Marketing Service – Transportation Division.The planning committee for this project involves three farmers selling into the wholesale market, four regional supply chain businesses, three regional non-profit partners, ten academics and seven students. For more information on the committee download our bios- truck hub proj-11.10.15