Food Systems-Related Research at The Northeast Regional Center for Rural Development: Applications to Maine

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The National Agricultural and Rural Development Policy (NARDeP) Center and Professor of Agricultural and Regional Economics; The Pennsylvania State University

Presentation to the Agricultural Council of Maine
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Funding under NIFA Grant 2012-51150-19609 and from other sources is gratefully acknowledged.
1. A Changing Context
2. Production Capacity and Potential
3. The Question of Distribution
4. Local and Regional Foods
5. Conclusion
The Northeast Regional Center for RD

1. **Mission**: to support NE Land Grant Universities in their rural development activities
   - Report to BOD drawn from NERA/NEED and others
   - Advised by Technical Advisory Committee

2. **Priority areas**: food systems, jobs and entrepreneurship, natural resources, capacity building
1. A Changing Context
1. Looking at changing economic and socio-demographic data may provide clues about changing demand patterns for food
   - for example, access to markets, changes in income and changes in ethnic populations may create new opportunities for farmers

2. Changes are also occurring in the natural environment...
Metro areas are gaining, rural areas continue to lose population....
Northeast is Part of Rapid Minority Population Gains, 2000-2010

Figure 5.
Percentage Change in Minority Population by County: 2000 to 2010
(Counties with a minority population of at least 1,000 are included in the map. Minority refers to people who reported their ethnicity and race as something other than non-Hispanic White alone in the decennial census. For information on confidentiality protection, nonsampling error, and definitions, see www.census.gov/prod/cen2010/doc/pl94-171.pdf)
The Northeast’s Ethnic Population

With thanks to Rick van Vranken, Rutgers University

Data: US Census 2000 and 2010
Ethnic Population by Geography

Data: US Census 2010
Market opportunity (Puerto Rican)
Market opportunity (Vietnamese)
Poverty Rates, 2008-2012

USDA’s 2020 Initiative: (20% of funds to regions with >20% poverty rate)

Data: US Census, American Community Survey, 2008-2012
Poverty rate change, 2005-2009 to 2009-2013

Rising poverty may reduce demand for local F&Vs

Source: US Census/ Small Area Income and Poverty Estimates
Job changes vs. wages, 2001-2013, Non-metro areas of Maine

- Real estate and rental and leasing
- Arts, entertainment, and recreation
- Health care and social assistance
- Accommodation and food services
- Retail trade
- State and local
- Construction
- Manufacturing
- Information
- Military

- Increased
- Decreased
- Recovered and grown
- Recovered
- Relatively unaffected
- Has not recovered
- Recession accelerated decline

←Lower Wages  Industries  Higher Wages→
Changes in NE Crop Production Possibilities?

National Arbor Day Foundation

Map showing changes in plant hardiness zones from 1990 to 2006.
Soil moisture 30 cm below ground projected through 2100 for moderate emissions scenario RCP 4.5. The soil moisture data are standardized to the Palmer Drought Severity Index and are deviations from the 20th century average. *Image Credit: NASA's Goddard Space Flight Center*
Drivers of Change in NE Agriculture

Starting in the 1850s

Slide courtesy Tim Griffin (adapted)
2. Production Capacity and Potential
Project Goal:
To assess whether greater reliance on regionally-produced foods can improve food access and affordability for disadvantaged communities, while also benefiting farmers, food supply chain firms, and others in the food system.

Production → Distribution → Consumption, outreach, education, scenario modeling, evaluation
## The NE Food System: Context

<table>
<thead>
<tr>
<th>Northeast as a percent of U.S. (excluding Alaska)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>21.6</td>
</tr>
<tr>
<td>Land area</td>
<td>5.6</td>
</tr>
<tr>
<td>Crop land area</td>
<td>4.2</td>
</tr>
<tr>
<td>CRP land</td>
<td>0.4</td>
</tr>
<tr>
<td>Pasture land</td>
<td>6.4</td>
</tr>
<tr>
<td>Range land</td>
<td>0.0</td>
</tr>
<tr>
<td>Forest land</td>
<td>19.4</td>
</tr>
</tbody>
</table>

Compiled from US Census, USDA NRCS and ISU Ctr Survey Stat and Methodology
Baseline Land Use (Regional)

**Northeast regional mean agricultural land area, 2001-2010**

- **Forages and field and grass seeds** (animal feed)
- **Other land in farms** (not in production)
- **Field crops** (animal feed)
- **Pasture land** (grazed)

**Source:** T. Griffin and C. Peters, Tufts
1) Input data layers (weather, soil, management, land use) are georeferenced and organized in ArcGIS for the region of interest.

2) Spatially homogeneous modeling units (MUs) are created.

3) For each unique input combination, 30 independent growing seasons are simulated with SPUDSIM and MAIZSIM.

4) Output is spatially linked and aggregated to the county level.
Yield Index - One step further

Crop Production Footprints

USDA, FSA, NAIP
18 June 2009
1500 ha scene (1 m resolution image)

Cropland Data Layer 2009
Barley=deep pink, Broccoli=orange, Potato=brown, Rye=purple
1500 ha scene (56 m resolution)

CDLs 2008-2010
crop sequence mosaic
P-B-P (purple), P-Br-B (bright green), B-P-B (dark green), Br-R-P (bright red)
(56 m resolution RGB)

### Baseline Balance (Regional)

<table>
<thead>
<tr>
<th>Vegetable Group</th>
<th>Regional Self-Reliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark Green</td>
<td>12%</td>
</tr>
<tr>
<td>Starchy</td>
<td>44%</td>
</tr>
<tr>
<td>Red and Orange</td>
<td>13%</td>
</tr>
<tr>
<td>Other</td>
<td>34%</td>
</tr>
</tbody>
</table>

*Source: T. Griffin and C. Peters (Tufts University)*
<table>
<thead>
<tr>
<th>Self-reliance category</th>
<th>Mean regional production (10^6 lbs)</th>
<th>Mean regional consumption (10^6 lbs)</th>
<th>Mean self-reliance (%)^a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commonly Eaten Fruit^b</td>
<td>40</td>
<td>300</td>
<td>13</td>
</tr>
<tr>
<td>Berries</td>
<td>79</td>
<td>13</td>
<td>619</td>
</tr>
<tr>
<td>Melons</td>
<td>0.3</td>
<td>34</td>
<td>0.8</td>
</tr>
<tr>
<td>Vegetables</td>
<td>1,678</td>
<td>519</td>
<td>323</td>
</tr>
<tr>
<td>Dark Green Vegetables</td>
<td>&lt;0.1</td>
<td>17</td>
<td>0.3</td>
</tr>
<tr>
<td>Starchy Vegetables</td>
<td>1,661</td>
<td>204</td>
<td>815</td>
</tr>
<tr>
<td>Red and Orange Vegetables</td>
<td>15</td>
<td>162</td>
<td>9.0</td>
</tr>
<tr>
<td>Other Vegetables</td>
<td>3.0</td>
<td>137</td>
<td>2.2</td>
</tr>
<tr>
<td>Food grains</td>
<td>68</td>
<td>444</td>
<td>15</td>
</tr>
<tr>
<td>Pulses^c</td>
<td>0.4</td>
<td>10</td>
<td>4.1</td>
</tr>
<tr>
<td>Oils^d</td>
<td>3.8</td>
<td>656</td>
<td>0.6</td>
</tr>
<tr>
<td>Sweeteners^e</td>
<td>4.4</td>
<td>171</td>
<td>2.6</td>
</tr>
<tr>
<td>Total</td>
<td>3,670</td>
<td>3,015</td>
<td>122</td>
</tr>
</tbody>
</table>

^a Percent of regional consumption met by regional production, (Production/Consumption)*100
^b All fruit except berries and melons
^c Dry beans and peas
^d Corn, soybean, canola
^e High-fructose corn syrup, glucose, honey, cane and beet sugar, maple syrup, molasses, refiners’ syrup, sugarcane syrup, sorgo

From: Griffin, Timothy; Conrad, Zach; Peters, Christian; Ridberg, Ronit; Parry Tyler, Ellen. (2014). Regional self-reliance of the Northeast food system. *Journal of Renewable Agriculture and Food Systems.*
### Mean production and consumption of dairy and poultry products in Maine, 2001-2010

<table>
<thead>
<tr>
<th>Self-reliance category</th>
<th>Mean production ($10^6$ lbs live weight)</th>
<th>Mean consumption ($10^6$ lbs live weight)</th>
<th>Mean self-reliance (%)$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy$^b$</td>
<td>609</td>
<td>787</td>
<td>77</td>
</tr>
<tr>
<td>Eggs$^c$</td>
<td>135</td>
<td>43</td>
<td>312</td>
</tr>
<tr>
<td>Chicken</td>
<td>0.1</td>
<td>175</td>
<td>$&lt;0.1$</td>
</tr>
<tr>
<td>Turkey</td>
<td>0.2</td>
<td>28</td>
<td>0.6</td>
</tr>
<tr>
<td>Total</td>
<td>744</td>
<td>1,034</td>
<td>72</td>
</tr>
</tbody>
</table>

$^a$ Percent of regional consumption met by regional production, (Production/Consumption)$\times$100

$^b$ Fluid milk equivalent

$^c$ Chicken eggs

### New England regional mean production and consumption of lamb, beef, and pork products, 2001-2010

<table>
<thead>
<tr>
<th>Self-reliance category</th>
<th>Mean production ($10^6$ lbs live weight)</th>
<th>Mean consumption ($10^6$ lbs live weight)</th>
<th>Mean regional self-reliance (%)$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamb</td>
<td>2.7</td>
<td>3.1</td>
<td>87</td>
</tr>
<tr>
<td>Beef</td>
<td>24</td>
<td>202</td>
<td>12</td>
</tr>
<tr>
<td>Pork</td>
<td>6.3</td>
<td>117</td>
<td>5.4</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>205</td>
<td>35</td>
</tr>
</tbody>
</table>

$^a$ Percent of regional consumption met by regional production, (Production/Consumption)$\times$100

$^b$ Fluid milk equivalent

$^c$ Chicken eggs

Northeast regional self-reliance for fish: 23%; shellfish: 45%

From: Griffin, Timothy; Conrad, Zach; Peters, Christian; Ridberg, Ronit; Parry Tyler, Ellen. (2014). Regional self-reliance of the Northeast food system. Journal of Renewable Agriculture and Food Systems.
Fresh Vegetables Production, NE Counties

Preliminary estimates

Source: H. Etemadnia, Penn State and P. Canning, USDA ERS Washington, DC
3. The Question of Distribution
Distribution and product transformation...

1. Food is usually not produced where it is consumed (farmers and food consumers are separated by space)

2. Food also goes through various degrees of transformation before reaching consumers’ plates
Food System: Analytical framework

1. Production $\rightarrow$ Distribution $\rightarrow$ Consumption

2. Questions of capacity – at what price? – changes over time, at all three levels
2. Food Systems/Supply Chains as networks

Marketing Channels

Producers → Processors

Food Manufacturers → Processors

Food Service Firms → Processors

Consumers

Export

Grocery Retail – Wholesalers
Why distribution matters

87.9% of the consumer dollar pays for costs incurred after food leaves the farm

2012 Food dollar: Industry Group (nominal)

Farm production 9.7¢
Food processing 15.8¢
Transportation 3.3¢
Packaging 2.7¢
Wholesale trade 9.3¢
Retail trade 13¢
Foodservices 31.1¢
Finance & insurance 3.3¢
Energy 5.6¢
Other 3.8¢

Research questions

- Given that food is not produced where it is consumed...
  - What is the role of hubs in ensuring least-cost assembly and distribution of food? Where should hubs/aggregators be located?
  - For perishables, what are the quickest pathways?
  - How might optimal supply chain locations and aggregations change as climate changes?
  - Are concentrated supply chains also resilient, and resistant to failure or other disruption?
2. Food Systems/Supply Chains as *networks*

**Marketing Channels**

- Producers
- Processors
- Food Manufacturers
- Food Service Firms
- Consumers

- Export
- Grocery Retail – Wholesalers

[Diagram showing the connections between producers, processors, manufacturers, service firms, and consumers through hubs]

Producers → Hubs → Consumers
Simulating the optimal number and locations of hubs

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Production-Hub Max Dist (Mile)</th>
<th>Hub-Consumption Max Dist (Mile)</th>
<th>Hub(s) Capacity (Ton)</th>
<th>No. of Hub(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>40</td>
<td>39</td>
</tr>
<tr>
<td>4</td>
<td>Unlimited</td>
<td>Unlimited</td>
<td>150</td>
<td>11</td>
</tr>
</tbody>
</table>

![Case 2](image1.png)  ![Case 4](image2.png)
2. Food Systems/Supply Chains as *networks*

Marketing Channels

- Producers
- Processors
- Food Manufacturers
- Food Service Firms
- Consumers
- Export
- Grocery Retail – Wholesalers

*Direct Marketing*
4. Local and Regional Foods

Compare where food is produced with where it is potentially consumed
Search term comparison: Local Food vs. Organic Food

93:10

55:21
Fruit and Vegetable Farms, 2012, Maine

Some farms are very close to populations, others are not.
Frozen Fruit and Vegetable Manufacturing
Fruit and Vegetable Canning
Refrigerated Warehousing and Storage
Fruit and Vegetable Markets (specialized)
Distribution Networks of Five Northeast Supply Chains

Basic data: Clancy and Ruhf, 2010

Map prepared by David Fleming, The Northeast Regional Center for Rural Development; http://nercrd.psu.edu
www.farmfreshconnection.org
5. Concluding Thoughts
Economic Impact of Maine’s Food Industry

• $11.5 Billion in sales revenue, 122,674 full- and part-time jobs, and $3.1 billion in labor income

• Direct farm sales have statistically significant local economic growth impacts in the Mideast and New England States, by increasing overall farm sales
National Ranking on Various Agricultural Measures, Maine, 2012

- Total value of Ag Products sold: 44th
- Operations with direct sales: 23rd
- Value of direct sales: 21st
- Percent of farm operations selling directly: 5th
- Percent of farms in CSAs: 3rd
- Percent of farms selling wholesale directly to retailers and institutions: 7th

Maine Employment LQ’s*, 1998 and 2012
Meats and Fruits & Vegetables, Post Farm Gate

*Employment Location Quotients (LQ) show how important a sector is within a state, compared to the nation. A value of 1.0 indicates it is equally important in the state as in the nation in terms of employment, while a value greater than 1.0 indicates it is more important in the state than nationally. The opposite is true for a value < 1.0.
Overall Agribusiness Friendliness Index*

**Overall Score and National Rank**

<table>
<thead>
<tr>
<th>State</th>
<th>Score</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Hampshire</td>
<td>6.4</td>
<td>4</td>
</tr>
<tr>
<td>Vermont</td>
<td>6.0</td>
<td>9</td>
</tr>
<tr>
<td>Maine</td>
<td>5.6</td>
<td>13</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>5.0</td>
<td>26</td>
</tr>
</tbody>
</table>

Agricultural processing only

1. Colorado State University, 2014; [http://abfi.agsci.colostate.edu](http://abfi.agsci.colostate.edu)

Factors that help in Maine: Government Regulations (A) and Government Services (A)

Factors that hurt: Government Efficiency of Revenues and Expenditures (F) and Business Climate (C)
Thank You!

sgoetz@psu.edu
Collaborations/Credits

• Thanks to the following individuals for their help with this presentation:

  – P. Canning, USDA ERS Washington, DC
  – K. Clancy, EFSNE Deputy Director
  – H. Etemadnia, Y. Han, Penn State University
  – D. Fleisher, USDA ARS Beltsville, MD
  – T. Griffin, C. Peters, Z. Conrad, Tufts University
Food Systems Research at The Northeast Regional Center for Rural Development

• On average, nearly 88 cents out of every consumer dollar spent on food goes towards paying for value added to the food once it has left the farm gate. Understanding the complex web of transactions that handles, transforms and distributes different food products is essential for identifying constraints, opportunities and vulnerabilities of the food system to economic and human as well as natural shocks. The Northeast Center is involved in a number of longer-term studies to understand the dynamic linkages between food production, distribution and consumption in the region, with primary goals of shedding light on regional self-reliance in various foods, optimal food distribution models and patterns, economic and geographic changes in the distribution and retailing landscape, and changing consumer behavior and preferences. This presentation provides an overview of selected findings from the foods systems research projects currently underway at the Center.

• University Park, PA, February 22, 2015
All of Maine

- Real estate and rental and leasing
- Arts, entertainment, and recreation
- Health care and social assistance
- Accommodation and food services
- Finance and insurance
- Other services, except public administration
- Farm
- Retail trade
- Construction
- Information
- Military
- Manufacturing

Job changes:
- Increased
- Decreased

Color codes:
- Green: Recovered and grown
- Green light: Recovered
- Yellow: Relatively unaffected
- Red: Has not recovered
- Red dark: Recession accelerated decline

Lower Wages Industries Higher Wages
2. Food Systems/Supply Chains as networks

Marketing Channels

Producers (Supply) → Processors → Export → Food Manufacturers → Food Service Firms → Grocery Retail – Wholesalers → Consumers (Demand)

Marketing Margins

Price vs. Quantity

Demand vs. Supply

Marketing Margin

DSD

DD
What types of scenarios can we simulate to evaluate the potential production capacity?

• Current production
• Production Scenarios
  – Water use
  – Land use change
  – Climate change
• Questions
  – How much land
  – Highest potential yield?
  – Production constraints?
  – Resource needs?

Fruit & Vegetable Production, the U.S.

Source: Goetz et al. (2013) forthcoming
Why distribution matters (cont.): where the consumer dollar goes...

<table>
<thead>
<tr>
<th>Category</th>
<th>1st Year</th>
<th>2nd Year</th>
<th>3rd Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail trade</td>
<td>13.3</td>
<td>12.5</td>
<td>14.3</td>
</tr>
<tr>
<td>Foodservices</td>
<td>28.7</td>
<td>25.4</td>
<td>31.1</td>
</tr>
<tr>
<td>Energy</td>
<td>4.6</td>
<td>3.3</td>
<td>6.8</td>
</tr>
<tr>
<td>Finance &amp; Insurance</td>
<td>3.5</td>
<td>2.9</td>
<td>4.0</td>
</tr>
<tr>
<td>Advertising</td>
<td>2.5</td>
<td>2.3</td>
<td>2.8</td>
</tr>
<tr>
<td>Legal &amp; accounting</td>
<td>1.4</td>
<td>1.3</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Distribution channels becoming more concentrated

How do reductions in supply chain options affect farmers’ access to markets, and their economic resilience?

http://www.dailyyonder.com/examining-walmarts-rural-stranglehold/2010/12/06/3068
Why distribution matters (cont.): where the consumer dollar goes...

<table>
<thead>
<tr>
<th>Industry group</th>
<th>Avg</th>
<th>Min</th>
<th>Max</th>
<th>1993 to 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agribusiness</td>
<td>2.8</td>
<td>2.0</td>
<td>3.6</td>
<td></td>
</tr>
<tr>
<td>Farm production</td>
<td>8.7</td>
<td>7.4</td>
<td>9.8</td>
<td></td>
</tr>
<tr>
<td>Food processing</td>
<td>17.4</td>
<td>14.9</td>
<td>19.7</td>
<td></td>
</tr>
<tr>
<td>Packaging</td>
<td>3.7</td>
<td>2.7</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Transportation</td>
<td>3.7</td>
<td>3.3</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Wholesale trade</td>
<td>9.8</td>
<td>9.2</td>
<td>10.3</td>
<td></td>
</tr>
</tbody>
</table>

Survey/Modeling Strategy

One of 9 locations
(e.g., Syracuse)

One neighborhood or community per (underserved) location; focus groups

Two stores on average per neighborhood; consumers patronizing the stores

Supply chains, business owners

Ag. production capacity in 300 Northeast Counties

Market Baskets

Milk, beef, apples, peaches, cabbage, potatoes, broccoli, bread
Market opportunity (Korean)