Innovations in Logistics

Innovations in the Food System: Shaping the Future of Food, a Food Forum Workshop

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Health & Medicine Division

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Moving food to people and moving people to food

- 1960s – distribution heyday
- 1970s – fuel price volatility
- 1980s – shake up in the labor market; privatizing supply chains
- 1990s – Big Box and the rise of logistics
- 2000s – consolidation and access issues
- 2010s – climate volatility

The Big Rig Viscelli, S. 2016. University of California Press

"Public Markets and Municipal Reform in the Progressive Era" Tangires, H. 1997. *Prologue, Vol. 29, No. 1*

Concentration and Power in the Food System Howard, P. 2017. London: Bloomsbury Academic

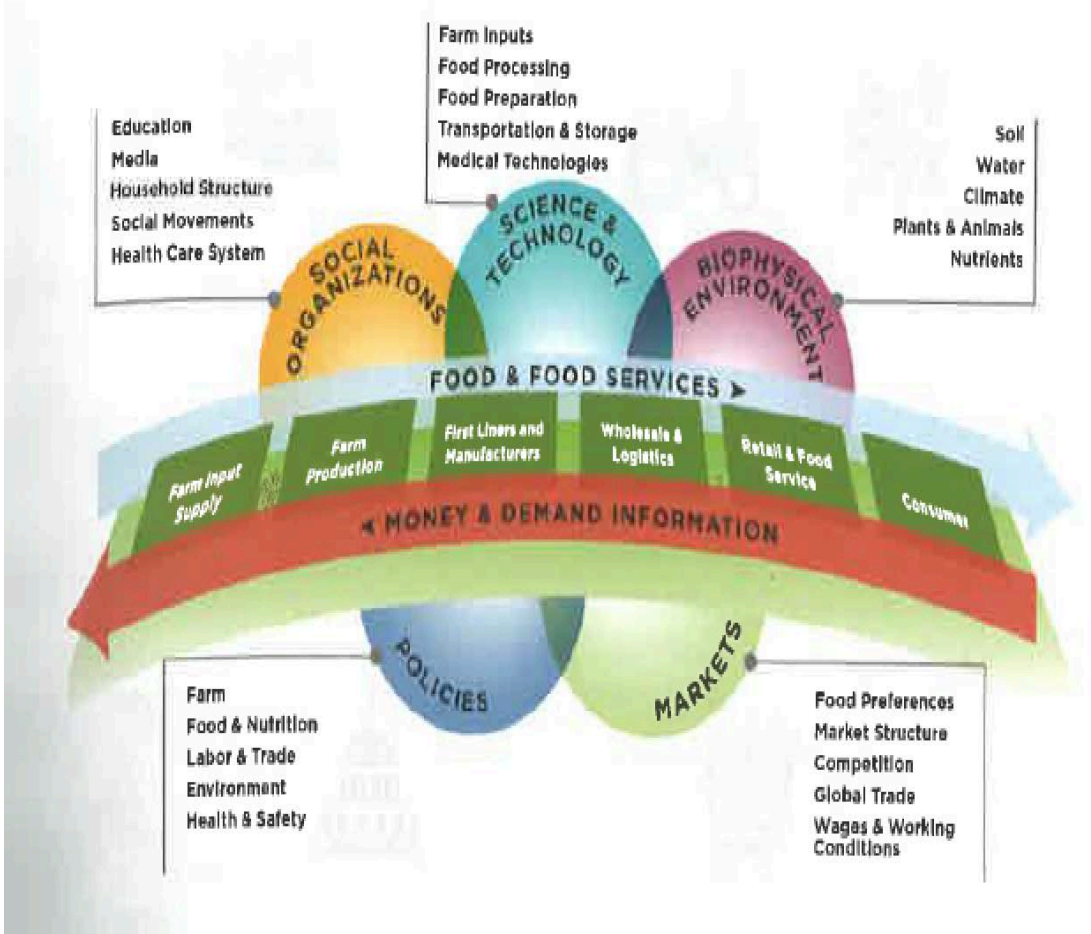
Climate Change Adaptation and Food Supply Chain Management Paloviita, A., Jarvela, M. 2016. Routledge

The Food System as a Complex Adaptive System: the food supply chain & the biophysical, social institutional context

A Framework for Assessing Effects of the Food System Institute of Medicine and the National Research Council 2015. Washington, D.C. The National Academies Press

Food Supply Chain Management: Economic, Social and Environmental Perspectives Pullman, M., Wu, Z. 2012. Routledge.

The Dynamics of Change in the US Food Marketing Environment Tropp, D. 2008. USDA-AMS Agriculture Handbook 728-3



CAS: The role of certainty (volatility mgt) and agreement (trust/control) in a dynamic system

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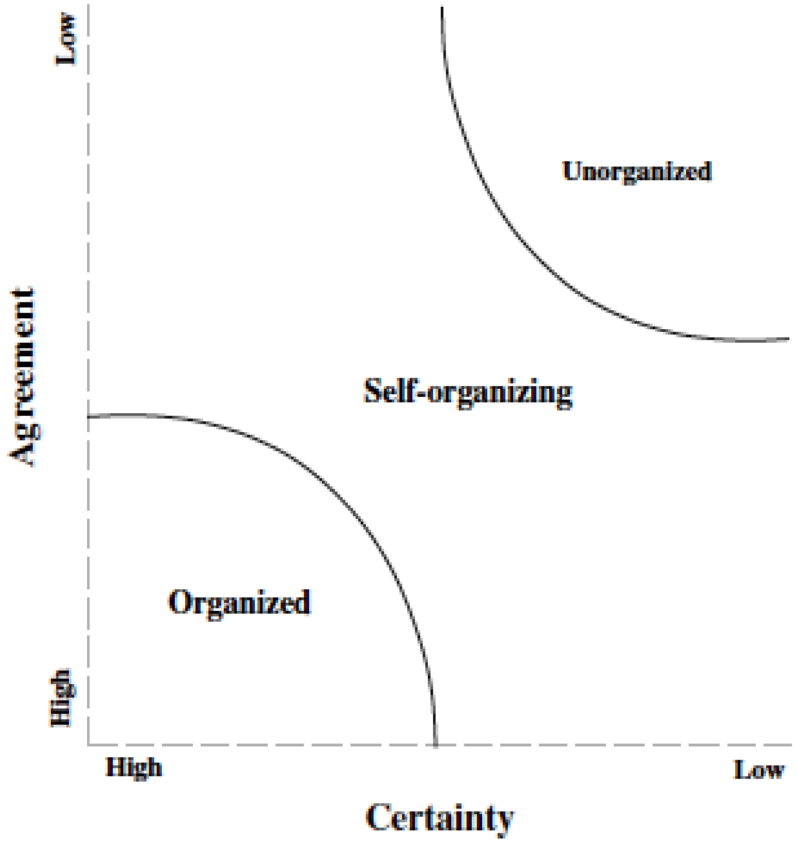
"Report on resilience framework for EU agriculture", Meuwissen et. al. 2018. Technical report. European Union Horizon 2020 research and innovation program.



CAS: System Characteristics Necessary for Adaptation and Evolution

- **Diversity**
- **Flow**
- **Non-linearity**
- **Aggregation**

"Design of Complex Adaptive Systems" Monostori, L. and Ueda, K. 2006. *Advanced Engineering Informatics* DOI 10.1016/j.oei2006.05.009

Diversity Flow Non-linearity Aggregation

- To lessen seasonal volatility, fruit and vegetable production moved to “Fruitful Rim”
- Oversimplified, highly efficient production & distribution systems are creating unintended environmental disruptions
- Optimizing diversity in products and supply chain ownership at multiple scales and parts of the food system is critical for resiliency

“Crop Species Diversity Changes in the United States: 1978–2012”

Aguilar, J., Gramig, G. G., Hendrickson, J. R., Archer, D. W., Forcella, F., & Liebig, M. A. 2015. *PloS one*, *10*(8), e0136580.

Resilient Agriculture: Cultivating Food Systems for a Changing Climate Lengnick, L. 2014. New Society: British Columbia

A Framework for Assessing Effects of the Food System

Institute of Medicine and the National Research Council 2015. Washington, D.C. The National Academies Press

“Metropolitan foodsheds: a resilient response to the climate change challenge?”

Lengnick, L., Miller, M., Marten, G. G. 2015. *Journal of Environmental Studies and Sciences*, *5*(4), 573-592.

Optimizing two narratives: efficiency and diversity

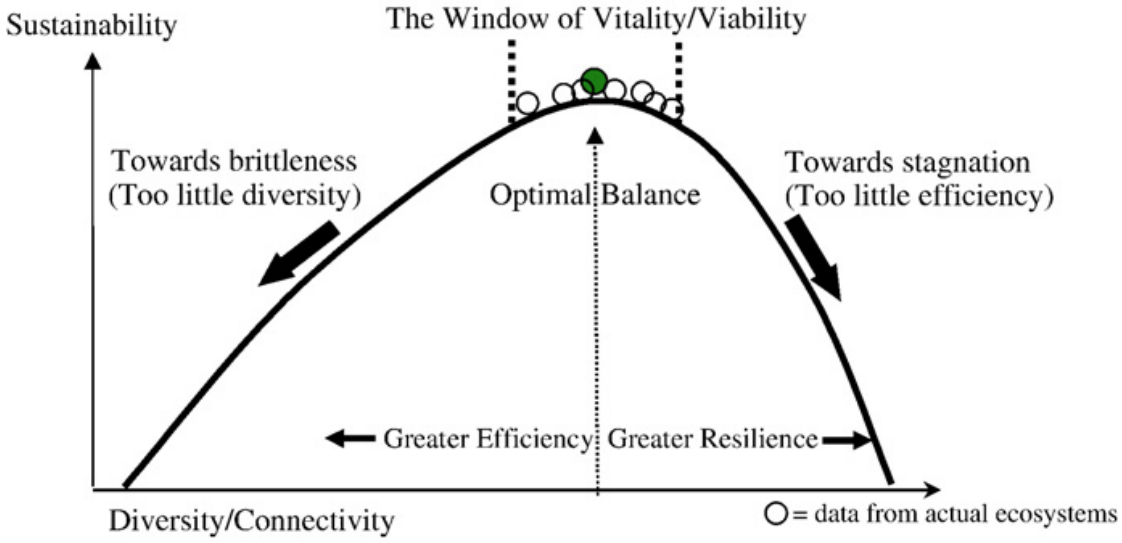
"Quantifying economic sustainability: Implications for free-enterprise theory, policy and practice" Goerner, S. J., Lietaer, B., Ulanowicz, R. E. 2009. *Ecological Economics*, *69*(1)

Thinking in Systems Meadows, D. 2008 Chelsea Green.

Systems Thinking for Social Change Stroh 2015 Chelsea Green

"New Thinking on Regional"

Clancy, K., Ruhf, K. 2018. *Journal of Agriculture, Food Systems and Community Development*. Vol 8, Issue 3



"Systemic Analysis of Food Supply and Distribution Systems in City-Region Systems"

Armendariz, V., Armenia, S. and Atzori, S.A., 2016. *Agriculture*; doi:10.3390/agriculture6040065

"A Network Analysis of Food Flows within the United States of America" Lin, X., Dang, Q., Konar, M. 2014. *Environmental Science and Technology* doi:10.1021/es500471d

Five Borough Food Flow: 2016 NYC Food Distribution and resiliency study results

Economic Development Corporation (EDC) 2016. New York City EDC.

"Logistics Best Practices for Regional Food Systems: A Review" Mittal, A., and Krejci, C. 2018. *Sustainability* 2018, 10, 168; doi:10.3390/su10010168

Diversity Food Flow Non-linearity Aggregation

- Regional flow is insufficiently organized
- Chicago is the epicenter for private food warehousing
- Last-mile *public* terminals are critical for smaller supply chains
- *Logistics for small supply chains are underdeveloped, lack analytics*

"Environmental and economic impacts of localizing food systems: the case of dairy supply chains in the Northeastern US"

Nicholson, C., He, X., Gomez, M., Gao, HO, Hill, E. 2015. *Environ. Sci. Technol*. 2015, 49, 12005−12014 DOI: 10.1021/acs.est.5b02892

"Optimal size and location planning of public logistics terminals" Taniguchi, E., Noritake, M., Yamada, T., Izumitani, T. 1999. *Transportation Research Part E 35*. Pergamon, Elsevier Science

"Design of a Logistics Nonlinear System for a Complex, Multiechelon, Supply Chain Network with Uncertain Demands"

Campanur, A., Olivares-Benitez, E., Miranda, P., Perez-Loaiza, R., Ablanedo-Rosas, J. 2018. *Complexity* doi 10.1155/2018/4139601

Diversity Flow Non-linear supply chains Aggregation

- Temporal -- seasonal production
- Geographic – route
- Longer chains = bullwhip effect = need for higher "agreement"
- Agreement through trust, communication, reduced risk, vertical integration (ownership of supply chain capital)

Diversity Flow Non-linearity
Aggregation critical thresholds

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. 2016. Project report for USDA-AMS, Transportation Division. DOI: 10.13140/RG.2.2.21422.51522

First Mile Trip Segment
- Distance to aggregation, processing
- Is this a point of sale?

Over-the-Road /Regional Trip Segment
- Distance to wholesale market
- Access to transportation
- Tractor-trailer efficiencies
- Sufficient single product load (interregional) & diversity of product (intraregional)

Last Mile Trip Segment
- Access to cold storage warehousing
- Truck size
- Traffic congestion
- Increasing to serve e-commerce
- Single point of pick up – Click and Collect
- Who pays to move food – consumer, wholesale buyer, seller

The supply chain – first to last mile

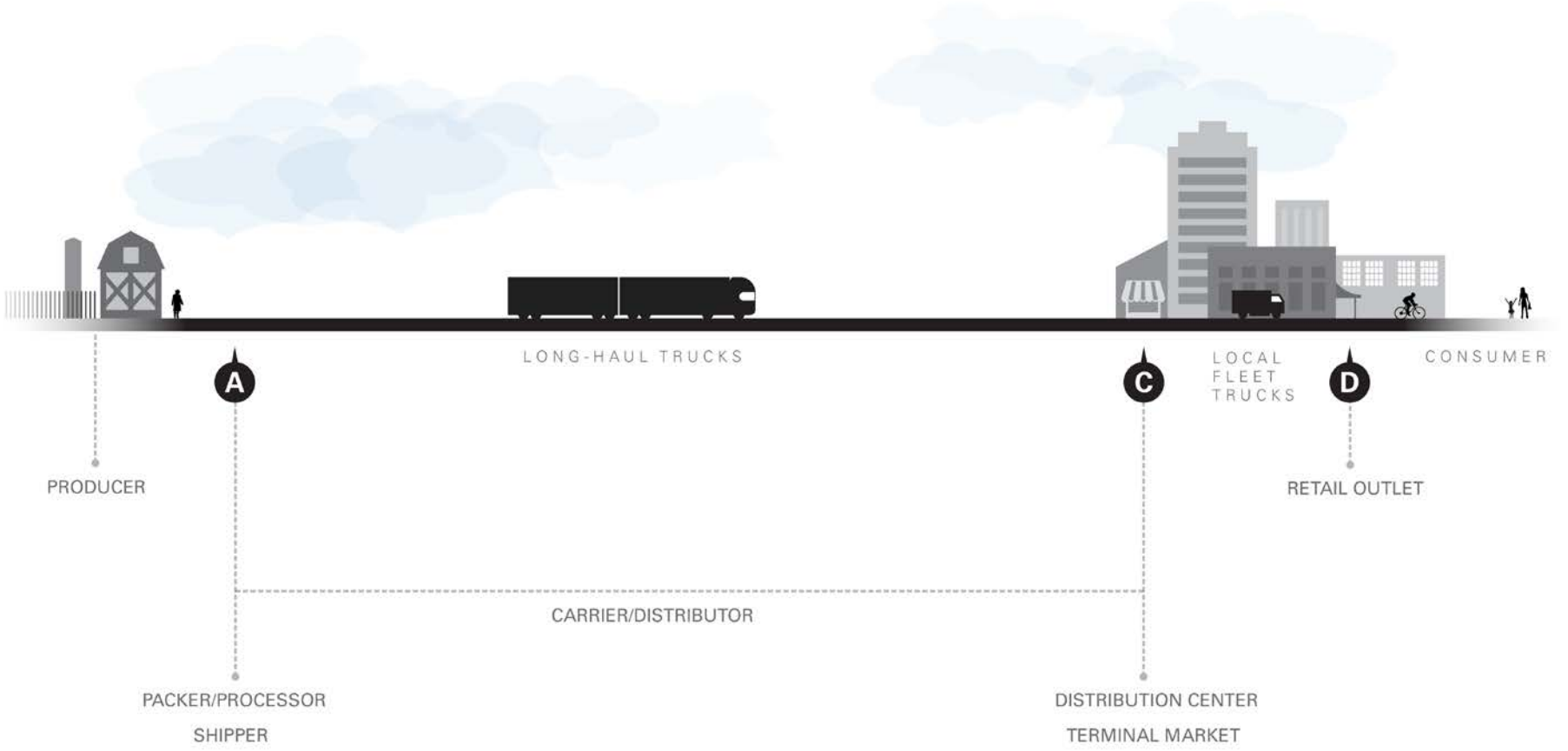


IMAGE BY JULIA SCHILLING

The Great Mindshift: How a New Economic Paradigm and Sustainability Transformations Go Hand in Hand Goepel 2016. Springer. https://www.springer.com/gp/book/9783319437651

Public food procurement – promoting population health, food security and ecosystem resilience. 2019 Session at the Royal Geographic Society – Institute of British Geographers, Annual International Conference.

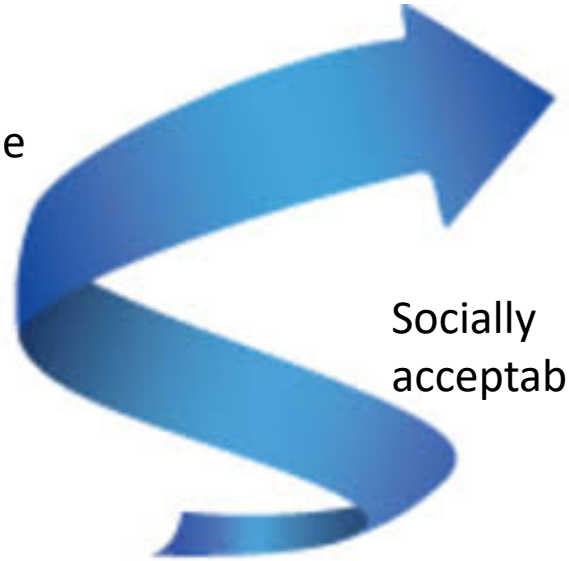
Technological responses

Organizational responses

Ecological responses

Sustainability as an emergent property

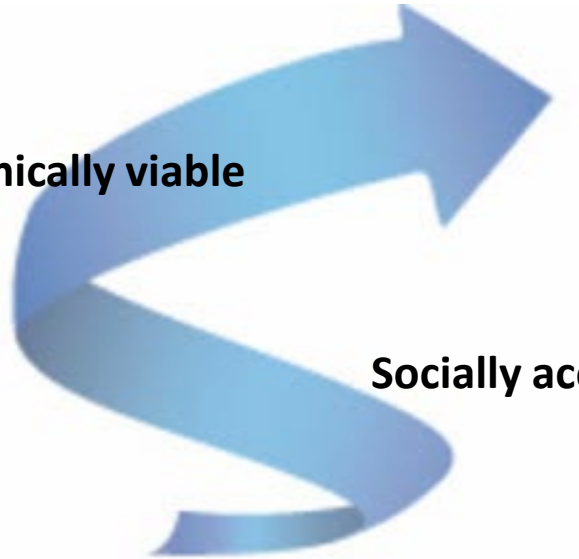
Economically viable



Socially acceptable

Environmentally sound

Sustainability redefined



Economically viable

Socially acceptable

Environmentally sound

Supports health and well-being

Promotes community

Eco-regionally appropriate

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Barriers to innovation

Regional food freight: lessons from the Chicago region Miller et.al. 2016. USDA-NIFA project report

Internet of Food and Farm 2020 Sundmaeker et.al. 2011. Wageningen University and Research https://www.iof2020.eu/

"Let them eat kale: the misplaced narrative of food access" Rosenberg & Cohen 2018. Fordham Urban Law Journal Vol 45 No 4

"GPS in Interstate Trucking in Australia: Intelligence, Surveillance, or Compliance Tool?" IEEE 2017. Technology and Society.

Human organization

- Scale disconnect
- Ownership
- Sharing risk and reward
- Underdeveloped governance
- Reduced market access

Technology

- Scale disconnect
- Ownership
- Sharing risk and reward
- Underdeveloped governance
- Technology access
- Data overload

Organizational innovations – to increase agreement

Regional food freight: lessons from the Chicago region Miller et.al. 2016. USDA-NIFA project report

"New Thinking on Regional"

Clancy, K., Ruhf, K. 2018. JAFSD Vol 8, Issue 3

Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition.

HLPE 2019. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, FAO, Rome.

Regionalization: System redesign to address market and food access, reduce waste & energy consumption

- Agroecology, agency, ownership
- Return of regional freight
- Public food terminals
- Stakeholder governance

Open source

- Compatible platforms
- Global standards

Connectivity

- Rural broadband

Technological innovations- to reduce uncertainty

Machine learning

- Algorithms to understand production volatility
- Also applied at the supply chain scale

Distributed ledgers

- Assist with supply chain information flow & transparency
- Distributed storage & processing of big data

Multi-tenant apps

- Many supply chains sharing software and server
- Critical for cold chains

"Machine Learning Methods for Crop Yield Prediction and Climate Change Impact Assessment in Agriculture," Crane-Droesch, A. 2018. *Environmental Research Letters* 13.11(2018):114003.

Climate change and agricultural risk management into the 21st C., USDA-ERS, 2019. ERR-266

"Are distributed ledger technologies the panacea for food traceability?" Pearson, et al. 2019. Global Food Security. Elsevier. https://doi.org/10.1016/j.gfs.2019.02.002

"Design of smart cold chain application framework based on Hadoop and Spark" Ko, et. Al. 2015. International Journal of Software Engineering and Its Applications Vol. 9, No. 12 http://dx.doi.org/10.14257/ijseia.2015.9.12.08

Technological innovations – to reduce uncertainty

"Simulation-ready digital twin for real-time management of logistics systems" Korth et al 2018. 2018 IEEE International Conference on Big Data, Seattle, WA.

"Fuel reactivity controlled compression ignition combustion in light and heavy duty engines", Kokjohn et al. 2011. SAE International Journal of Engines.

More regional freight: an opportunity for trucking? Mihelic & Roeth 2019. NACFE

Madison Terminal Market Study. Gottwals 2019. City of Madison, WI

"Food waste prevent in Europe – A cause-driven approach to indentify the most relevant leverage points for action" Priefer et al. 2016 *Resources, Conservation and Recycling Vol 109*

Digital twins

- Product can be monitored, controlled, planned and optimized remotely
- Real-time virtual rather than on-site observation

Engine innovations

- Hybrid-electric & renewables
- Vehicle specialization

Telematics

- GPS asset tracking
- Load matching systems

Automated material handling

- Response to low labor availability
- Need to improve fulfillment requirements

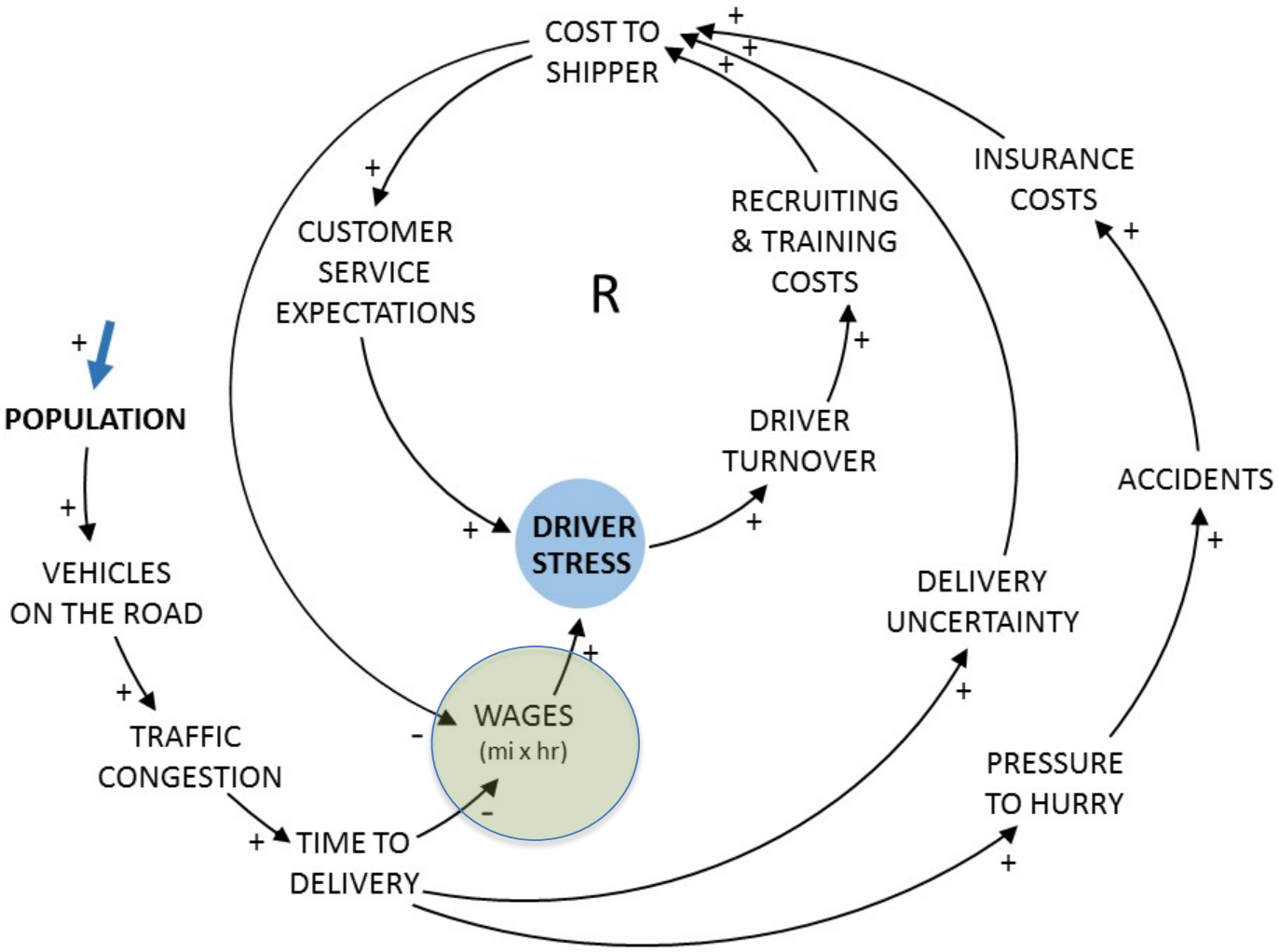
CR England trajectory

CR England Company History
CR England 2015.
http://www.crengland.com/about-us/company information/company-history

SmartWay Excellence Awards
USEPA 2015.
https://nepis.epa.gov/exe/Zy

- North America's largest wholesale cold chain
- Founded in 1920 as regional food carrier in UT
- First reefer in 1950
- 1960 1st cross country runs to public food terminal
- 1978 opened 1st DC in NJ
- 2015 also in CA, IN, TX
- 2016 LA dropyard to separate duty cycles, improve last mile
- EPA SmartWay awardee
- Run efficiencies shared with client

Wage rates as a leverage point for transportation labor



Vanessa Reese

Food Sovereignty & the Ontario Food Terminal

“The financial performance implications of differential marketing strategies: exploring farms that pursue local markets as a core competitive advantage”. Thilmany, McFadden, Bauman and Jablonski, 2016. Presented at the 153th Congress of the European Association of Agricultural Economists, Gaeta, Italy

Regional food freight: lessons from the Chicago region Miller et.al. 2016. USDA-NIFA project report

Farmers make money in wholesale markets

- Too small – too diverse and operating under economic thresholds
- Too big – too efficient and operating beyond environmental limits
- Just right – serving regional markets

Regional market requirements

- Within 200 miles/four hours of a single drop point
- Enough production to fill 53’ trucks
- Affordable cold storage space
- Enough production diversity for healthy soil
- Enough efficiency to streamline farm labor
- Partner with 12 month supply

Truckers, wholesale buyers must make money

- Regular hauling and buying contracts
- Full trucks
- 1-day runs (no overnights)
- One point of delivery
- Anticipated, minimal road congestion
- Trip-segment (duty cycle) specific engineering
- Affordable cold storage space
- 1-truck delivery to buyer
- Wholesale B-B market within 50mi of retail buyers

Systemic change to improve food access

- Food is a right, not a privilege. Physical and economic access is a public good.
- Increase the food flow first, then neighborhood groceries will emerge, not the other way around. Avoid gentrification by creating means for ownership.
- Food terminals are a public utility. If the private sector is not meeting the needs of small wholesale supply chains and independent business ownership, then there is a need for a public terminal.
- Terminal design must hold space for businesses of all sizes, and improve last mile and region-to-region freight movements.
- Terminals give access to high-tech innovations and logistics improvements for independent businesses.
- Terminals need to optimize energy efficiency (esp refrigeration) and product diversity.
- Terminals need a governance structure that protects the public interest in food, decent work, environmental protections, and gives users a stake in facilities management.

Logistics in the public interest

- Detailed, dynamic understanding of food flow at national and regional levels
- Algorithms for seasonal logistics accessible to small business collaborations
- Drive time data analysis accessible to small, independent, regional fleets
- Food access emergency planning data
- Regional systems designs for improved food access within cities and rural areas under anticipated climate scenarios
- Support for USDA(AMS, ERS, NIFA) to collect and analyze relevant data and assist with infrastructure development
- Public policies that support civic interest in resilient food supply chains

Thank you.

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