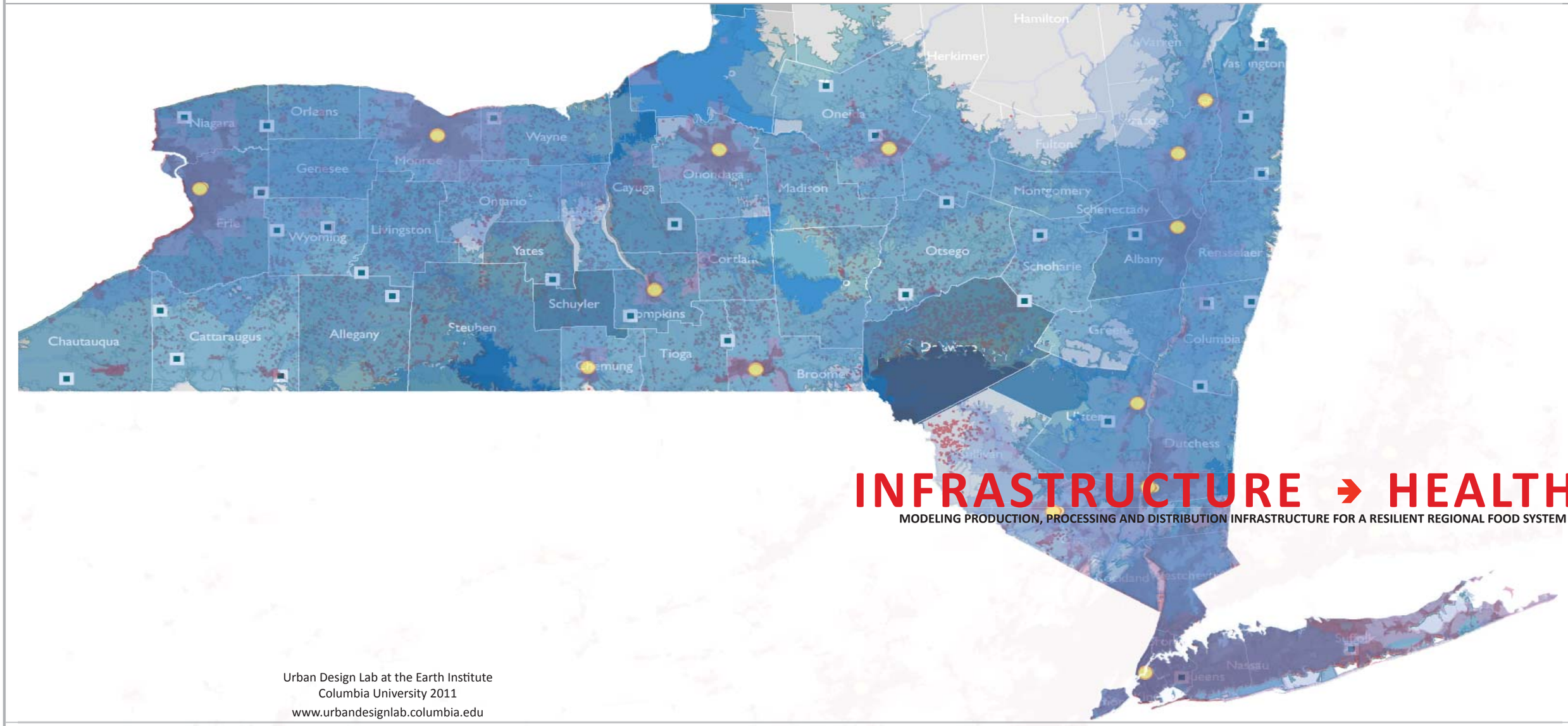

INFRASTRUCTURE → HEALTH

MODELING PRODUCTION, PROCESSING AND DISTRIBUTION INFRASTRUCTURE FOR A RESILIENT REGIONAL FOOD SYSTEM

Urban Design Lab at the Earth Institute
Columbia University 2011
www.urbandesignlab.columbia.edu

URBAN DESIGN LAB
THE EARTH INSTITUTE | COLUMBIA UNIVERSITY

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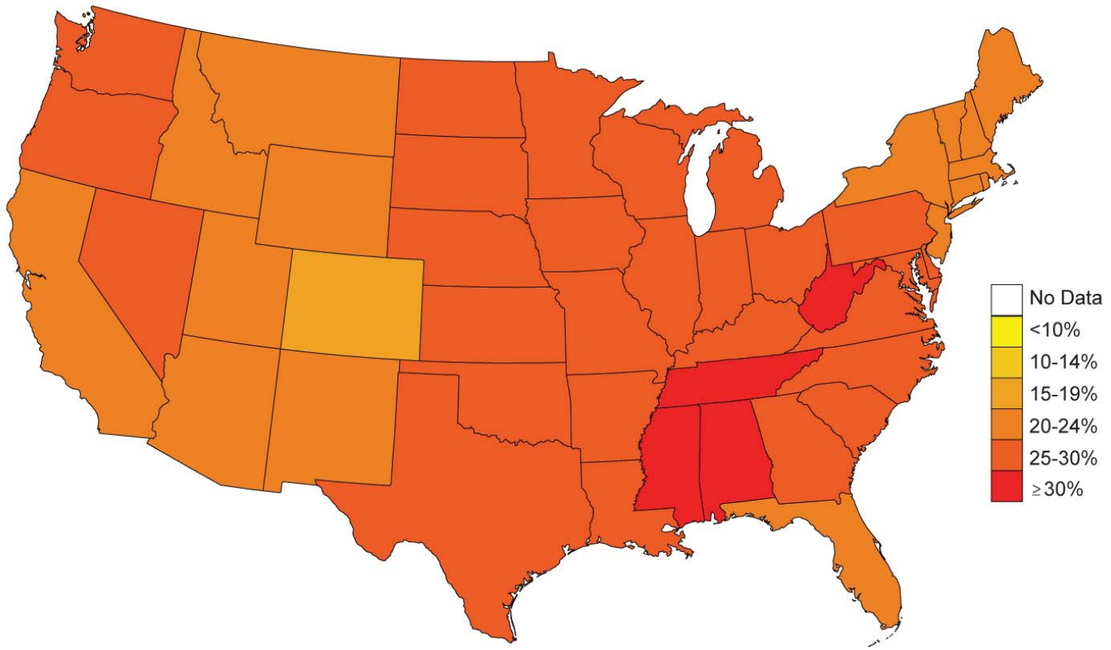
This report represents a milestone in the ongoing food systems research being conducted by the Urban Design Lab at the Earth Institute, Columbia University. The NEW YORK REGIONAL FOODSHED PROJECT, undertaken in partnership with the Stone Barns Center for Food and Agriculture is an assessment of the food production capacity, processing and distribution infrastructure, and access and availability of healthy foods in the nine-state New York City Metropolitan Region.

The NEW YORK REGIONAL FOODSHED PROJECT both informs and is informed by the NATIONAL INTEGRATED REGIONAL FOODSHED PROJECT, being conducted at the UDL with MIT Collaborative Initiatives. This project is evaluating the process of regionalization of the food system at a national level, and involves coordination with regional stakeholders and the USDA to develop models for regional food systems change related to multiple geographic regions. The Optimization Model Pilot was developed with funding by an anonymous foundation that recognized the need to demonstrate practical applications of the research and the vision.

We are thankful to the Rockefeller Brothers Fund for their generous support of the infrastructural capacity assessment and the preparation of this report as a step toward improving the accessibility and affordability of healthy regionally sourced foods.

OBESITY TRENDS AMONG U.S. ADULTS (BMI ≥ 30)

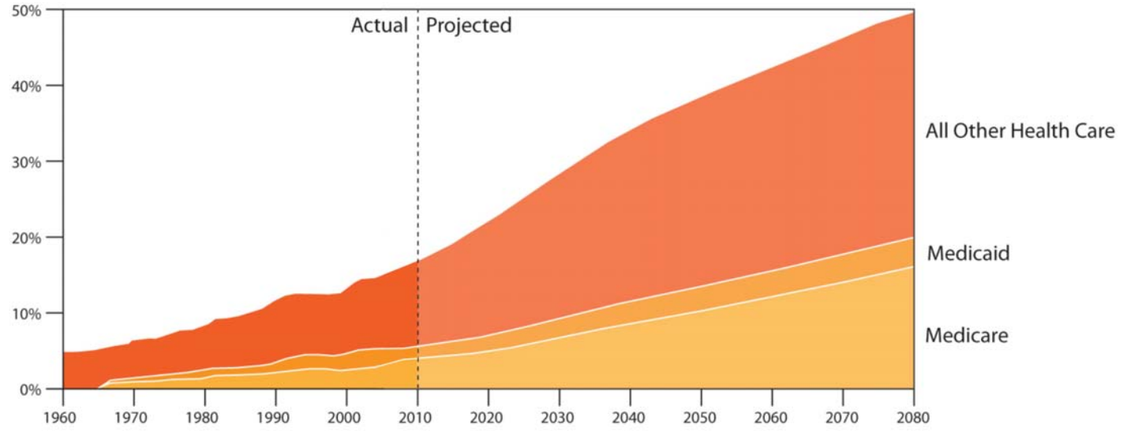


Sources: CDC NHANES data, Levi J, et.al. *F is for Fat: How Obesity Policies are Failing in America 2009*, Trust for America's Health, 2009.

The cornerstone of a strong nation is the health of its citizens. Unfortunately, ours is being undermined. Obesity prevalence presently exceeds 33% in America.[1] Food-related chronic diseases have become a serious burden on our national economy, amounting to nearly $800 billion dollars per year in direct and indirect costs, with over $168 billion dollars per year in healthcare spending for obesity-related diseases alone.[2,3]

Epidemiologists believe that obesity will soon rival tobacco as the world's leading cause of preventable deaths. This pandemic is reversing the population-level life expectancy gains made in recent decades[4].

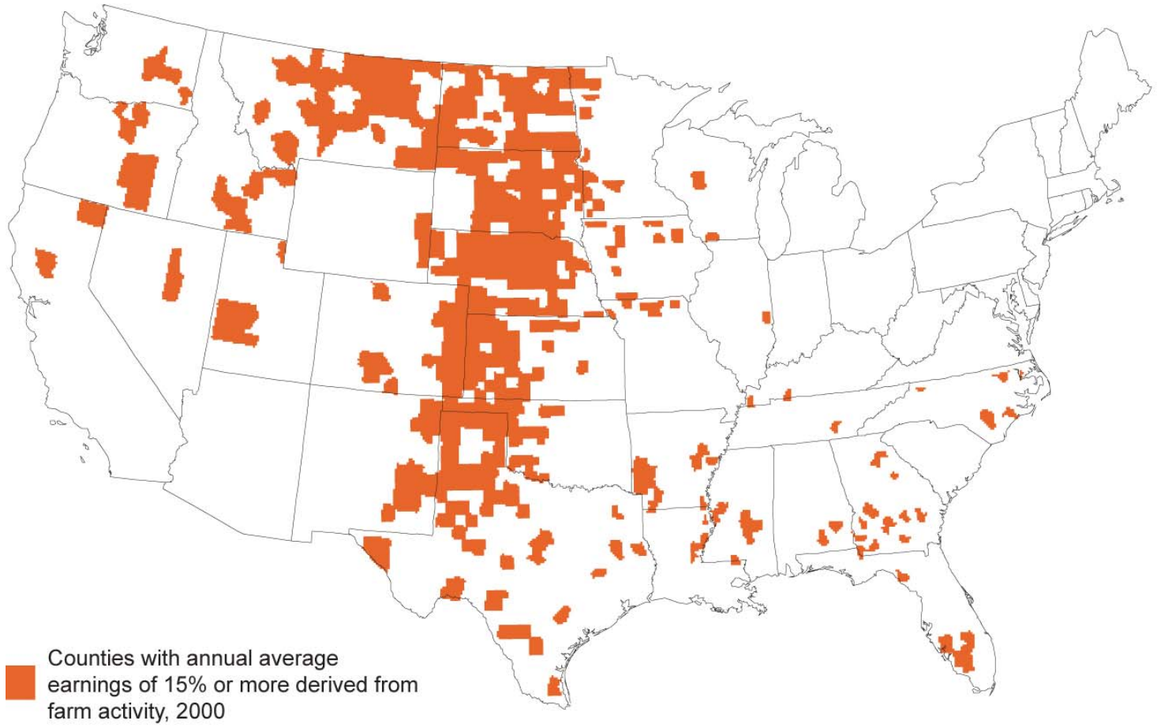
HEALTH CARE SPENDING AS PERCENTAGE OF U.S. GDP, 1960 - 2080



In 2008, the total cost of obesity in the United Stated was estimated to be $168 billion

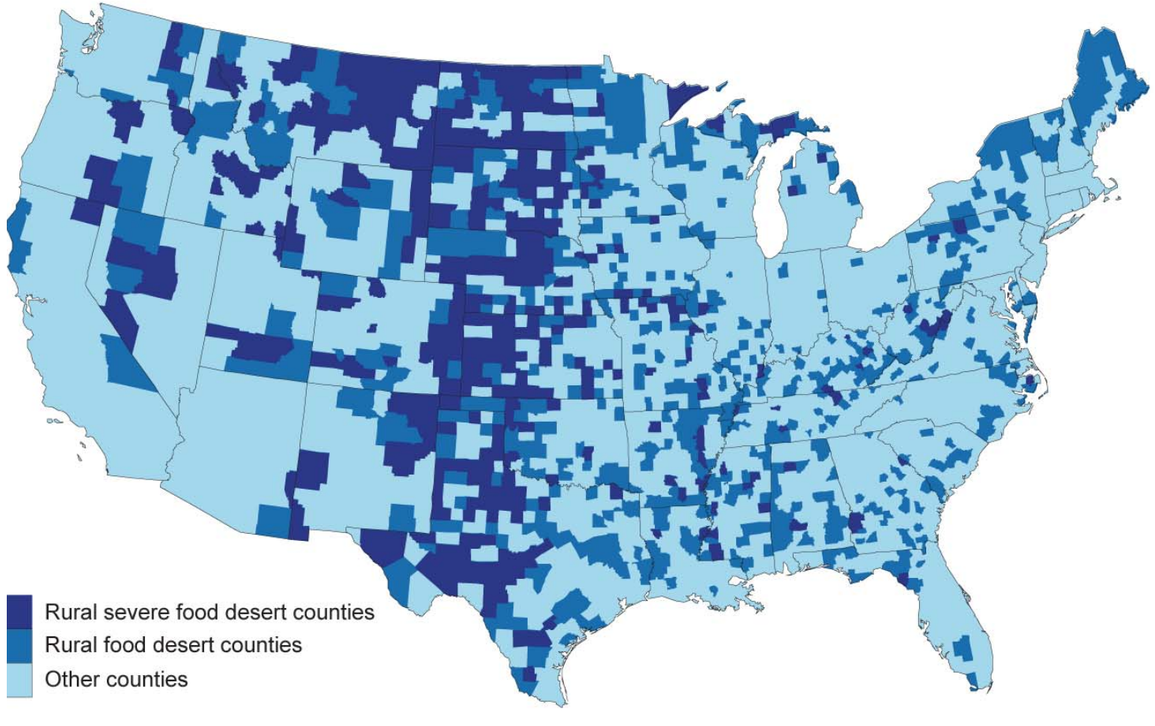
Sources: Congress of the United States Congressional Budget Office, 2007. "The Long Term Outlook for Health Care Spending." and National Bureau of Economic Search, 2010. ''The Medical Care Cost of Obesity: An Instrumental Variables Approach''

Health complications due to weight gain are fast becoming a global human health issue as the global overweight population now exceeds that of people suffering from under-nutrition.[5]



Source: Blanchard, T.C., 2002. "Retail Concentration, Food Deserts, and Food Disadvantaged Communities in Rural America"; USDA Economic Research Service.

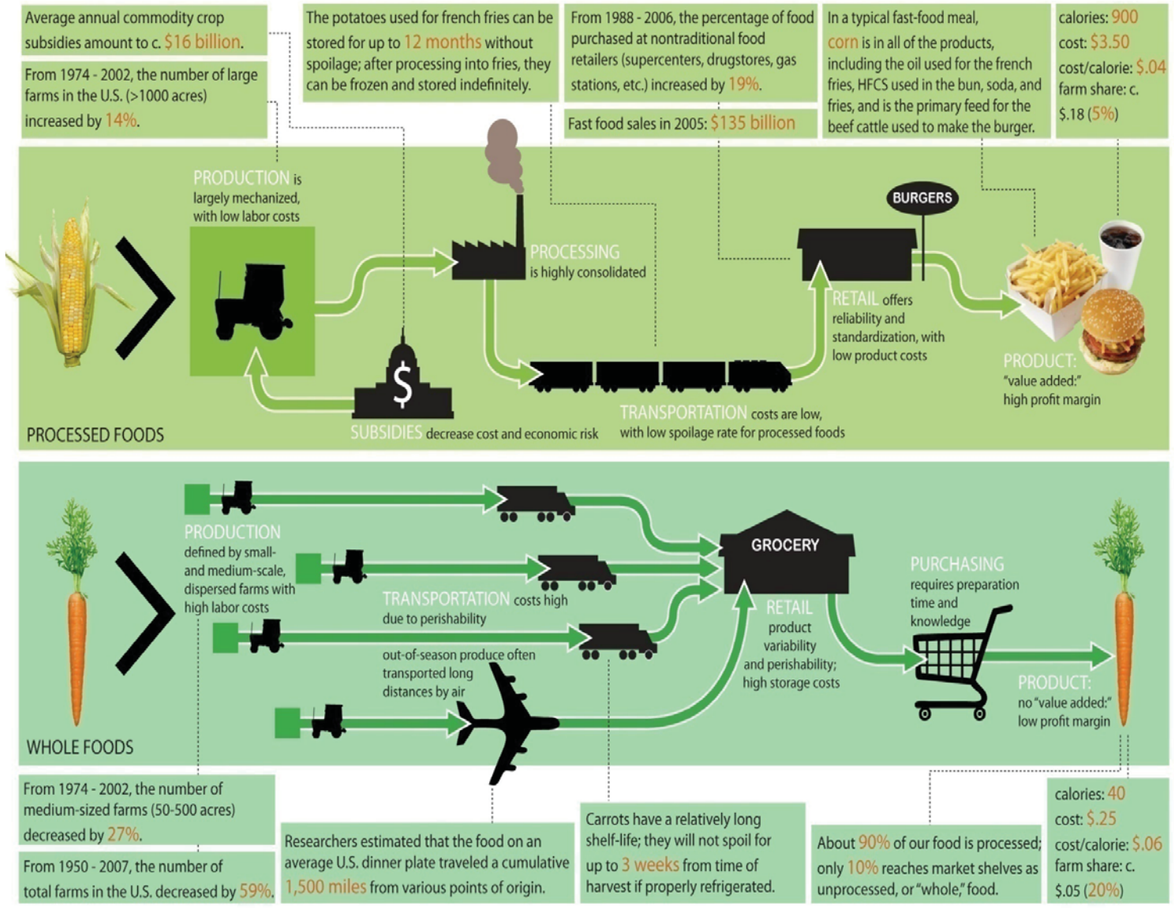
16% of Americans are food insecure, (defined as having inadequate access to enough food for an active, healthy lifestyle), while in some counties food insecurity exceeds 33%.[6] As shown in these images, there is a correlation between counties with substantial agricultural activity and counties where healthy, affordable food is difficult to obtain. In these areas, agricultural production consists primarily of crops used for processed foods, cattle feed and ethanol. These commodity crops are being grown in the places where healthy foods are not adequately available.



Source: Blanchard, T.C., 2002. "Retail Concentration, Food Deserts, and Food Disadvantaged Communities in Rural America"; USDA Economic Research Service.

Intensifying global competition for food and increasing food insecurity in America, Korea is securing its own food reserves by acquiring grain elevators and contracting with local farmers in the United States.[7]

DIAGRAMMATIC COMPARISON OF PRICE FACTORS FOR PROCESSED VS. WHOLE FOODS



Obesity can be viewed as a problem of infrastructure, with health and environmental consequences.

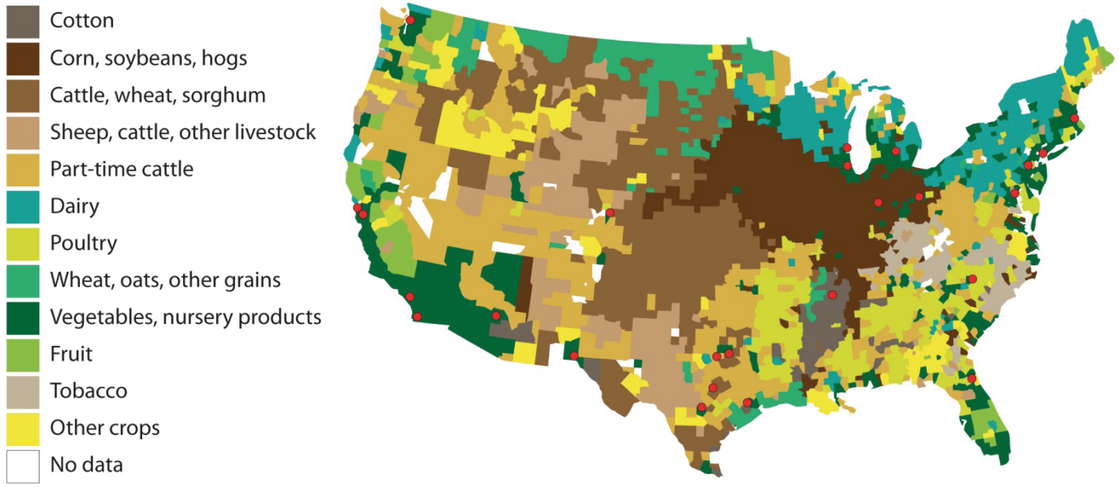
High intake of fruits and vegetables is linked to better cardiovascular health, including lower risk of stroke and coronary heart disease,[8-11] and healthy dietary patterns, including fruit and vegetable intake, are associated with a lower risk of type two diabetes.[12,13] Our existing food system, however, makes highly processed, unhealthy foods the default for consumption, in that such foods are often cheaper per calorie than whole foods.

Production of processed foods is largely mechanized with low labor costs. Subsidies decrease the cost and economic risk of commodity crop production. The processing industry is highly consolidated. Transportation costs are low with low spoilage rates for processed foods. Retail of such foods benefits from reliability and standardization. Such "value added" foods have a high profit margin for the processors and retailers. In this example of a typical fast food meal, the cost per calorie is approximately $.04, with a 5% "farm share," or share of what consumers pay for the food that is returned to the farm.

Production of whole foods, by contrast, often takes place on comparatively small and medium scale dispersed farms with higher labor costs. Transportation costs are high due to perishability with out-of-season produce often transported long distances by air. Retailers of such products are challenged by higher comparative variability and perishability, with high storage costs. Purchasing requires preparation time and knowledge. The product has no "value added" and is generally low profit margin for processors or retailers. Cost per calorie in this example is approximately $.06 with a higher farm share of 20%.

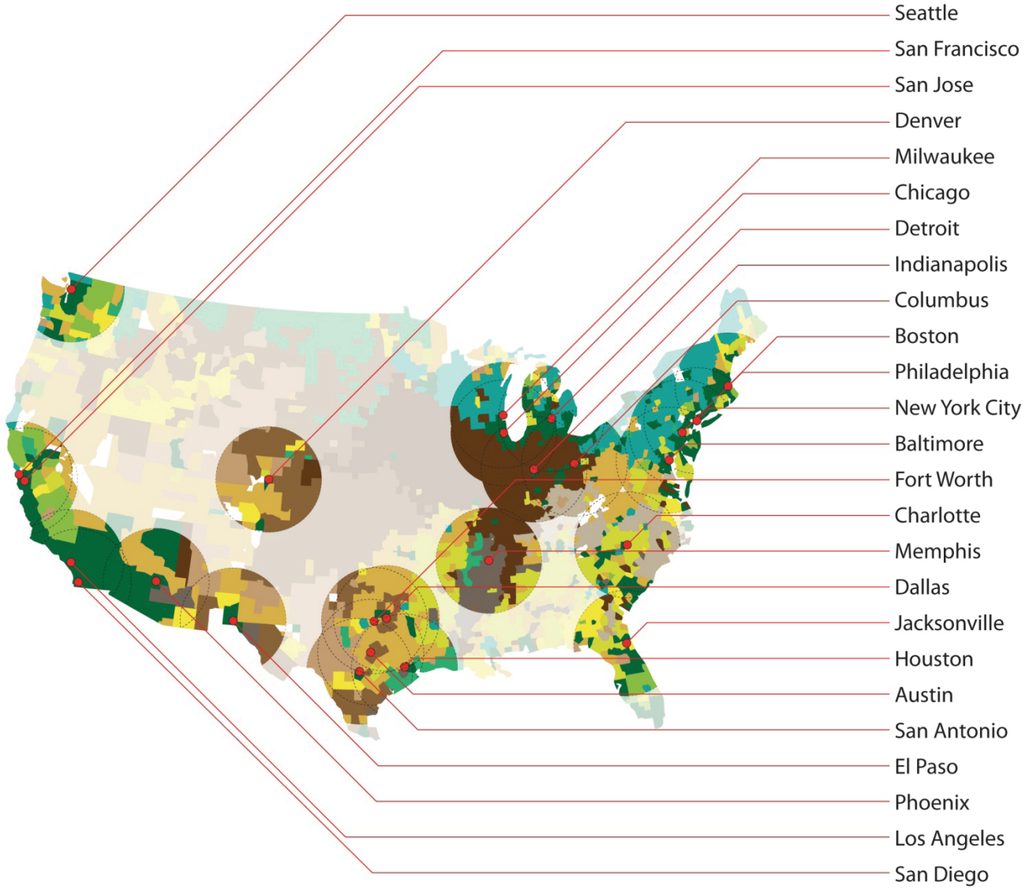
Beginning in the late 1800's and accelerating after WWII, regional food production, processing, and distribution infrastructures were dismantled with the introduction of national and global systems. The gaps in our current food system's regional and local infrastructure make healthy food expensive and unavailable for a large percentage of the population. As demonstrated by studies on cost of healthy and unhealthy foods, the price of food influences purchasing behavior.[14]

Most global food crises have been infrastructural, involving breakdowns in regional distribution systems— not crises of inadequate production.

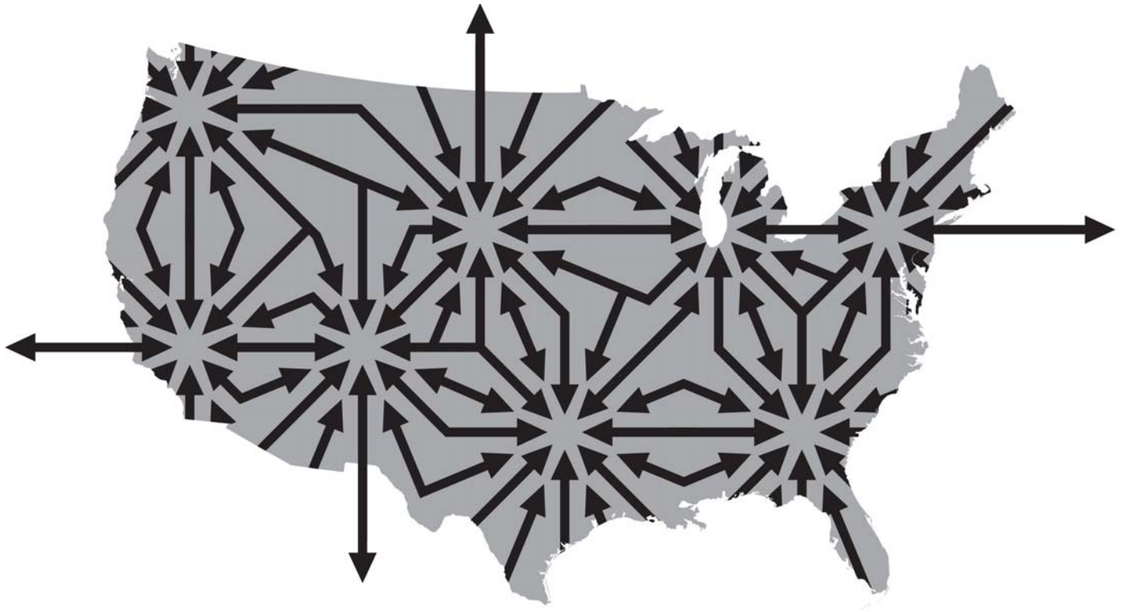


Source: Sommer, Judith E. & Hines, Fred K. Diversity in U.S. Agriculture. A New Delineation by Farming Characteristics. United States Department of Agriculture Economic Research Service. Report Number 646. 1991

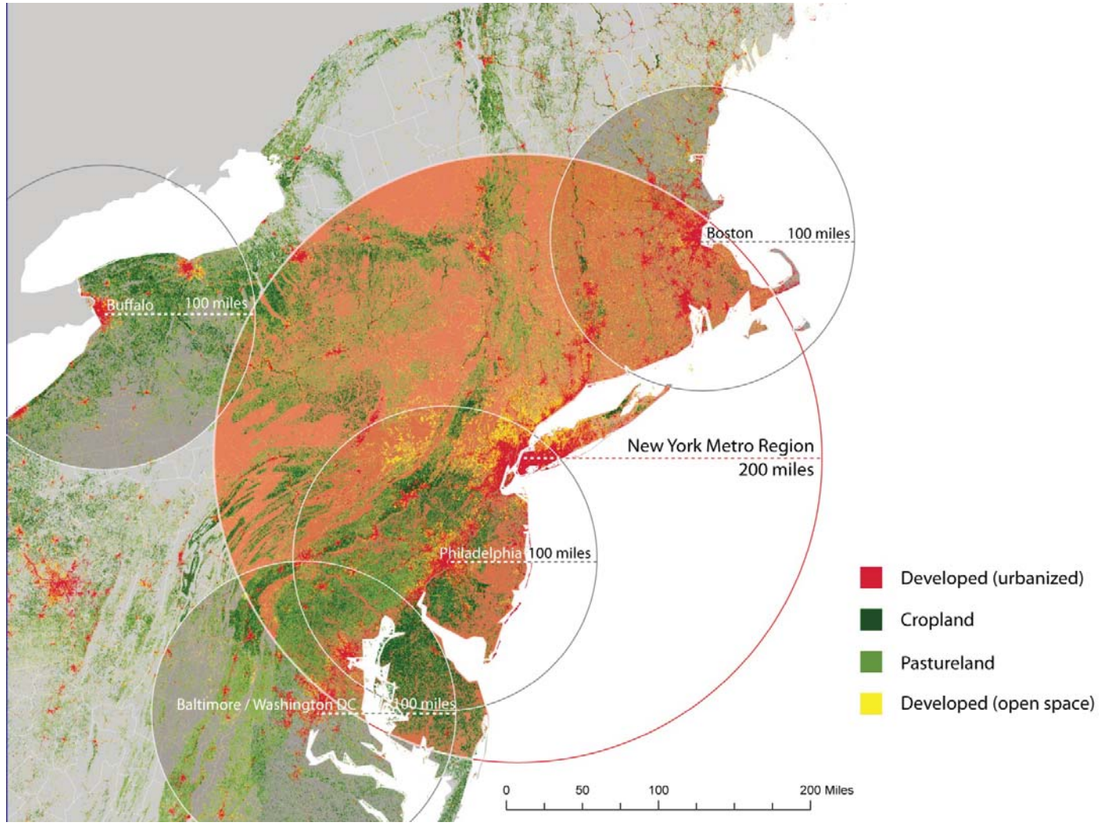
US Consumers, concentrated mostly in cities and their periurban regions, can drive the change toward a new system. There is over $866 million in unmet demand for locally grown foods in New York City alone.[15] Fortunately, agricultural diversity still exists nationally around many of these population centers. Such diversity is important to ensuring access to a wide variety of healthful foods and also contributes to greater resilience in the food system by limiting the potential impacts of environmental or economic instability. Policymakers in many cities are beginning to understand the need for public sector participation to reestablish, maintain and manage their regional food resources. In New York City, municipal agencies are actively reforming food policies to reflect many of these goals.[16,17]



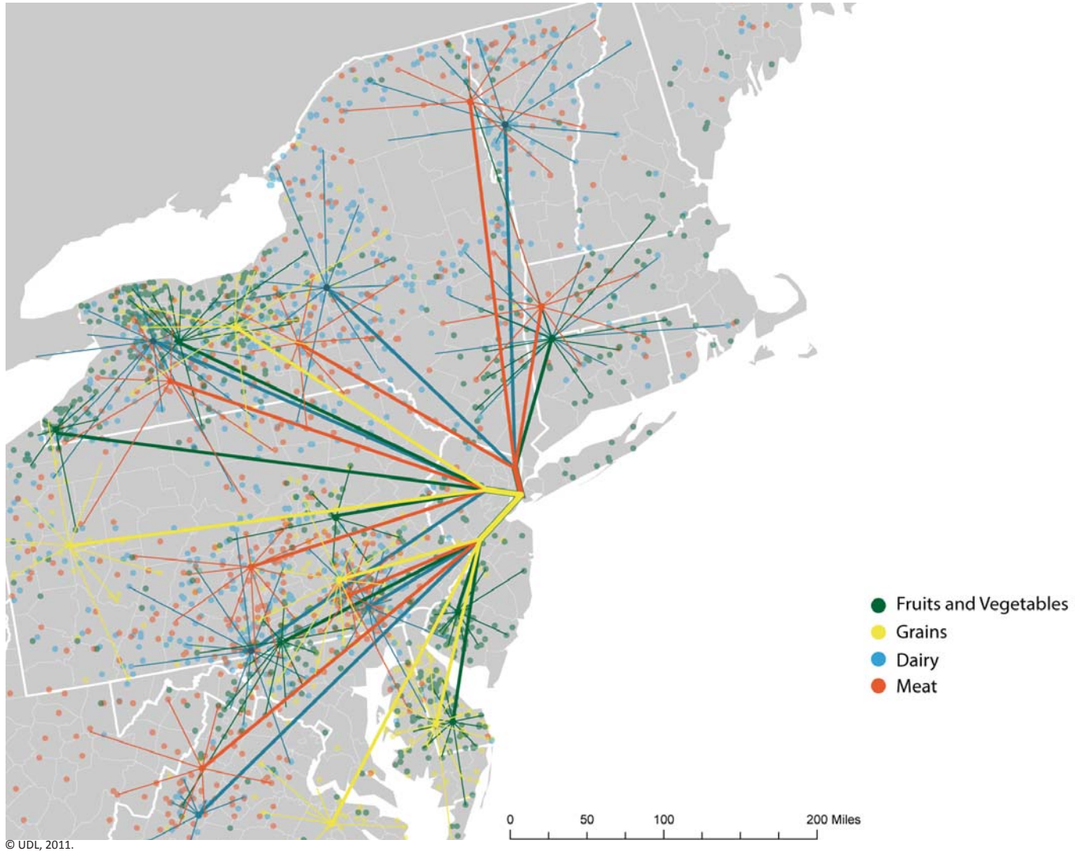
Improved infrastructure leads to better access, availability and awareness, and better access, availability and awareness leads to improved health.



Our research of four years suggests that a robust Nationally Integrated Regional Food System (NIRF) can significantly impact the obesity crisis. The opportunities of such a system include improved access to and lower costs for healthy foods and increased the awareness of the food system and healthy eating, which have positive behavioral impacts.[18] Additional opportunities include increased food security, environmental benefits such as lower carbon footprint, and increased food sovereignty and local economic development with improved consumer buying power. Comprehensive community-based approaches, such as Hardwick, Vermont[19] and Somerville, Massachusetts[20,21] have shown success in the short term. However, to remain competitive, regional food infrastructural improvements will be required to sustain them. With proper infrastructure, a New York State apple grown in Washington County could reach New York's populations fresher and cheaper than a Washington State apple—and it would taste better.

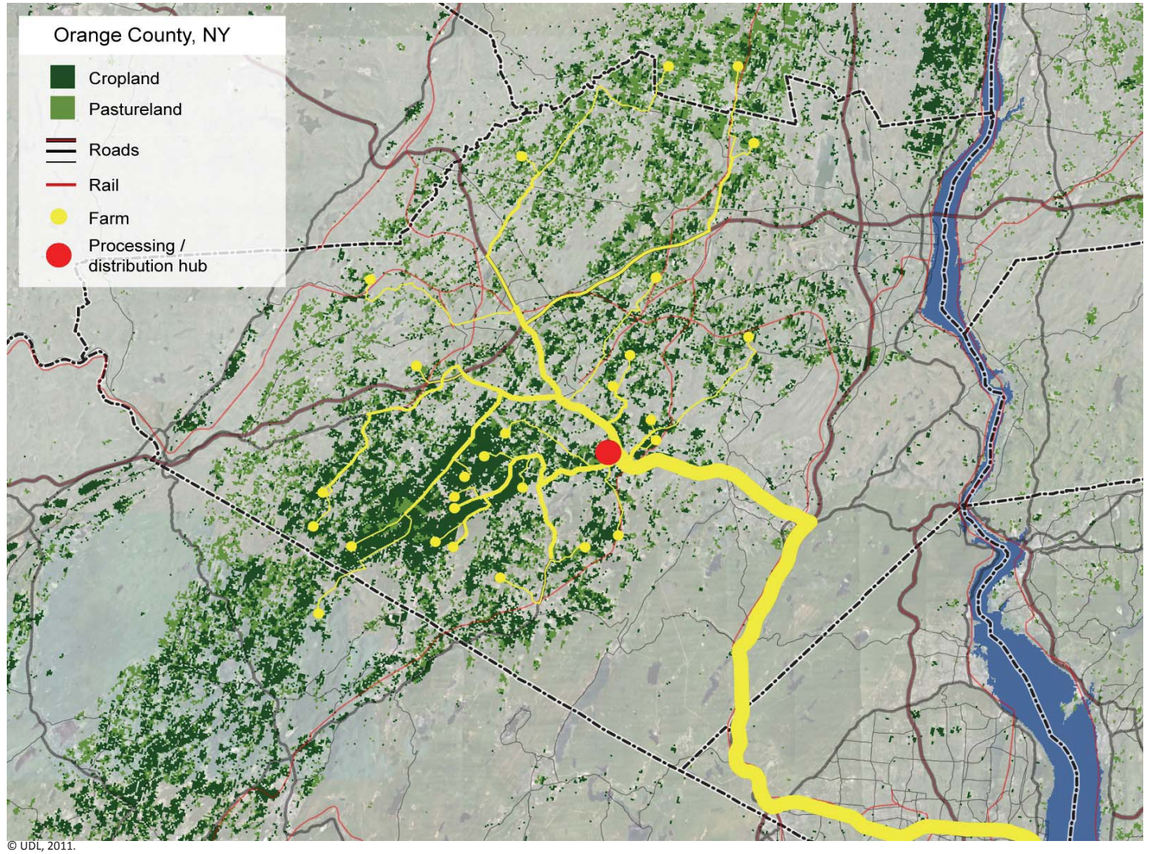


Regional foodsheds, as part of a national system, provide their regions with affordable, accessible, healthy foods.



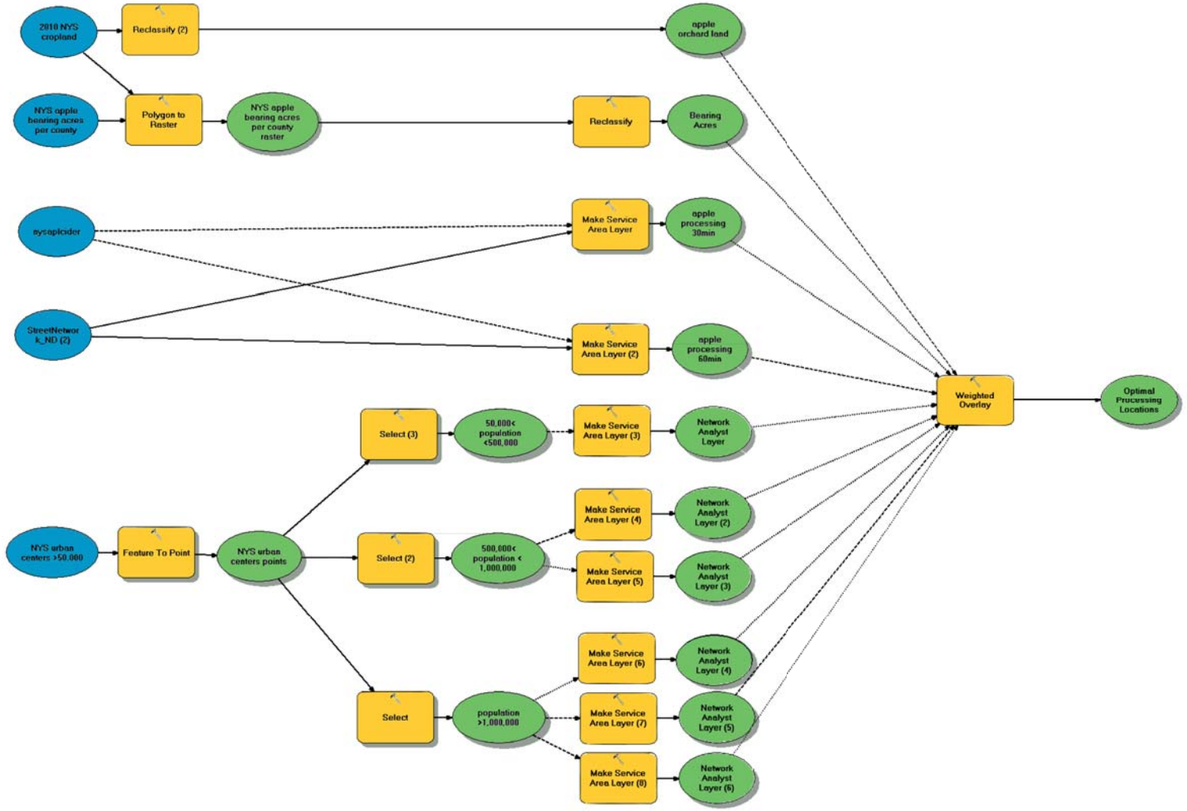
Source: 2007 Census of Agriculture. USDA National Agricultural Statistics Service; Quick Stats Beta; 2007.

Regional infrastructure is critical in all the links of the value chain, through production, processing, consolidation, and to final distribution. An effective way to aggregate small and midsize producers to help regionalize national enterprises is to create "spoke and hub" distribution configurations. As shown in this diagram, it's imperative that we examine each critical food group's value chain—meat, dairy, fruits and vegetables, and whole grains—because each chain has specific infrastructural requirements. The regional spoke and hub infrastructure is already being developed on a small scale in certain areas—like Chicago, where the Federal Reserve Bank is investing in food processing centers.[22] Virtual communities are forming, such as the web-based FoodHub in the Pacific Northwest.[23] And food hubs are also being developed nationally, some being linked to health care. But these efforts are only marginally integrated and networked.

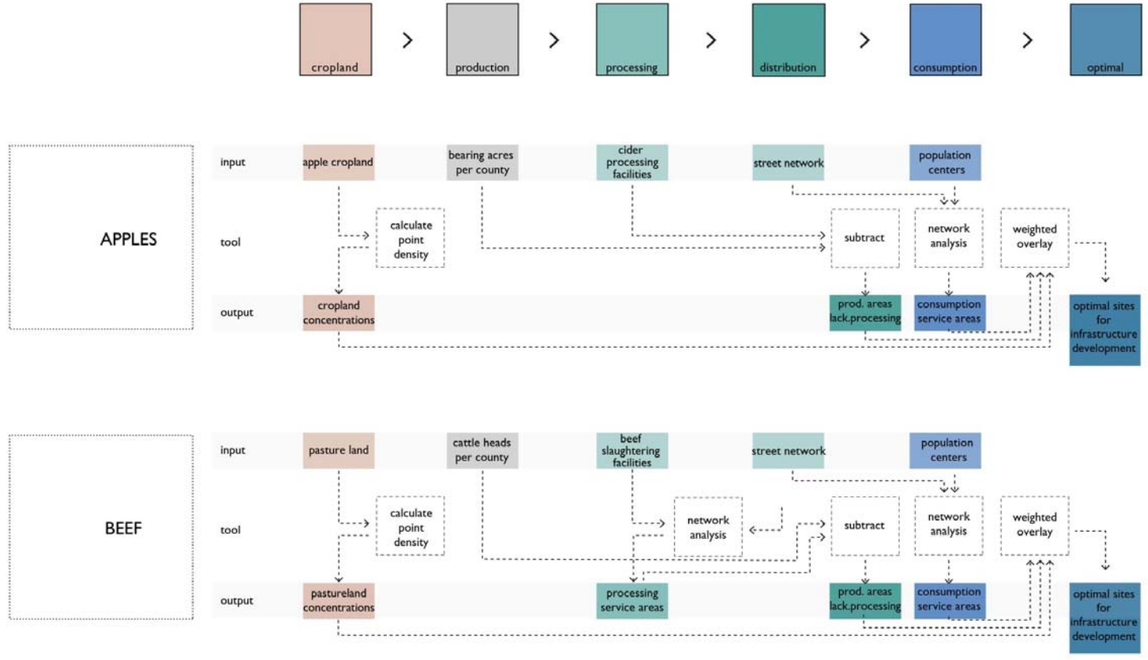


Sources: National Land Cover Data 2006:U.S. Department of the Interior, U.S. Geological Survey.

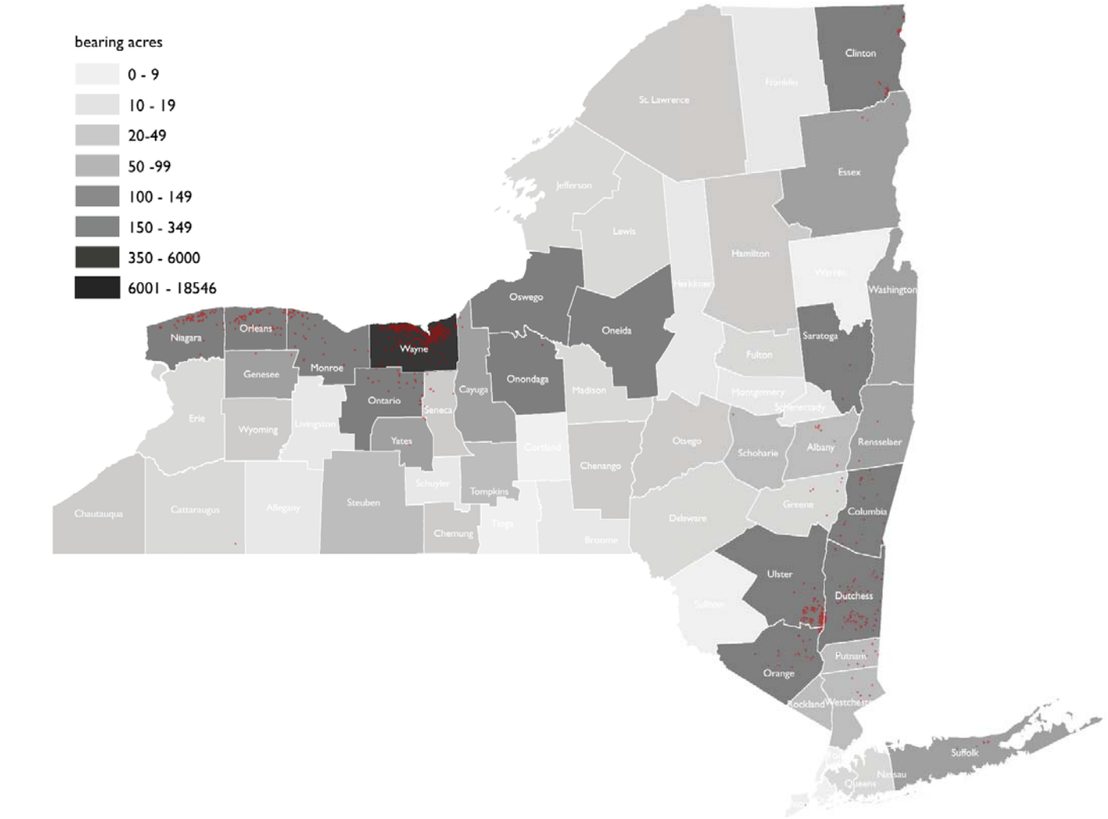
This image is an example of county-level patterns of land cultivation, indicating farmland and pastureland concentrations. Production locations inform the location of aggregation, processing and warehousing facilities. The red dot shows the optimal location for an aggregation food hub in Orange County, New York. Hubs such as these could provide for greater delivery reliability than can be obtained through purchasing from many small producers acting independently. They can also become opportunities for mid-sized farmers who would like to transition to local markets but deal in greater volumes than are typical of direct sales markets. The target markets for these facilities are typically wholesale customers –institutions, restaurants and grocery stores.

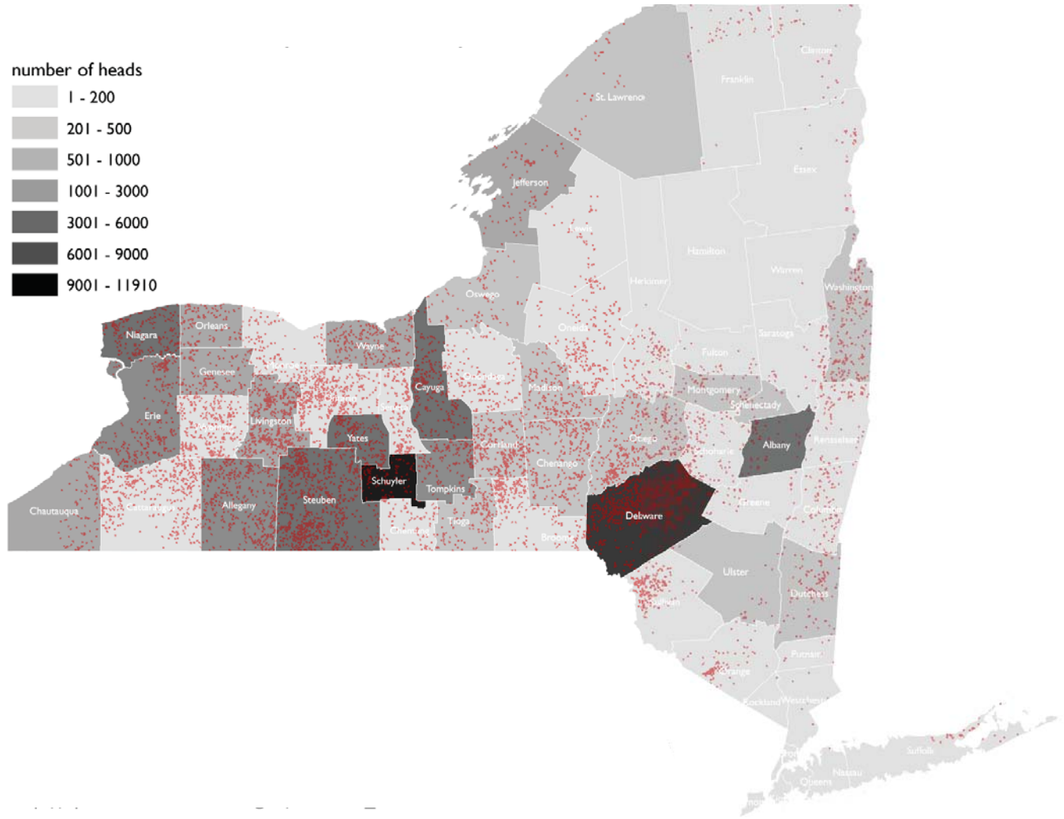


The above diagram outlines the general processes used by a Geographic Information Systems (GIS) model being developed at the UDL. A data-driven optimization model is valuable as an analysis tool to assess how we can augment the current local and regional food system to increase its efficiency and as a tool to effectively demonstrate the potential outcomes of specific changes in the food system—prior to investment or policy change. The access to accurate, substantiated data and metrics creates a more informed discussion around costs and benefits of various alternatives. This tool will result in a tremendous asset for local communities across the country that are planning and considering investments, but lack the data needed to inform their decisions. Once completed, the model will be able to assess potential economic and health impacts of various food-system infrastructure development scenarios.



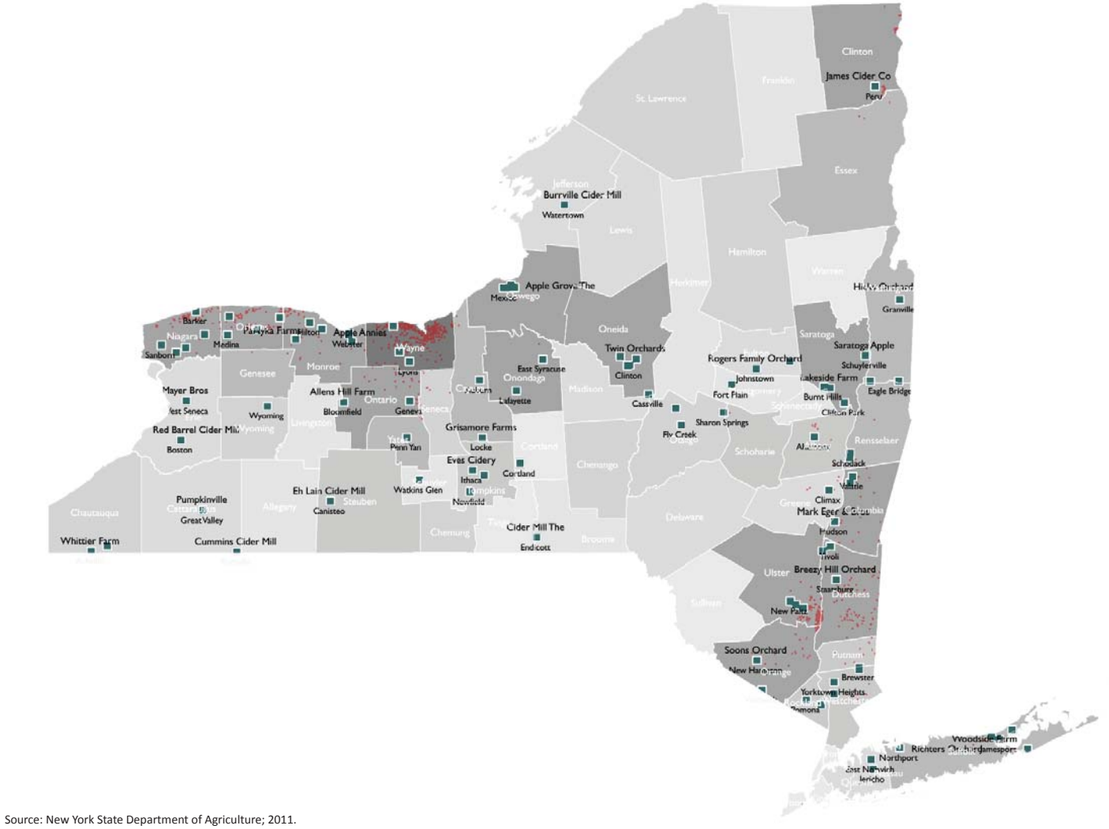
The optimization model has been piloted using data from both public and proprietary sources for each phase of the value chain. Two of the twelve highest sales volume commodities, beef and apples, are probes to consider locations for slaughterhouses (the lack of which is well known for beef) and locations for distribution/storage infrastructure, which for apples is commonly cited as an example of a food delivery problem. Both have been substantiated in conversations with farmers and retailers. New York State has been used as a pilot because of the ability to access proprietary state level processing data. The diagram above isolates the components of the overall model that were used to generate the maps on the following pages. When fully populated, the model will be able to suggest optimum locations for production, processing, packaging, distribution, and wholesale market locations in all bordering states and include other foods as well.





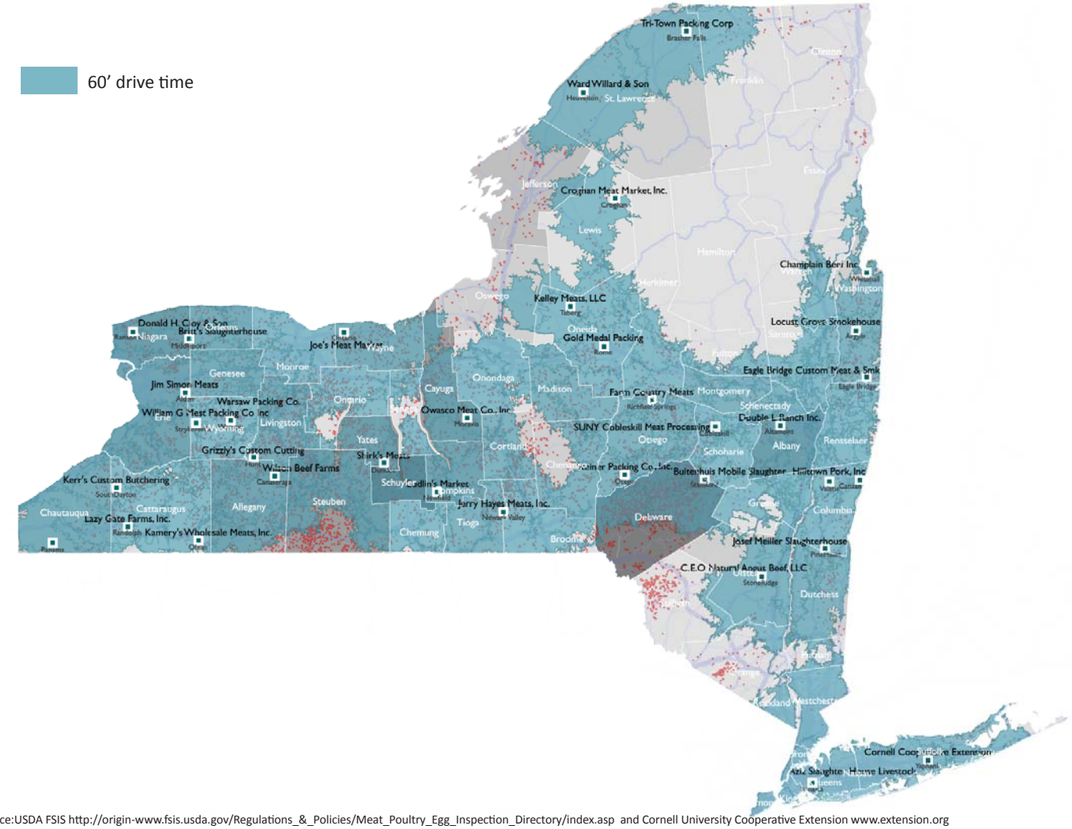
Source: 2007 Census of Agriculture. USDA National Agricultural Statistics Service; Quick Stats Beta; 2007.

The map above indicates the distribution of orchards and estimated apple production of each county. The facing page shows the pastureland and estimated beef production from small farms with less than fifty cattle head in each county. Small farms were selected because they are the ones most challenged by the current lack of regional infrastructure. Apple production is concentrated along the shoreline of the Great Lakes and in the Hudson Valley, whereas small scale beef production is more widely dispersed throughout the State, with some concentrations in the Finger Lakes region and Delaware County.

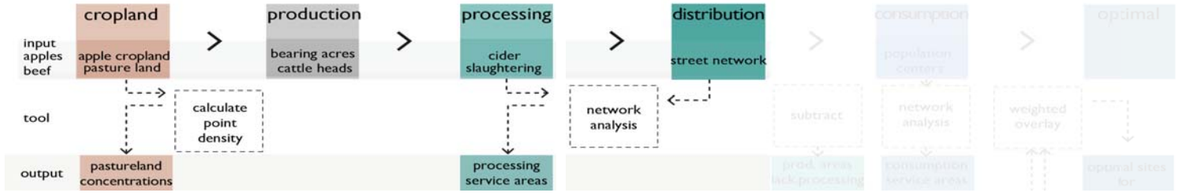


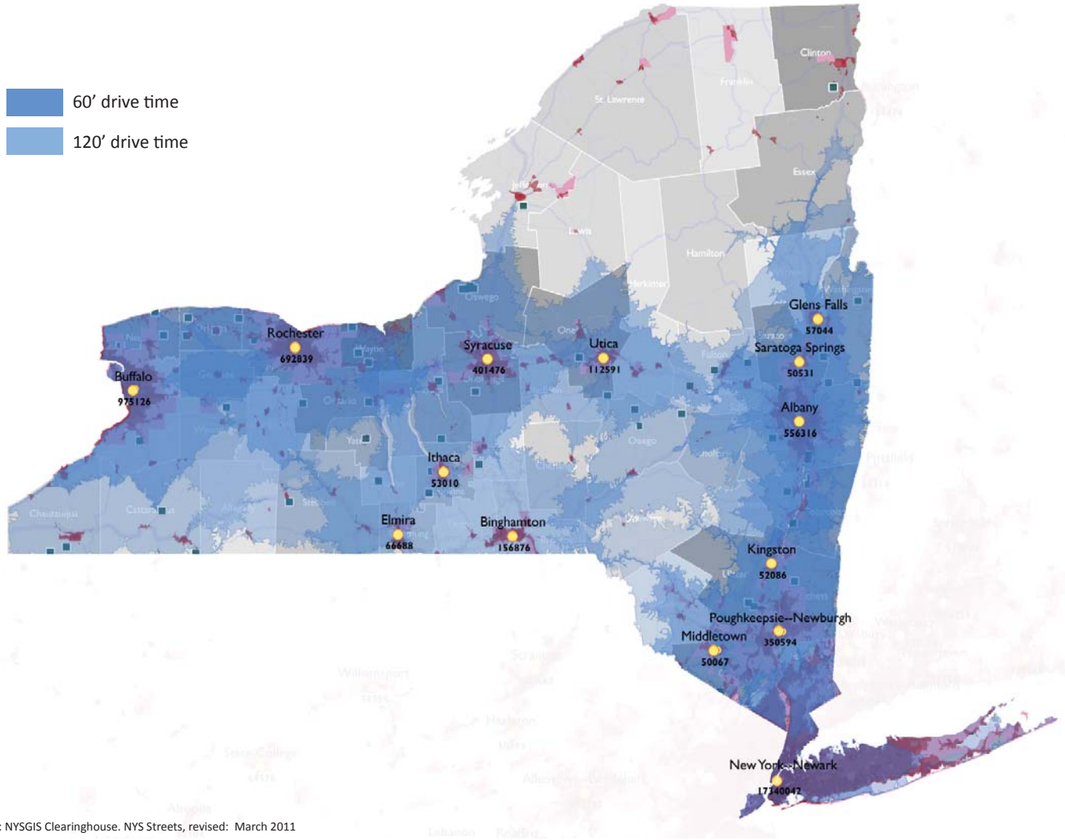
Source: New York State Department of Agriculture; 2011.

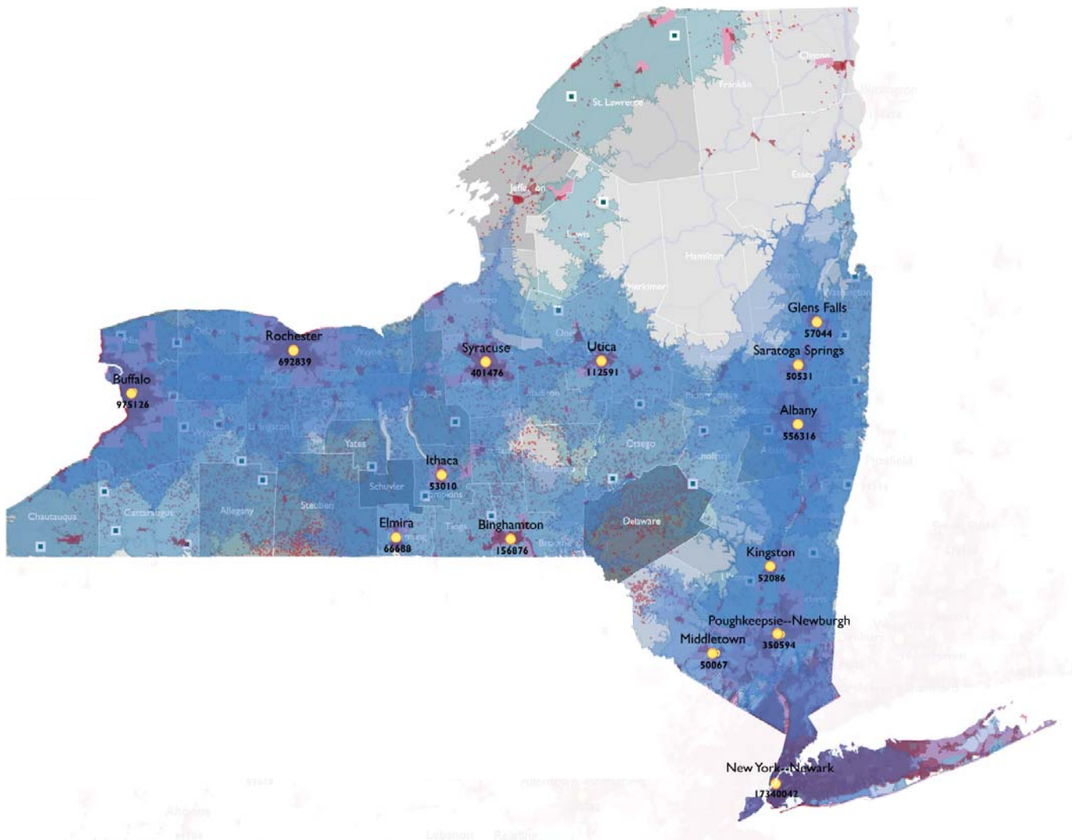
Locations are shown for cider processing centers for apples on this page and slaughter facilities for beef on the facing page. Although processing is not a significant part in the apple value chain, the locations of the cider processing centers are mapped to show one example of a regional apple value chain currently being expanded. Need for additional processing facilities in the beef value chain is very well-recognized, as the lack of such infrastructure is one of the primary impediments to the continued viability and expansion of this regional industry.[24] Thirty-three USDA approved slaughtering facilities provide services to the small farms were chosen to indicate the slaughtering capacity of the region. Reasonable access to slaughtering facilities is indicated by a one-hour drive time to each facility.



Source:USDA FSIS http://origin-www.fsis.usda.gov/Regulations_&_Policies/Meat_Poultry_Egg_Inspection_Directory/index.asp and Cornell University Cooperative Extension www.extension.org

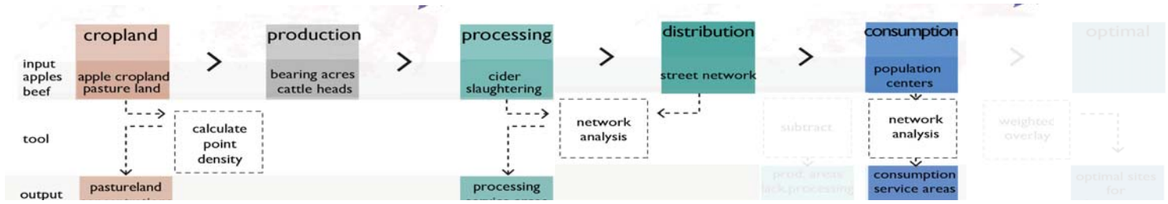


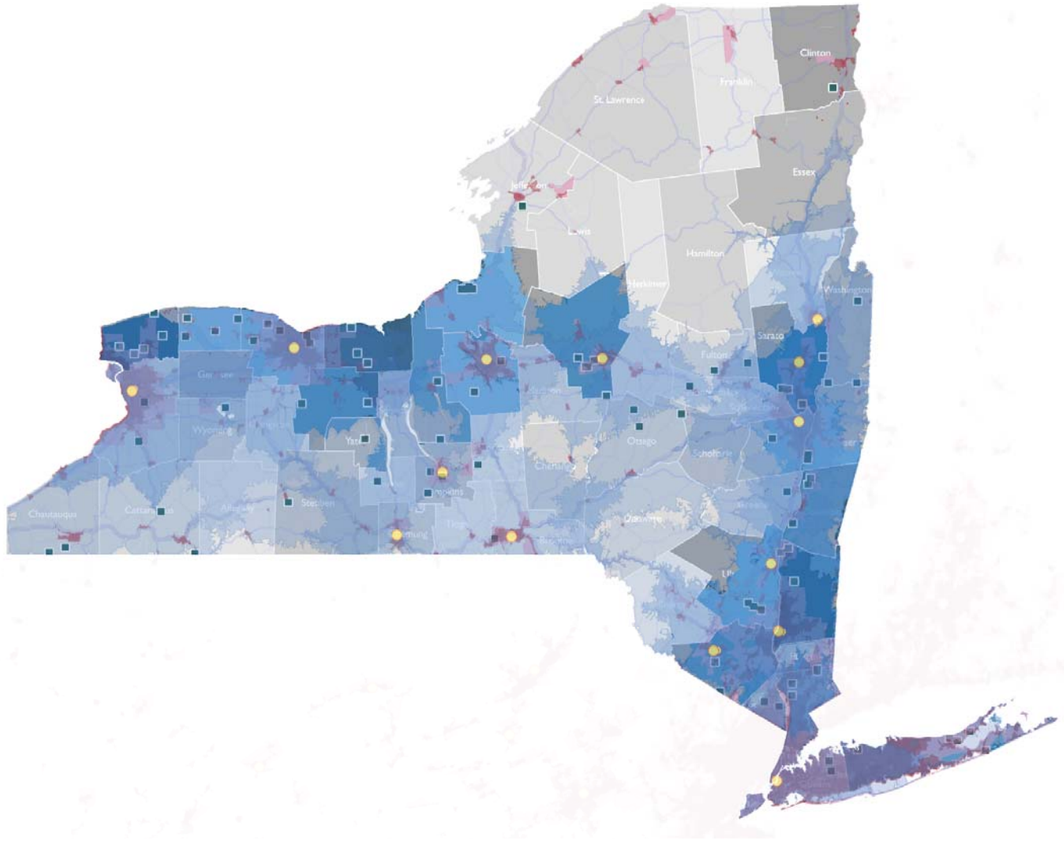




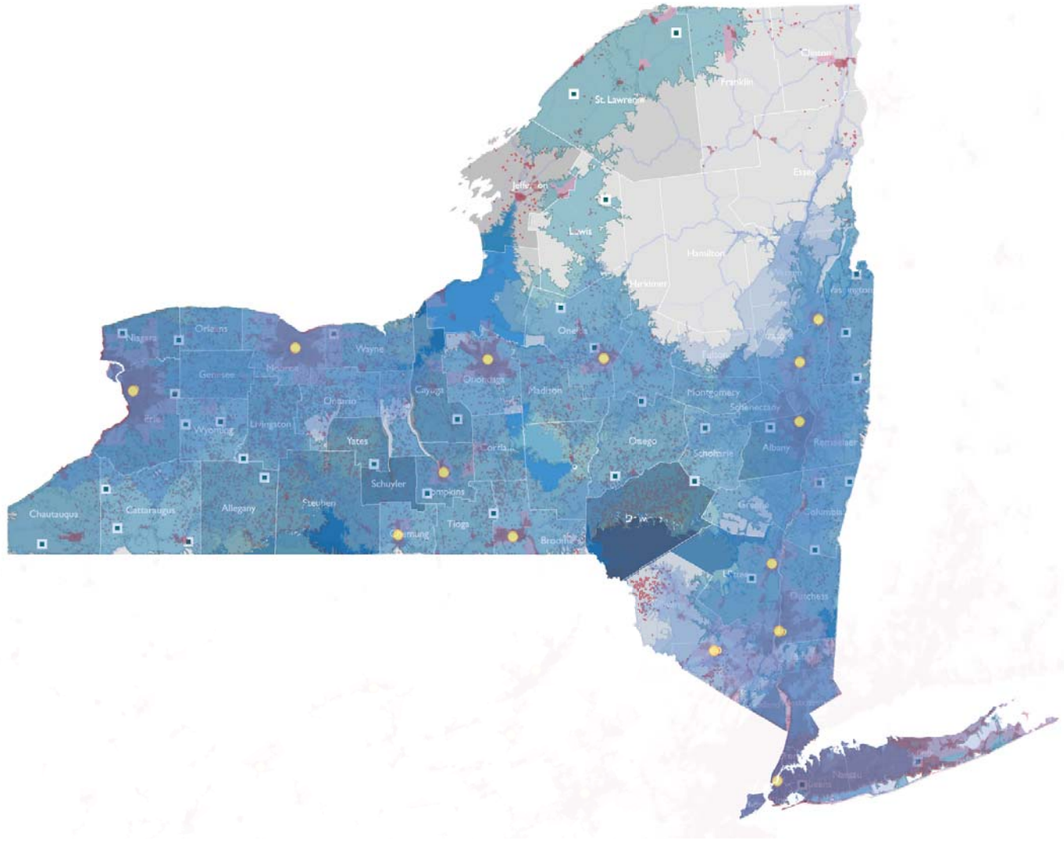
Source: NYSGIS Clearinghouse. NYS Streets, revised: March 2011

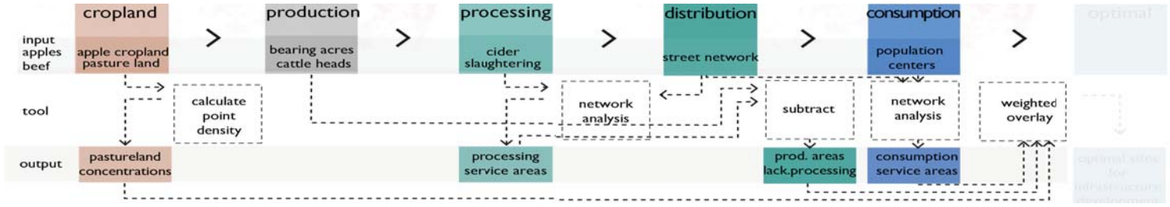
Fourteen population centers with over fifty thousand residents represent major consumption centers in New York State. One to three hour drive times from each center are mapped, depending on the relative size of each urban center. More data on the size and location of retail establishments will be included in the final model to more accurately assess its role in the value chains.

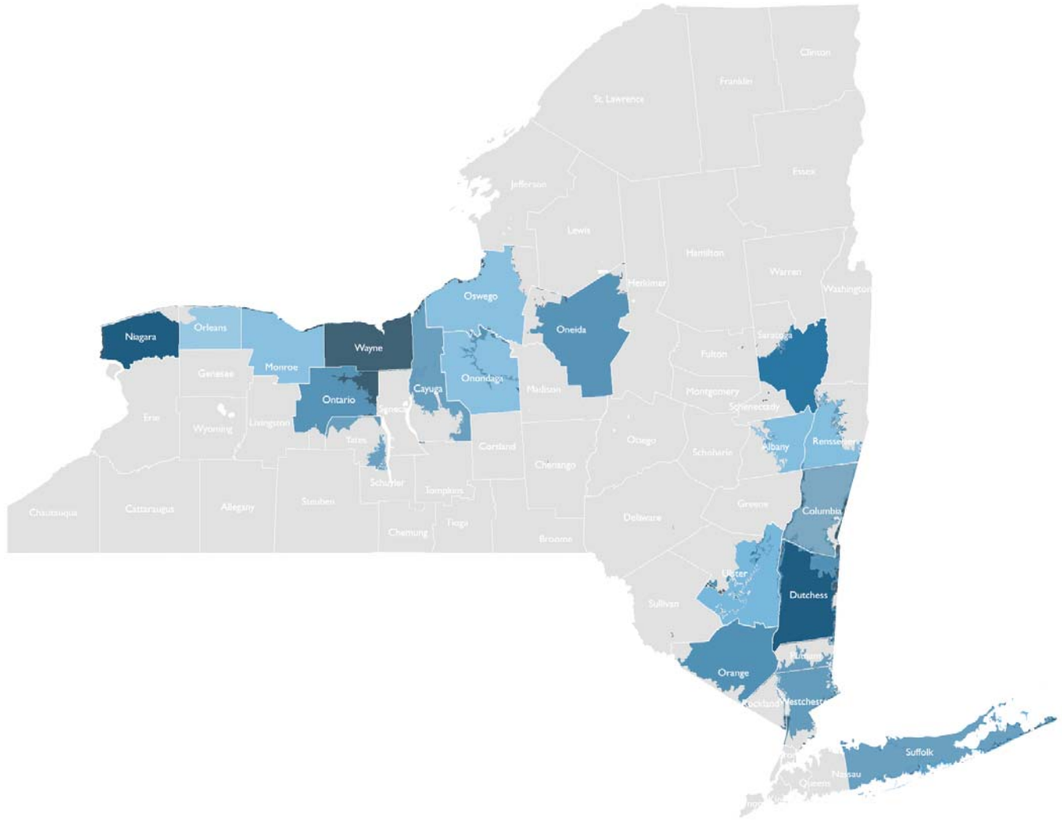




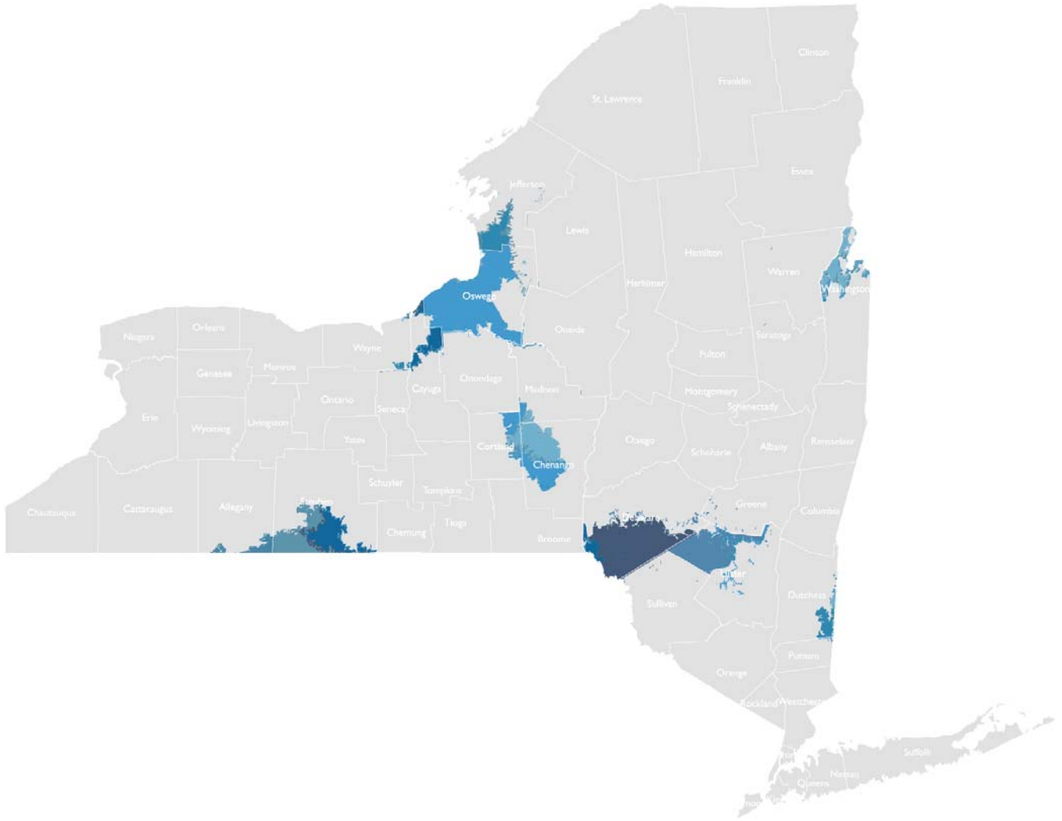
This superimposition of the maps of production, processing, and consumption centers show the optimal locations for storage/ distribution hubs for apples on this page and the new slaughter facilities for beef on the facing page. Data layering highlights areas in need of additional food system infrastructure.

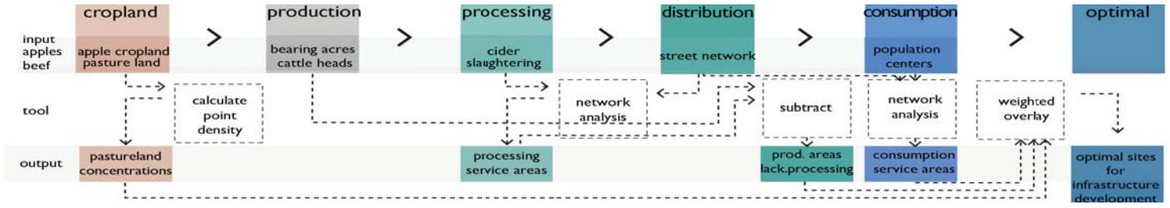


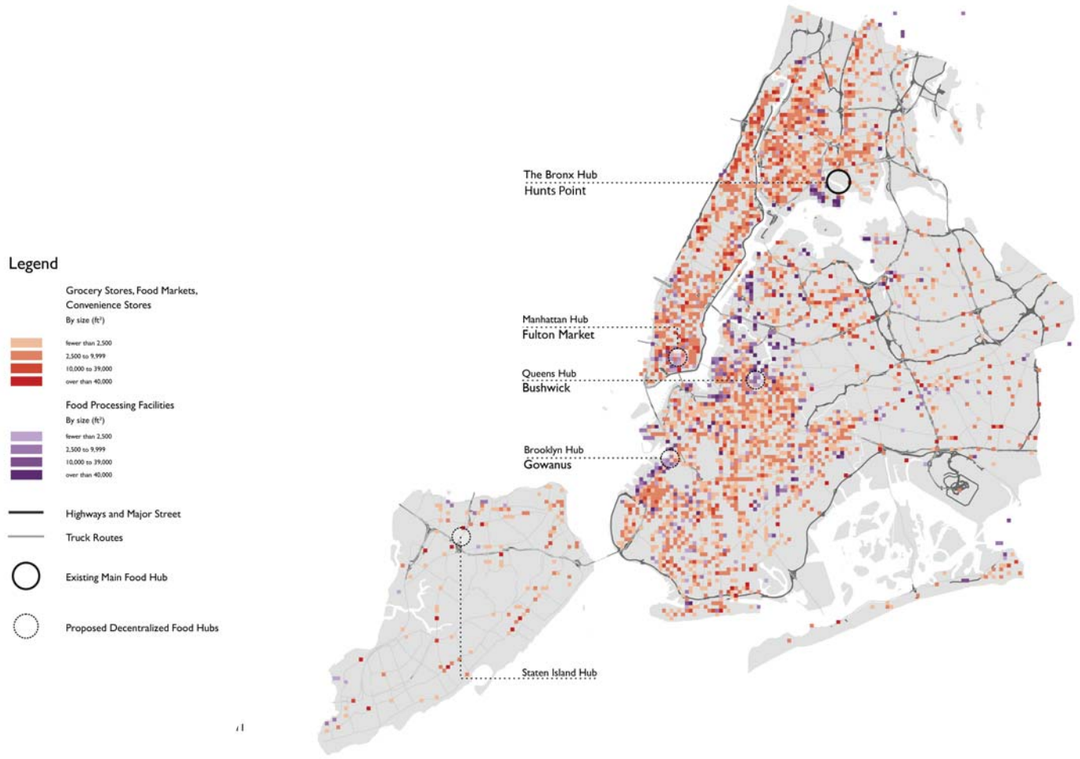




The "optimal map" for apples indicates areas of high production proximal to the population centers, including the counties on the shore of Lake Ontario and in the Hudson Valley. On the facing page, the "optimal map" for the location of new beef slaughter facilities illustrates areas that are highly productive, close to urban centers, but deficient in slaughtering services. These include primarily areas in Delaware County but also in part of Steuben, Cayuga, Oswego, Jefferson, Ulster, Chenango, Dutchess, and Washington Counties.







Source: Reference USA; 2010; NYS Deparment of Agriculture and Markets; May 2011

The Optimization Model will be able to assess the impacts of differing distribution policies and on-the-ground projects. This image shows concentrations of grocery stores and processing facilities in New York City and can be used to compare the impacts of various wholesale market locations. Additionally, this aspect of the model assists in assessing larger questions of economic viability, food security, and environmental justice issues surrounding distributed wholesale market infrastructure.

Our goal is to refocus the food system to be a positive driver for health. Our methods are design-based, synthesizing multiple objectives into a collaborative approach with clear, incremental and achievable steps. The Optimization Model not only helps begin to envision a more resilient nationally integrated regional food system, it also helps to develop practical steps to achieve this system. We have completed the first phase of the Optimization Model Pilot; moving forward, we plan to expand the model to include all major food groups, and test it in multiple regions. We will incorporate health data to link access and affordability and improved health outcomes, and we will incorporate business and economic analyses to evaluate the cost-effectiveness and the cost impact of regionalization. With an Optimization Model in place we will be able to decrease the cost and economic risk for future investments.

Our food system must change. Creating and preserving regional infrastructural system is critical to effecting this change. It will never happen if we continue independently within a system that supports processed and unhealthy food as the inexpensive default. Challenging obesity and chronic disease is a collective responsibility and will only be achieved through the work of multiple organizations, businesses and individuals. The Optimization Model can contribute greatly to these efforts. We look forward collaborating with others making change happen by taking significant structural steps toward a stronger more resilient food system and a healthier nation.

1. CDC resources page. Centers for Disease Control and Prevention website: http://www.cdc.gov/obesity/data/trends.html.
2. *NANA CDC briefing book*. Center for Science in the Public Interest, Washington, D.C; 2010. retrieved from http://www.cspinet.org/new/pdf/cdc_briefing_book_fy10.pdf.
3. Cawley J, Meyerhoefer C. The Medical Care Costs of Obesity: An Instrumental Variables Approach, *Working Paper* No. 16467, The National Bureau of Economic Research. Oct, 2010. http://www.nber.org/papers/w16467.pdf.
4. Susan T. Stewart et al., Forecasting the effects of obesity and smoking on US life expectancy, *New England Journal of Medicine*, 2009, Volume 361, Number 23, pp. 2252-60.
5. Squires, N. Overweight people now outnumber the hungry. *The Telegraph*. Aug. 15, 2006. retrieved from http://www.telegraph.co.uk/news/uknews/1526403/Overweight-people-now-outnumber-the hungry.html.
6. Feeding America website: http://feedingamerica.org/.
7. Brown, Lester R. "The New Geopolitics of Food," *Foreign Policy*, May/June 2011, pp. 55-65.
8. Ness AR and Powles JW. Fruit and vegetables and cardiovascular disease: A review. *International Journal of Epidemiology*. 1997;26(1):1-13.
9. Hu FB. Plant-based foods and prevention of cardiovascular disease: An overview. *American Journal of Clinical Nutrition*. 2003;78(suppl):544S-51S.
10. Bazzano LA, He J, Lorraine OG, Loria CM, Vupputuri S, Myers L, Whelton PK. Fruit and vegetable intake and risk of cardiovascular disease in US adults: The first National Health and Nutrition Examination survey epidemiologic follow-up study. *American Journal of Clinical Nutrition.* 2002;76:93-99.
11. He FJ, Nowson CA, and MacGregor GA. Fruit and vegetable consumption and stroke: meta-analysis of cohort studies. *Lancet.* 2006;367:320-26.
12. Ford ES and Mokdad AH. Fruit and vegetable consumption and diabetes mellitus incidence among U.S. adults. *Preventive Medicine*. 2001;32;33-39.
13. Esposito K, Kastorini CM, Panagiotakos DB, Giugliano D. Prevention of type 2 diabetes by dietary patterns: a systematic review of prospective studies and meta-analysis. *Metabolic Syndrome and Related Disorders*. 2010;8(6):471-476.
14. Monsivais P and Drewnowski A. Lower-energy-density diets are associated with higher monetary costs per kilocalorie and are consumed by women of higher socioeconomic status. *Journal of the American Dietetic Association*. 2009;109(5):814-822.
15. Urban Design Lab, ed. *Ground Up: Cultivating Sustainable Agriculture in the Catskill Region*. New York, NY: Columbia University; 2011.
16. Brannen S. et al. *Food Works: A Vision to Improve NYC's Food System*. New York, NY: The New York City Council; 2010.
17. *Food in the Public Interest: How New York City's Food Policy Holds the Key to Hunger, Health, Jobs and the Environment*. New York, NY: Office of Manhattan Borough President Scott M. Stringer; 2009.
18. Andreyeva T, Long MW, Brownell KD. The impact of food prices on consumption: A systematic review of research on the price elasticity of demand for food. *American Journal of Public Health.* 2010;100(2):216-222.
19. Burros M. Uniting Around Food to Save an Ailing Town. *The New York Times*. October 7, 2008. retrieved from http://www.nytimes.com/2008/10/08/dining/08verm.html.
20. Tufts University Resource Page. Shape Up Somerville. Tufts University website: http://nutrition.tufts.edu/research/shapeup-somerville
21. Economos C. Shape Up Somerville – A Social Movement [Audio podcast]. Yale Rudd Center For Food Policy & Obesity April 9, 2009. retrieved from http://yaleruddcenter.org/podcasts.aspx
22. Adams B. Rural commercial kitchens form local food network. *Wisconsin State Journal*, June 22, 2011. retrieved from http://host.madison.com/wsj/business/article_4389819e-9d1b-11e0-97e7-001cc4c002e0.html.
23. FoodHub website: http://food-hub.org/.
24. Martinez S, et al. *Local food systems: concepts, impacts, and issues*. Washington, D.C.: USDA ERS; May 2010. retrieved from http://www.ers.usda.gov/Publications/ERR97/ERR97.pdf.