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Theme Overview: Transformations in the Food System, Nutritional and Economic Impacts

Carola Grebitus, Jane Kolodinsky, and Dawn Thilmany McFadden

JEL Classifications: D10, I15, Q13, R20 M310, Q130

Keywords: consumer acceptance, dietary change, food systems, school programs, urban farms

This theme highlights opportunities and challenges of contemporary food systems in general, with a particular focus on aspects that are more common in urban systems. Urban agriculture issues are especially relevant given that over 50% of the world's population resides in urban areas. In the United States, the share of the population in urban areas is even higher, at 80% (World Bank, 2016).

Two of the articles focus on consumer preferences for and acceptance of relatively novel food production methods and urban geographies, with an emphasis on how fully those characteristics are perceived as "natural." Coyle and Ellison studied consumer perceptions of vertical farming techniques for growing fresh produce and conclude that this production method, while generally acceptable in terms of safety and quality, is viewed as less natural and overall less acceptable by some; subsequently, consumers were less likely to purchase vertically grown produce. Printezis and colleagues report on urban farming as it relates to consumers' preferences for natural production types. Their findings indicate that produce labeled as locally grown is preferred when shoppers perceive urban farming and organic production to be natural.

Three of the articles in this theme focus on dietary changes among children. Roche and colleagues report on a school garden approach to nudging children toward healthier choices, with a long-term goal of decreasing obesity. Two important findings are that children in this national study had increased self-efficacy and reported planning to eat vegetables after participating in a school garden program. Kolodinsky and colleagues report on an on-going transdisciplinary cost-offset community supported agriculture project with a similar goal of decreasing childhood obesity. This article discusses how a formative evaluation with input from CSA members, farmers, and extension professionals informed an intervention currently in the field. Becot and colleagues report on potential economic impacts of farm-to-school programs and needed improvements to data collection and modeling.

Ultimately, the American food system includes large and small producers and a consuming public with a large variety of preferences and price points. This collection of articles addresses the expanding choices Americans have in the food system and provides insight to stakeholders about the variety of approaches that are available to meet their needs, including the increasing prevalence of food system activities emerging in urban areas of the United States.

For More Information

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School Gardens May Combat Childhood Obesity

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JEL Classifications: I12

Keywords: Farm-to-school programs, Knowledge and intent, School-based gardens, Social cognitive theory

Obesity is a contributing factor to a variety of chronic diseases (Wang and Lobstein, 2006). Childhood obesity is particularly troubling because it is much more difficult to sustain weight loss than to maintain a healthy weight. Obese children are much more likely to become obese adults; further, restrictive diets for children could result in a diminished supply of nutrients necessary for healthy growth and development (Daniels, 2009; Han, Lawlor, and Kimm, 2010; Ogden et al., 2007). The National Health and Nutrition Examination Survey (NHANES) has shown that one in six children are obese (Ogden et al., 2012), and the rate is higher among racial minorities and those with fewer economic resources (Ogden et al., 2014).

Eating fruits and vegetables decreases the likelihood of childhood obesity (Bradlee et al., 2010; Roseman, Yeung, and Nickelsen, 2007), but most children do not consume the recommended daily amount of produce (Centers for Disease Control and Prevention, 2013; U.S. Department of Agriculture, 2013; Krebs-Smith et al., 2010). In recent years, considerable emphasis and energy have been invested in hands-on programming—such as cooking, farm-to-school, and gardening—to connect children with healthy foods. The most promising approaches may combine curricular learning with hands-on experiences.

Many of these programs have yielded promising results, such as improved science test scores (Klemmer, Waliczek, and Zajicek, 2005; Rahm, 2002). Evaluations of farm-to-school programs have shown improvements in child and teacher eating behaviors, food service at the school level, farmer involvement, and parent attitudes and/or behaviors toward healthy foods (Joshi, Azuma, and Feenstra, 2008). Children who received garden education combined with nutrition education wished to eat more fruits/vegetables than those who received only the nutrition education, or those in control groups (Parmer et al., 2009). These children also had an increased ability to identify fruits and vegetables and higher confidence in preparation (Somerset and Markwell, 2009). In addition, these types of programs appear to have a greater effect among inner-city students, especially in nutrition and food knowledge (Beckman and Smith, 2008; Somerset and Markwell, 2009). Our study was designed to assess the impact of a school gardening curriculum on children's knowledge of and intent to eat fresh vegetables.

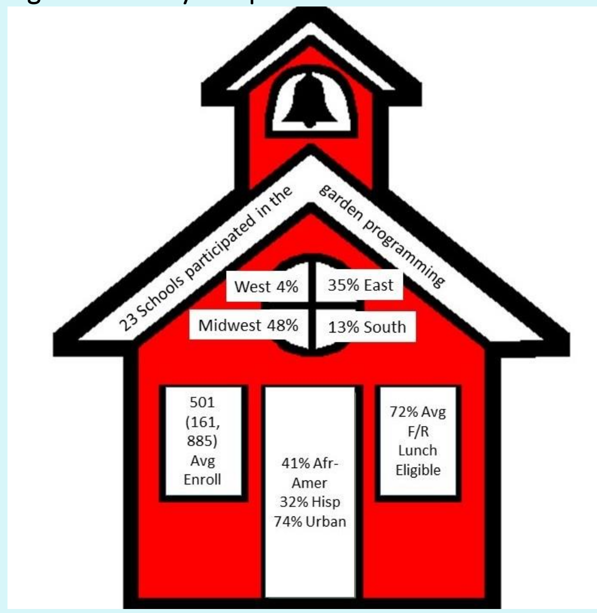
Social Cognitive Theory

Increased knowledge of nutrition and science are positive outcomes, but knowledge has not been strongly correlated with behavior change (Contento, Randall, and Basch, 2002). Social Cognitive Theory (SCT), which considers factors that contribute to healthy behavior adoption (Bandura, 2004), provides a framework for many studies of children and healthy behavior. SCT describes behavior as the result of personal (including knowledge), behavioral, and environmental factors and self-efficacy, or one's belief in the ability to perform a health-related behavior (Bandura, 2004). Self-efficacy affects consumption of healthy foods both directly (Cusatis and Shannon, 1996; Thompson et al., 2007) and indirectly (Anderson, Winett, and Wojcik, 2007).

One environmental factor is "Social Norms," which describes how a child perceives the behavior of others, including peers, adults, and family members. Changing children's attitudes and beliefs about healthy food—

especially their willingness to try new things and the belief that healthy foods are socially acceptable—is a precursor to making positive changes in their food choice behaviors.

Figure 1: Survey Sample Statistics



Program Overview

To better understand how school garden programming contributes to children's knowledge of and intent to consume vegetables, our study followed a cohort of students from just before initial planting of a garden to after the garden was harvested, typically from spring to fall (covering two separate academic years). Participating schools received all the materials necessary for creating a raised-bed garden, as well as curriculum tools to relate the garden to math, science, health, and other concepts. The program also focused on community-wide celebrations and activities.

Twenty-three schools participated in two waves between 2012 and 2014. Each school administered surveys to third- and fourth-grade students for one full "garden year," before and after participating in the school-based garden program. We also surveyed same-aged students from two control schools to control for normal developmental progress. The surveys did not collect identifying information from students, but a unique code was assigned to each survey to track students' pre- and post-test data. In addition to the student surveys, eight of the twenty-three schools provided data from adults involved in the program. Only data from students and adults at these schools were used for the socioeconomic status with Program Integration analysis (Figure 1).

Knowledge and Intent

Because knowledge is not strongly correlated with behavior, we created a dependent variable that combined knowledge and intent. Before students participated in a school-based gardening program, we estimated the relationship between the SCT factors and knowledge/intent. Student knowledge was measured by students' answers to a "MyPlate" question: "Shade in the part of the plate that should be covered in fruits and vegetables." Intent was measured by asking the students about their intent to eat vegetables later that day: "Will you eat vegetables at dinner tonight?" As shown in Table 1, higher Self-Efficacy and Social Norms increased the likelihood of students being "Knowledgeable with Intent" to consume vegetables. In addition, better gardening skills increased the likelihood that students were knowledgeable (MyPlate, Figure 2) and intended to eat vegetables that evening.

Table 1: The Impact of SCT Factors on Student Knowledge/Intent

	Odds ratio (Likelihood)
Self-Efficacy	6.00*
Gardening Skills	2.74*
Social Norms	2.96*
Preferences	2.23*
Food System Learning	0.41*
Suburban	4.04*
Urban	0.46
County Percent White/Caucasian	0.99*
County Poverty Rate	1.06
County Obesity Rate	1.02
County Fast-food Restaurant Prevalence	3.02

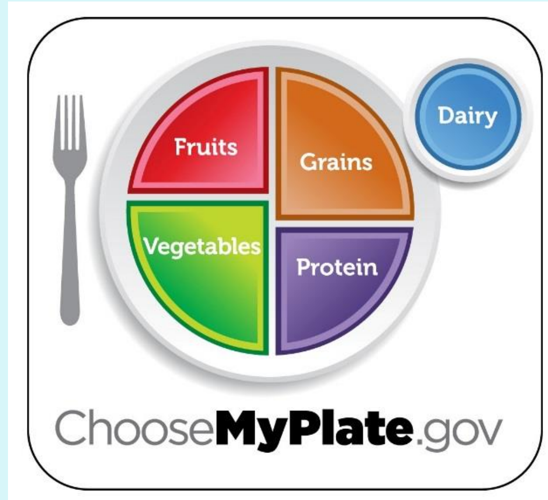
Notes: *Statistically significant at the 10% level or better

Each school was in a different U.S. county, but most county-level environmental variables tested—such as county food environment and poverty rates—did not predict student knowledge/intent. The exception was that enrollment in a suburban school increased the probability of students being knowledgeable with intent.

In Schools that Change the Environment, More Students Intend to Eat Vegetables

Table 2 compares Knowledge, Intent, and Garden Skills among participating students before and after the school-based gardening program compared to a control group. After completing a school-based garden program, three times more students (a statistically significant difference) expressed intent to consume vegetables that evening, while the intent of a control group of same-aged students remained essentially unchanged. MyPlate knowledge and knowledge of gardening were slightly lower, but not statistically significant. Figure 3 shows that gardening knowledge did increase after the program for students of low socioeconomic status. For the purposes of this study, schools with low socioeconomic status were defined as those with 60% or more of students eligible for free or reduced-price lunches.

Figure 2: USDA MyPlate Graphic



Source: https://www.choosemyplate.gov/MyPlate

Schools changed their environments through planting, maintaining, and harvesting school gardens. More students at these schools intended to eat vegetables. In a subset of schools (8 of 23), adults at the school who were familiar with the garden program (a combination of teachers, staff, and parent volunteers) shared their involvement and perceptions of the program. Some schools demonstrated to students that adults were committed to these changes to the school environment. Adult modeling of healthy food choices and engagement, connections from the garden to the classroom, and community involvement in these changes helps students—especially those in low-income communities—change their beliefs and attitudes about healthy food.

Table 2: Change in Student MyPlate Knowledge and Intent to Eat Vegetables

	Program Group		Control Group	
	Pre-test	Post-test	Pre-test	Post-test
MyPlate Knowledge	41.9	39.7	41.8	36.3
Intent to Eat Vegetables	7.2	24.3***	7.7	9.9
Garden Skills (mean out of 8)	4.4	3.9	3.4	3.7

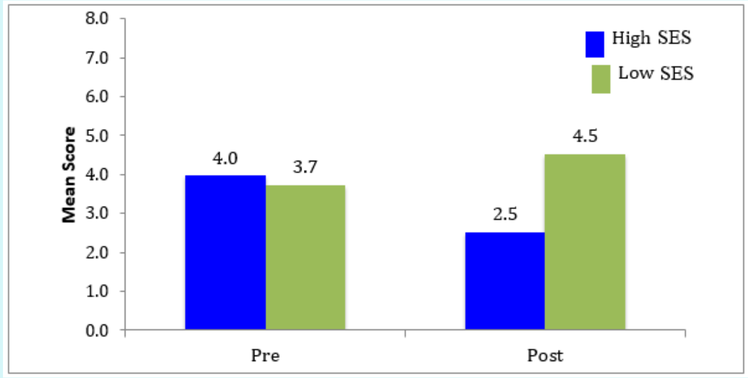
Notes: ***Statistically significant at the 1% level

Summary

Consistent with other studies, self-efficacy, social norms, and gardening skills helped change student knowledge about and intent to eat vegetables. And, importantly, demonstrated commitment by school personnel can amplify changes in gardening skills, especially in lower income communities. Childhood obesity disproportionately affects those with fewer economic resources. In this study, school gardening programs in inner-city schools increased students' life skills, knowledge of and confidence in their ability to make healthy choices surrounding fresh produce.

Gardens can provide alternative access to fresh produce, especially in urban areas that may lack full-service grocery stores. Locating gardens on school grounds may provide students, teachers, and communities with connections to produce and offer opportunities for learning new skills, developing new preferences, and changing social norms. However, school garden programs appear to provide less effect in communities where gardens and grocery stores are more readily available and households have more resources and choices available to them.

Figure 3: Change in Gardening Knowledge after Garden Intervention by Socioeconomic Status



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Do Farm-to-School Programs Create Local Economic Impacts?

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JEL Classifications: O11, O13

Keywords: Economic development, Economic impact, Farm-to-school programs, Nutritional outcomes

Farm-to-school (FTS) programs began in two schools in 1996 as a grassroots movement and now reach approximately 23.6 million students in 42% of U.S. school districts (U.S. Department of Agriculture, 2016a). FTS programs are supported by policy and funding at the federal and state government levels and financial support from private foundations (National Farm to School Network, 2016b). Interest in assessing the impact of FTS programs and other local food initiatives has recently grown, not only to evaluate progress, but also to demonstrate efficacy to funders (Jablonski and Schmit, 2015; Thilmany McFadden et al., 2016).

FTS programs leverage food procurement and educational programming to increase nutritional knowledge and skills among students, improve the nutritional value of school meals, and provide economic opportunities for local farmers (Conner et al., 2012; Izumi, Wright, and Hamm, 2010; Vogt and Kaiser, 2008). While FTS programs vary considerably from one school to another, all programs use a multi-pronged approach that includes a mix of core elements such as school gardens, local food procurement, nutrition education, and agricultural literacy (National Farm to School Network, 2016a; Vermont FEED, n.d.).

Economic impact studies of local food initiatives beyond FTS programs have shown positive impacts, but these impacts tend to be modest or overstated (Gunter, 2011; O'Hara and Pirog, 2013). Overall, claims related to economic development benefits remain largely untested (Hughes and Boys, 2015). We look at the economic impacts of local food procurement, which is a central component of FTS programs. We also explore economic impact of FTS beyond food procurement.

FTS as an Economic Development Strategy

There are two ways in which local food procurement by schools are viewed as an economic development strategy. First, local purchases lead to increased economic activity at the community level through import substitutions and spillover effects (Martinez et al., 2010). Second, farmers gain access to larger markets, enabling them to grow their operations because of increased demand. Farmers participating in FTS programs tend to have small- and medium-scale operations and to sell directly to consumers or to institutions through a middleman (Low et al., 2015). These small- and medium-scale farmers are believed to have a greater impact on the social and economic development of their communities because they purchase more inputs locally and interact directly with their consumers. This belief is rooted in the Goldschmidt hypothesis and the concept of Civic Agriculture. Goldschmidt (1947) hypothesized that farm scale and farm management impact community well-being, and the concept of Civic Agriculture holds that communities have a civic duty to support local food producers due to their positive impact on economic and community development (Lobao, 1990; Lyson, 2000, 2004).

What We Know

Several studies have assessed the economic impact of FTS local food procurement (see box 1 for a description of economic impact studies). Table 1 summarizes six economic studies of FTS local food procurement. These studies used an input-output model called IMPLAN to examine various scenarios of local food use (see box 2 for a description of the IMPLAN model) at varying geographic scales, with varying levels of details, assumptions, and customizations of the model. Haynes (2009) and Gunter (2011) customized the agricultural sector in IMPLAN to better reflect the patterns of how small- and medium-scale operations that participate in FTS programs spend money. The IMPLAN model is frequently customized so that it appropriately represents the impacts of smaller, diversified farms and other small-to-medium scale operations that frequently participate in FTS programs (Lazarus,

Economic Impact and Contribution Studies

An economic impact study measures the changes in spending in a geographic area that would result from a *hypothetical* change in economic activity, such as a plant closing or opening, a festival, or a natural disaster. This type of analysis calculates the cumulative amount of money that cycles through the economy among industries, households, and government agencies, as a result of the change (Day, n.d.). Similarly, an economic contribution study measures the cumulative economic activity from an *existing* industry or events. Economic impact and contribution studies should not be confused (Watson et al., 2007), but results for economic impact and economic contribution studies are generally reported and interpreted in the same way.

The economic impact or contribution of an activity or event has three types of effects on the economy: direct, indirect, and induced effects. Taking FTS local food procurement as an example:

- The **direct effect** comes from schools' local food purchases.
- The **indirect effect** comes from food suppliers purchasing goods and services and hiring workers to fill the schools' orders.
- The **induced effect** comes from changes in household income that result from the direct and indirect effects.

Each of the effects (direct, indirect, and induced) result in output (also referred to as total sales), value added (equivalent to gross domestic product), labor income, and employment. The sum of the direct, indirect, and induced effects is the total economic impact.

IMPLAN Software

Economic impact and contribution studies use input-output (IO) and Social Accounting Matrix (SAM) models. The combination of these two models represents the whole economy under study, including transactions among industries, institutions, and households. The software package and database IMPLAN (IMpact Analysis for PLANing) is commonly used to conduct these types of studies. Data for the IMPLAN database are supplied by the U.S. Department of Commerce, the U.S. Department of Labor Statistics, the U.S. Department of Agriculture, and other federal and state government agencies. The latest IMPLAN version uses 536 sectors based on the North American Industry Classification System (NAICS) to represent the economy. The agricultural sector is represented by 19 sectors and the food manufacturing sector is represented by 45 sectors.

Platas, and Morse, 2002; Schmit, Jablonski, and Kay, 2013; Swenson, 2011). Customizing the model requires access to data: the Roche et al. (2016) study specifically mentioned its inability to customize the IMPLAN model due to lack of secondary data.

Beyond the actual results of these studies, the diversity of approaches is noteworthy. Some of the studies looked at demand for local food, including existing school purchases, purchasing goals, and changes in menus (Haynes, 2009; Kane et al., 2010; Pesch, 2014; Roche et al., 2016). The other studies looked at supply, including changes in the growing season, purchase shifts from wholesaler to direct from farmers, and changes in prices (Gunter, 2011; Haynes, 2009; Pesch, 2014).

The diversity of approaches and geographic areas makes it difficult to compare results across studies (table 1). While the IMPLAN multipliers allow for some level of comparison, direct comparisons are still not recommended. Still, multipliers can provide an indication of the general magnitude of impacts that can be expected from FTS programs. In general, smaller geographic areas show smaller impacts. The studies reported a sales multiplier that varied from 1.03 in the 2009 Minnesota study to 2.4 in the Florida study (Haynes, 2009; Kluson, 2012). The

Table 1: Summary of Identified Economic Impact studies of Farm-to-School Programs

Study	Haynes, 2009, and Tuck et al., 2010	Kane et al., 2010	Gunter, 2011	Kluson, 2012	Pesch, 2014[#]	Roche et al., 2016
Location	Minnesota	Oregon	Colorado	Florida	Minnesota	Vermont
Geographic scale	School districts	School districts	Multi-county	Multi-county	Multi-county	State
Type of study	Impact study	Impact study	Impact study	Impact study	Contribution and impact study	Contribution and impact study
Modeled shift of sales from wholesaler to food producer	Yes	Not specified	Yes	Not specified	Yes	Yes
Modeled changes in food prices	Yes	Yes	No	Not specified	Yes	No
IMPLAN customization	No	No	Yes	Not specified	No	No
Multipliers	Sales = 1.03 - 1.25*	Sales = 1.86 Value-added = 2.82 Jobs = 2.43	Sales = 1.47-1.63 Employment = 1.27 – 3.30 Labor income = 1.32-1.43	Sales = 2.4 for produce Sales = 1.84 for dairy	Sales = 1.7 - 2.19* Employment = 1.58 - 3* Labor income = 0.49 – 1.47*	Sales = 1.6 Value added = 2.1 – 2.4 Labor income = 2.2 – 2.8 Employment = 1.5 -2.2

Notes. *Calculation made by authors. [#] study included schools and health care facilities.

employment multiplier ranged from 0.49 in the 2014 Minnesota study to 3.3 in the Colorado study (Gunter, 2011; Pesch, 2014). Not all studies reported an income multiplier, but the studies that did, reported an income multiplier between 1.4 and 2.8 (Roche et al., 2016; Gunter, 2011; Pesch, 2014). Gordon and Mulkey (1978) explain that income multipliers should be between 1.05 and 2.5 and that a multiplier over 2.5 is suspect.

Studies on how FTS programs affect farmers are limited both in number and in scope. Overall, sales to FTS programs seem limited, as previous studies have found that these sales represented just 1% to 5% of farmers' overall sales (Conner et al., 2012; Izumi et al., 2010; Joshi et al., 2008). Despite the low sales, some farmers have found benefits in selling to schools, including market diversification and generating social benefits. Market diversification can include adding a market channel, identifying an outlet for small, visually imperfect, or otherwise unsold produce, while social benefits can include embedding farmers into the community, networking, and increased social capital (Conner et al., 2011). Barriers for increased sales are related to complex supply chain networks required for school delivery, the price sensitivity of schools, and the mismatch between the growing season and the school year (Becot et al., 2014; Conner et al., 2011).

Gaps in Knowledge

As the studies point out, the economic impact of FTS local food procurement appears to be modest, particularly when studies account for wholesalers' loss of economic activity due to schools purchasing directly from food producers. Only two of the studies highlighted above customized the agricultural sector in IMPLAN. Yet the IMPLAN model needs refinement because the expenditure patterns of farmers participating in local food system activities differ from the average farm sector in IMPLAN. These differences have bearings on the results of economic impact studies, as some impacts might be overstated or understated . However, access to the data needed to customize the model is difficult to obtain, and thus, restrains research in this area .

From the farmers' perspective, sales to schools have been small as a proportion of all sales. Furthermore, limited information exists about how these sales impact farmers' profitability in the short and long term. Social benefits seem to prevail in these transactions, and components of FTS programs such agricultural literacy and nutrition education might work to build a larger customer base in the long term . Though increased farm profitability has been touted as a benefit, the lack of knowledge about the interactions between sales to schools and profitability represents a research gap.

Economic Impact Beyond Local Food Procurement

Beyond the economic impacts of FTS programs related to local food purchasing, there are large gaps in knowledge about the economic impacts of food waste, health outcomes, and educational outcomes as related to FTS programs. Still, these additional economic impacts have been highlighted by farm to school advocates as benefits of the program.

First, anecdotal evidence suggests that FTS programs lead to reduced food waste, representing a cost saving for schools (U.S. Department of Agriculture, 2016b). The reduction in food waste might be due to improved quality of meals served and increased awareness of the value of food through FTS class programming. Since the current evidence is anecdotal, future research is needed to explore the relationship among FTS programs, food waste, and food costs.

Second, focus on healthy diets and education through food and agricultural literacy leads to improved nutritional intake, which could ultimately lead to improved health outcomes among children (Joshi et al., 2008; Roche et al., 2012). Improved health outcomes, including reduced rates of obesity and weight-related illnesses, would likely lead to healthcare costs savings (Fung et al., 2012; Qian et al., 2016). If FTS programs lead to improved health outcomes—and given that better health leads to healthcare cost savings—economic impact modeling may show that these programs have a negative impact on the economy. However, despite potential losses for the healthcare industry, gains at the societal level would likely be greater. The impacts of FTS on health and the ensuing economic impacts are currently large research gaps.

Third, educational programming is a cornerstone of FTS programs, but its effect on educational outcomes for students has received little attention. Research has shown that these educational approaches lead to improved outcomes because increased student engagement lead to positive attitudes towards learning (Bamford, 2015; Block et al., 2012). Schools participating in FTS programs have seen a decrease in behavioral referrals and school nurse visits, further indicating improved educational outcomes (Dirks and Orvis, 2005; Waliczek, Bradley, and Zajicek, 2001; Zipparo, 2016). Better educational outcomes have been associated with improved economic outcomes due to increased earning potential (Card, 1999). Research is needed to assess the relationship between FTS programming, educational outcomes, and future labor market productivity and labor earnings.

Interest in better understanding the economic impact of FTS programs has increased as the resources available to these programs have grown. While this article focused on the economic impacts of FTS programs, the likely impacts of FTS programs go beyond economics. Beyond the health and nutritional outcomes highlighted above, advocates argue that FTS programs lead to increased food and agricultural literacy, environmental awareness, lunch participation, perceived value of food service workers, and connections between schools and the community (National Farm to School Network, 2016b; University of Minnesota Extension, 2016; Vermont FEED, n.d.). Research to explore these impacts has been limited so far, likely due to a lack of resources, but this research is crucial. Changes such as improved health and educational outcomes are long-term changes that require longitudinal studies. Many of the other potential changes listed above could be suited for qualitative research approaches. No matter the research methodologies employed, much work remains to be done to gain a holistic understanding of the impacts of FTS programs.

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Can CSA Cost-Offset Programs Improve Diet Quality for Limited Resource Families?

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The current U.S. Department of Agriculture (USDA) strategic plan, which guides many of its grant programs, highlights the connection between financial sustainability of food producers, supply of fresh local food to consumers, and improved nutritional and health outcomes (U.S. Department of Agriculture, 2014). Achieving these goals requires an integrated and transdisciplinary approach to tackle the interactions between components of the complex food system and human health (Nesheim, Oria, and Yih, 2015). There is limited empirical evidence to date about the relationship between producers' financial sustainability and public health outcomes. In particular, there is little understanding of whether financial security and diet-related health outcomes can interact positively (Sitaker et al., 2014).

To fill these knowledge gaps, our team of researchers—spanning the fields of nutrition, public health, and economics—developed an innovative project that integrates increased access to fresh produce for low-income households with entrepreneurial food systems innovation. This project, called Community Supported Agriculture Cost-offset Intervention to Prevent Childhood Obesity and Strengthen Local Agricultural Economies, is funded by the USDA Agriculture and Food Research Initiative (AFRI) project. Its intent is to integrate research, extension, and education to examine subsidized or "cost-offset" community supported agriculture (CO-CSA) participation as a strategy for improving dietary quality among low-income families, help at-risk children achieve and maintain healthy body weights, and support vibrant agricultural economies.

This is the first transdisciplinary initiative to rigorously evaluate dietary outcomes resulting from the direct-to-consumer (CSA) sales of fresh produce to low-income families, combined with nutrition education, over multiple years as well as assessing impacts on the local economy. It draws on research related to obesity, fruit and vegetable consumption, food access in rural areas (particularly access to fresh produce), and farm viability in direct-to-consumer market channels. This article focuses on the formative research component of the larger study. Data were collected from CSA participants, extension educators, and farmers. Findings of the formative evaluation align with both anecdotal and academic findings: involvement, freshness, value, and variety are important to increasing familiarity and use of fruits and vegetables.

A Call to Action

More than a third of American children and adolescents are obese or overweight, creating alarming social, medical, and economic costs to society as a growing number of children experience costly and debilitating obesity-related health issues like type 2 diabetes and cardiovascular disease (Ogden et al., 2014). These problems may be compounded by other costly health conditions throughout life, including high blood pressure, osteoarthritis, certain cancers, stroke, and heart disease (National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 2012). Rates of obesity and chronic disease are higher among low-income and rural populations, the latter of which are more likely to live in poverty compared to urban populations (Lobmayer and

Wilkinson, 2002; Gamm et al., 2003; U.S. Department of Agriculture, Economic Research Service, 2014). Yet Americans currently eat less than two-thirds of the recommended amounts of fruit and vegetables, as well as lower than recommended levels of nutrient-dense dark green and orange vegetables (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2010).

Individuals with low socioeconomic status, food insecurity, and rural residence have even lower levels of fruit and vegetable consumption, partly due to less access to fresh, affordable foods (U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2010; Guenther et al., 2006; Bowman, 2007; Lallukka et al., 2010; Hanson and Conner, 2014; Lutfiyya, Chang, and Lipsky, 2012; Liu et al., 2012; Larson, Story, and Nelson, 2009).

Fruit and Vegetables Contribute to Good Health

Moderate evidence suggests that increasing fruit and vegetable consumption in adults can lead to weight loss when combined with reduced consumption of energy-dense foods, which may be effective in maintaining a healthy weight (Boeing et al., 2012; Mytton et al., 2014). *E*vidence of an association between fruit and vegetable consumption and weight development in children and adolescents is much weaker, but some observational and epidemiological studies have shown that consuming more fruits and vegetables is associated with lower body weight in children (Boeing et al., 2012; Tohill et al., 2004; Lin and Morrison, 2002). When substituted for energy-dense foods or combined with other strategies—such as increasing physical activity—increased fruit and vegetable consumption may prevent weight gain or promote weight maintenance (Ledoux, Hingle., and Baranowski, 2011; Rolls, Ello-Martin, and Tohill, 2004).

These relationships are important considerations for long-term child obesity prevention because we know that behaviors established in childhood and adolescence often persist into adulthood and that parental eating behavior is a potent influence on children's diets (Kelder et al., 1994; Mikkilä et al., 2004; Poti, Duffey, and Popkin, 2014). Collectively, this evidence supports integrated, family-based strategies for childhood obesity prevention that include increasing access to and consumption of fruits and vegetables, which can displace energy-dense foods and beverages.

CSAs Contribute to Good Health and Healthy Economies

Like other direct-to-consumer outlets, CSAs have the potential to improve physical and financial access to fresh produce (Cooley and Lass, 1998). CSAs allow consumers pay upfront for a "share" of a farmer's crop, receiving fresh produce regularly as it is harvested during the growing season. CSA produce can cost significantly less than similar types and amounts of produce bought at the grocery store (Perez, Allen, and Brown, 2003; Russell and Zepeda, 2008; Brehm and Eisenhauer, 2008). However, findings on the profitability of CSAs to the farmer are contradictory: In some cases CSAs are more profitable than wholesale accounts but, in others, farmers reported dissatisfaction with economic returns (Stagl, 2002; Jablonski, Perez-Burgos, and Gomez, 2011).

CSA membership has been associated with increased willingness to try new produce and greater consumption of meals at home (Russell and Zepeda, 2008; Andreatta, Rhyne, and Dery, 2008). It may also result in increases in the quantity and variety of fruits and vegetables consumed by CSA members (Russell and Zepeda, 2008; Uribe, Winham, and Wharton, 2012; Allen et al., 2016). Though logistical barriers to CSA share pick up and unfamiliarity with some CSA vegetables are reported by low-income families as rationale for lower participation, CSAs may be feasible and acceptable to low-income participants under the right conditions.

Subsidized CSA shares, convenient pick-up locations, and complementary nutrition education are strategies that researchers and educators have employed to increase participation among low-income families with children (Hayden and Buck, 2012; Healthy Food for All, 2014; Northeast Organic Farming Association of Vermont, 2014; Harnack et al., 2016; Quandt et al., 2013; Hoffman et al., 2012). Farmers can use a variety of strategies to help potential limited-resource members overcome income barriers, including accepting Supplemental Nutrition Assistance Program benefits (SNAP), payment plans, working shares, subsidies from grants or full-pay members, low-cost shares, transportation assistance, and bartering (Forbes and Harmon, 2008). Farmers have been shown to benefit from CSAs via improved financial security, decreased time and money spent on marketing (particularly during their growing season), and reduced production costs (Saulny, 2008; Stagl, 2002; LeRoux et al., 2010; Sabih and Baker, 2000; Cohen and Derryck, 2011; Jablonski, Perez-Burgos, and Gomez, 2011; Hardesty, 2010). By accommodating low-income participants through share subsidies, farmers can potentially expand their market reach.

Recent studies have shown positive changes in attitudes and consumer behavior toward fruit and vegetables among low-income CSA members (Harnack et al., 2016; Quandt et al., 2013; Hoffman et al., 2012) and among CSA members in general (Curtis, Allen and Ward, 2015). Nonetheless, aside from the rigorous dietary outcome measures reported in Harnack et al. (2016), who studied subsidized incentives for fruit and vegetable purchases, there is limited empirical evidence for the benefits of longer-term CSA membership on dietary quality, particularly among low-income families (McCormack et al., 2010; Hedden, 2011). Similarly, the economic impact of CO-CSAs on farm profitability has not been adequately studied.

Can CSA Cost-Offset Programs Prevent Childhood Obesity and Strengthen Local Agricultural Economies?

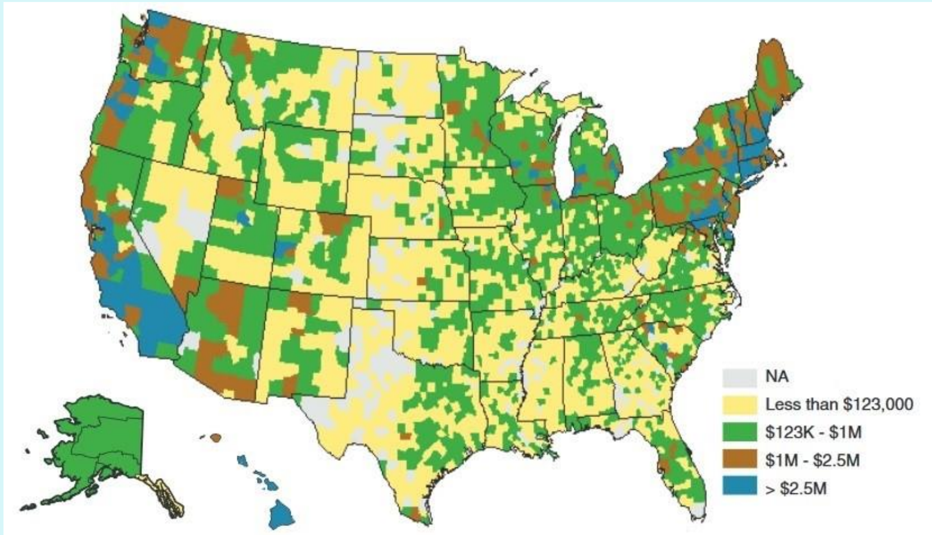
The formative research presented here includes participation in CSAs with different business models in New York, North Carolina, Vermont, and Washington. The quantity and value of direct-to-consumer sales varies considerably across the states and communities participating in this research and captures most of the range of variation in sales seen across the United States. Direct-to-consumer sales are consistently high across all Vermont counties; New York and Washington both have some counties with lower and some with higher direct-to-consumer sales; overall, North Carolina counties have lower direct-to-consumer sales (Low et al., 2015).

Between 2007 and 2012, all four states have seen areas of growth, stability, and decline in direct-to-consumer sales. By including multiple states and three U.S. regions, we aim to increase the likelihood that our research results will be relevant and transferable nationally to other communities trying to increase farmer viability and decrease childhood obesity by increasing fruit and vegetable consumption through direct-to-consumer markets.

We used formative research methods to develop an increased understanding of CSA beliefs, perceptions, and practices among key intervention stakeholder groups. This method leads to proper targeting and appropriate strategies for the intervention, which began during the 2016 growing season. We performed qualitative interviews in each of the four intervention states with twenty-four CSA farmers, forty-one parents in low-income households, and twenty community health educators. We chose respondents using sampling matrices to ensure that they represented a diversity of characteristics (such as farm experience with cost offset mechanisms and children of appropriate age in low-income households) that were of relevance to the intervention.

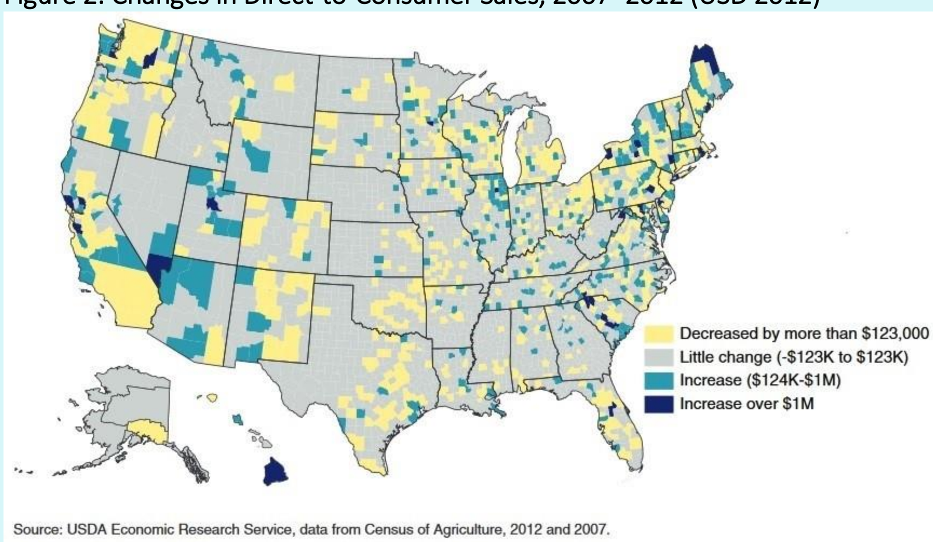
These interviews described the perceived benefits, opportunities, consequences, and barriers to the CO-CSA model and the proposed intervention. We used these findings to design the intervention, guided by emergent themes related to (i) general beliefs and attitudes about produce and farming, (ii) perceptions of CSAs, and (iii) perceptions of successful nutrition education curricula.

Figure 1: Total Dollar Direct-to-Consumer Sales, by County, 2012



Source: Low et al., 2015

Figure 2: Changes in Direct-to-Consumer Sales, 2007–2012 (USD 2012)



Source: Low et al., 2015

Multiple States and Multiple Disciplines Add Complexity

A transdisciplinary team with a breadth of perspectives requires deep discussion and consideration of the benefits and drawbacks of quasi-experimental comparison as opposed to randomized control designs, the appropriate level of randomization (individual versus community), and a host of measurement issues. Some of these challenges are outlined in the literature (Hamermesh, 2001; Kolodinsky et al., 2009; Kolodinsky and Goldstein 2011; Sturm, 2005; McKinnon et al., 2009). This consideration has allowed us to create a rigorous research design that integrates these perspectives and meets the demands of many fields.

A randomized experimental design with a delayed-intervention control group will maximize our ability to rigorously measure program impacts on low-income households while meeting high ethical standards for responsible community nutrition research (allowing all participants to ultimately benefit from the program). Individual 1:1 randomization is implemented within community clusters to produce equivalent intervention and control groups while also acknowledging that agriculture requires planning well in advance of the CSA season and that our CSA partner farms need to know how many shares are required in each year of the longitudinal intervention study.

Our data collection approach attempts to capture a broad range of information; therefore, we have employed a diverse array of data collection methods, including qualitative interviews and focus groups; longitudinal quantitative on-line surveys; in-person physical measurements of children and adults; on-line completion of 24-hour dietary recalls for children; on-line and paper process evaluation surveys from educators and participants; skin carotenoid measures using new, non-invasive technology; and end-of season interviews with farmers, educators, and participant parents. These multiple data sources provide a range of perspectives.

The rationale for integrating different disciplines in food system research has been clearly articulated, but there is limited evidence on food systems programs and policies that align with nutrition goals. Looking to the future, this project seeks to generate new evidence on what programs best serve the needs of both low-income families and local agricultural economies. In addition to studying impacts, the practical, real-world nature of this project will facilitate the development of a nuanced understanding of the incentives and disincentives for farmers and consumers in a CO-CSA model. Our team designed evaluation instruments collaboratively and iteratively to shed light on a range of implementation factors, including the perspectives of key stakeholders on how the intervention is working. Information gathered will help identify areas where targeted action could enhance nutrition and health as well as economic outcomes. We plan to share our program experiences so that others may benefit from what we learn.

Many opportunities exist for researchers in agriculture, nutrition, health, and community development to interact in projects such as this, which require deep inquiry, reflection, and problem-solving. All study materials—from data collection instruments to participant reminder messages and our logo—have been developed and refined collectively, and issues that have arisen have been resolved through discussion and critical reflection among research team members and institutions. The extended project time frame (five years) allows us to grow together while working on a tangible project that demands diverse expertise and perspectives.

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Will Consumers Find Vertically Farmed Produce "Out of Reach"?

Bradford D. Coyle and Brenna Ellison

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An Introduction to Vertical Farming

The global population is expected to increase to 9.7 billion people by 2050, approximately 2.4 billion more mouths to feed than we have today (United Nations, Department of Economic and Social Affairs, 2015). This likely means more food will need to be produced, yet there are concerns about the scarcity and quality of critical inputs for future food production. Lotze-Campen et al. (2008) note that land previously used for agricultural production will likely be converted for other purposes such as urbanization, infrastructure development, bioenergy production, or biodiversity protection. Others researchers caution that high-quality water and soil inputs may also be constrained (Tilman et al., 2002; Ehrlich, Ehrlich, and Daily, 1993). Climate change is also expected to be a major challenge for agricultural production in the coming years due to warming temperatures, increased carbon dioxide emissions, and more severe weather events (Howden et al., 2007). Climate change models predict that agricultural losses will be greatest in the developing world (Rosenzweig and Parry, 1994), especially in southern Asia and Africa (Parry, Rosenzweig, and Livermore, 2005).

One potential way to increase agricultural production (and ultimately the food supply) that is largely impervious to climate change is vertical farming, a type of controlled-environment agriculture that primarily uses artificial lighting and hydroponics to grow plants stacked in layers (Banerjee and Adenaeuer, 2014). Because the climate in a vertical farm is controlled, plants can grow faster and be harvested year-round. By stacking layers of plants on top of each other, vertical farms can produce much higher yields per unit of land than traditional farms.

Vertical farms also have the benefit of being able to produce crops like lettuce in non-traditional areas (Despommier, 2010). Vertical farms currently produce crops like fresh lettuce in cities in the northern United States, Northern Europe, and East Asia—areas where production is uncommon. The presence of vertical farms allows consumers in those areas to buy locally produced food, an attribute that has been shown to be highly valued by consumers (e.g., Loureiro and Hine, 2002; Darby et al., 2008; Onozaka and Thilmany McFadden, 2011). Additionally, vertical farms may be a good means for increasing produce availability in highly urbanized areas and urban food deserts, which could improve community food security (Specht et al., 2014).

Critics contend that vertical farming presents more problems than it solves. Cox and Van Tassel (2010) argue that energy usage is high because vertical farming depends on artificial lights to grow plants and that the production of additional electricity for vertical farms will result in increased pollution and greenhouse gas emissions. Furthermore, the cost to purchase the LED lights used in vertical farming is prohibitively expensive for many small farmers. Critics also argue that crops that can both be grown vertically and be economically viable are limited to the extent that vertical farming will not be a meaningful solution to our agricultural problems.

While there are arguments for and against vertical farming, whether consumers are even willing to buy vertically farmed produce—an important consideration in the cost-benefit discussion—is rarely discussed. Recent agricultural technologies—such as genetically modified (GM) crops, food irradiation, and nanotechnology—have often been met with consumer skepticism (Frewer et al., 2011; Dannenberg, 2009; Siegrist et al., 2007; Ragaert et al., 2004), so it is unclear how vertical farming will fare with consumers. The overall purpose of our research is to investigate consumers' perceptions of and willingness to pay (WTP) for produce—specifically, lettuce—grown in a vertical farm production system. Results from this study should provide insight on the potential for consumer acceptance of vertical farming as a new production technology relative to greenhouse and field production systems. This study will also examine the impact of information on perceptions of and WTP for vertically farmed lettuce.

Consumer Assessment

We conducted this study in January 2016. We recruited 117 participants from the University of Illinois campus and surrounding community. To be eligible for the study, participants had to be at least 18 years of age and consumers of lettuce. Participants were paid $5 for attending a 20-minute session that included an experimental auction and accompanying survey. We held 20 sessions across the study period, with an average of almost six subjects per session. The final sample included 116 observations, as we removed one observation from the sample due to a participant misunderstanding auction procedures.

Figure 1: Information Treatment Handout

	Vertical Farm	**Greenhouse**	**Field Farming**
			
Light Source	Artificial lighting	Sunlight and/or artificial lighting	Sunlight
Land Use	365 days/year	365 days/year	About 275 days/year
Soil use	None. Plants grown hydroponically.*	None. Plants usually grown hydroponically.*	Yes. Plants grown in soil.
Harvests per year	8–12 for lettuce	6–7 for lettuce	Usually 2 for lettuce
Water source	Local water network	Local water network	Rainfall and irrigation
Water use	Low 0.3 gallons/head of lettuce	Low 0.3 gallons/head of lettuce	High 6.5 gallons/head of lettuce
Electricity use	High. Lights run for 12–16 hours per day and heating system must be run in the winter.	Medium. Lights run for a 2–4 hours per day and heating system must be run in the winter.	Low
Pest control use	Enclosed building	Enclosed building	EPA-approved herbicides, insecticides and fungicides as well as traditional methods such as weeding, mulching and plowing.
Production	5,000,000 heads of lettuce/acre/year	1,600,000 heads of lettuce/acre/year	50,000 heads of lettuce/acre/year

Notes: *The roots are immersed in water and soak up nutrients from a solution added to the water.

In each research session, participants participated in a practice candy bar auction to explain the experimental auction procedure. For this study, we used the Becker-DeGroot-Marschak auction to determine consumers' WTP (Becker, DeGroot, and Marschak, 1964). After the practice auction, sessions were randomized to either receive information about the three agricultural production systems of interest (referred to as the treatment group) or to receive no information (referred to as the control group). For the treatment sessions, a table with information about vertical farms, greenhouses, and field farms was provided to all participants. The table contained a picture typical of each production system as well as nine pieces of information on water use, electricity use, and pest control use for each production system (Figure 1). The moderator discussed the information sheet, allowed participants to ask clarification questions, and then had participants answer comprehension questions at the start of their surveys to ensure that they understood the information presented. Participants in the control group did not receive any information about agricultural productions systems and proceeded directly from the practice auction to the rest of the study.

In the lettuce auction, participants placed three bids for 5-ounce boxes of lettuce produced by a vertical farm, a greenhouse, and a field farm. The session moderator showed participants a sample box of lettuce in order to communicate the quantity of lettuce they were bidding on.

We also asked comparison questions about the three agricultural production systems. Participants rated their perceptions of lettuce grown using each production system with regard to safety, quality, and naturalness. Additionally, subjects were asked to indicate their knowledge level of each of the production systems, as well if they thought the average consumer would be willing to buy lettuce grown in each of the production systems. Responses were indicated on a five-point scale (from 1 = very unsafe, low quality, unnatural, low knowledge, or very unwilling to buy to 5 = very safe, high quality, natural, high knowledge, or very willing to buy).

In addition to perceptions, participants were asked about their attitudes toward farming broadly and vertical faming specifically. The general farming statements corresponded to the information given to the treatment group, but both the control and treatment groups were asked about their attitudes to determine whether the information had impacted them. Sample statements included “Farmers use too much water,” “Farms should only use natural lighting,” and “Farmers should always maximize production per acre.” Similar statements were used to measure attitudes toward vertical farming, including “Vertical farming will improve the standard of living for future generations” and “Vertical farming will cause health risks in human beings.” For all attitude statements, subjects indicated their level of agreement on a five-point scale (1 = strongly agree to 5 = strongly disagree).

To learn more about how consumers expected vertically farmed lettuce to fit in to the market, subjects were questioned about where they expected this product to be sold. Since this survey was restricted to a single community, specific store names were used; however, several broad store types were represented, such as supercenters (Walmart, Target, Meijer), supermarkets (Schnucks, County Market), specialty stores (Common Ground Food Co-op, Strawberry Fields), and discount stores (Aldi).

How Does Vertically Farmed Lettuce Rate with Consumers?

Perceptions and Knowledge

Participants rated their perceptions of lettuce grown in three agricultural production systems—vertical farming, greenhouse farming, and field farming—with respect to naturalness, safety, quality, and willingness of the average consumer to buy (Table 1)., Significant differences between production systems existed for each variable of interest. For safety and quality ratings, vertically farmed lettuce was rated lower than greenhouse grown but higher than field-grown lettuce; however, only the safety ratings significantly differed across the three production systems. Despite strong quality and safety ratings, vertically farmed lettuce was considered to be the least natural (average ratings were 3.1, 3.5, and 4.4 for vertical farm, greenhouse, and field farm, respectively) and the least likely to be purchased by the average consumer (vertical farm=3.0; greenhouse=3.6; field farm=4.3).

Table 1: Consumer Perceptions by Production System

Production System	*Knowledge of System*	*Naturalness Rating*	*Safety Rating*	*Quality Expectation*	*Willingness of Average Consumer to Buy*
Vertical Farm	2.3[a]	3.1[a]	3.7[a]	3.8[ab]	3.0[a]
Greenhouse	3.1[b]	3.5[b]	4.0[b]	4.1[a]	3.6[b]
Field Farming	3.4[b]	4.4[c]	3.4[c]	3.6[b]	4.3[c]

NOTES: Averages in a column that share the same letter in the superscript are not significantly different at the 5% significance level. Participants were asked to rate their response on a five-point scale where *1=No Knowledge, Unnatural, Very Unsafe, Low, or Very Unwilling and 5=Very Knowledgeable, Natural, Very Safe, High, or Very Willing.*

The information treatment had little impact on ratings within or across production systems, with the exception of the natural rating. Here, we observed that participants in the control group rated vertically farmed and greenhouse grown lettuce as equally natural; however, once information was provided, vertically farmed lettuce was perceived to be significantly less natural than both greenhouse and field-grown lettuce. Knowledge of the three production systems was also assessed. Not surprisingly, the average knowledge level of the vertical farm system was significantly lower than knowledge of greenhouse and field farm production systems, but the information treatment marginally improved consumers' knowledge of vertical farming.

Will Consumers Pay?

On average, participants' WTP was $2.23 for a 5-ounce box of vertically farmed lettuce, $2.28 for the greenhouse grown, and $2.36 for the field-grown lettuce. Participants in the information treatment were not willing to pay as much for vertically farmed lettuce compared to those in the control treatment (average WTP for treatment: $2.00; average WTP for control: $2.47), but this difference was not statistically significant.

To better understand bidding behavior for an unfamiliar product, we asked participants to explain how they developed their bids for the vertically farmed lettuce. The most commonly cited factors participants listed for determining their bid were expectations about production costs. For participants who received the information treatment, the effect was even more pronounced, with participants focusing on the potential of vertical farms to produce large amounts of lettuce. These responses were likely referencing the part of the information sheet that listed production for a vertical farm at 5,000,000 heads of lettuce/acre/year (in comparison to field farming producing 50,000 heads of lettuce/acre/year).

The expectation that differences in production per acre between agricultural systems would result in lower cost expectations, and therefore lower WTP, may indicate a lack of consumer literacy among our participants. An underlying assumption of numerous qualitative responses seems to be that higher yield per acre is associated with lower-cost lettuce. However, we did not provide any information directly regarding costs of production. Further, the fact that participants seemed willing to base their WTP on what they perceived as costs of production does not fit neatly with neoclassical economic theory. It may be the case that participants considered other factors beyond their own costs and benefits when determining WTP.

Consumer Attitudes

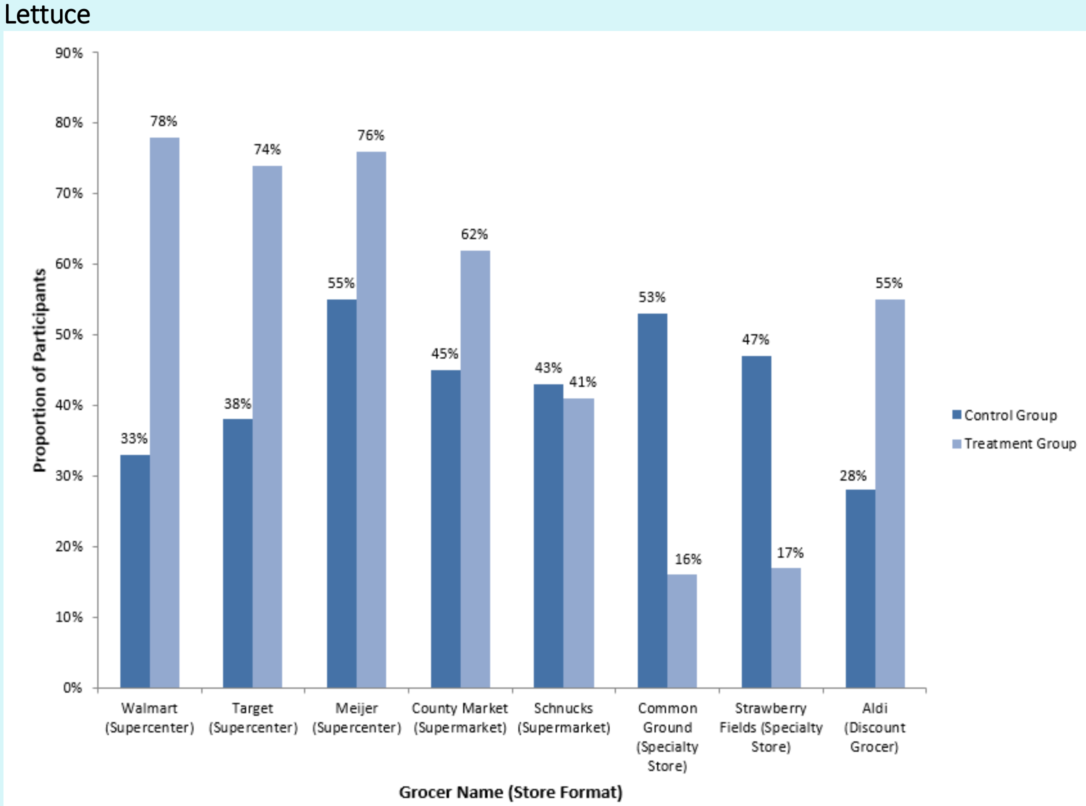
When asked about production practices broadly, consumers tended to agree that year-round crop production is desirable, but they were not in favor of pesticide use. Participants in the information treatment group had significantly higher levels of agreement with the statements "Growing crops at a faster rate is a good thing" and "Farmers should always maximize production per acre." These attitudes suggest that participants are open to a type of agriculture, such as vertical farming, that uses land intensively to grow pesticide-free plants at an accelerated pace year-round.

More specific attitude statements indicated that consumers viewed vertical farming positively. Participants generally agreed that vertical farming could be used to solve environmental problems, reduce the price of lettuce, and improve the standard of living for future generations. They did not expect vertical farming to cause health risks but were less certain about how natural vertical farming is or whether vertical farming would produce healthier lettuce.

A Place for Vertically Farmed Produce in the Market?

As an indicator of market placement, we asked participants to identify which type(s) of stores they expected to sell vertically farmed lettuce. As shown in Figure 2, store expectations were quite different between the treatment and control groups. Participants in the control group envisioned vertically farmed lettuce being sold at a variety of stores; high-end, specialty food stores were two of the three retailers most frequently selected. For those participants who received information, however, the specialty food stores were the two least frequently selected as potential sellers of vertically farmed lettuce. Instead, supercenters such as Walmart, Meijer, and Target were most frequently selected as stores that would sell vertically farmed lettuce.

Figure 2: Proportion of Participants Who Expect a Grocery Store to Sell Vertically Farmed Lettuce



Additionally, the proportion of individuals selecting Aldi (a discount retailer) was significantly higher in the treatment group. These results indicate that consumers who are unfamiliar with the vertical farming production system view vertically farmed lettuce as a premium product that would be sold in premium stores. As consumers learn more about the production efficiencies of vertical farming, though, their perceptions may adjust such that vertically farmed produce is a low-cost product that would be sold in supercenters and other discount grocers.

In Summary

Consumers' perceptions and WTP values suggest that many individuals see vertical farming as a comparable—and perhaps acceptable—form of agricultural production. WTP for vertically farmed lettuce was similar to that of greenhouse or field-grown lettuce. In addition, consumers rated the safety and expected quality of produce from all three production systems similarly. We see this as evidence that consumers largely fail to distinguish between these agricultural production methods when purchasing lettuce. That being said, it should be noted that study participants still rated vertically farmed lettuce as significantly less natural and significantly less likely to be purchased by the average consumer than other alternatives. Thus, while vertical farming may be one marketable solution to the problem of slowing yield growth and limited food supplies in the future, producers and retailers alike need to be prepared for hesitation on the part of consumers—a common occurrence with the introduction of many new food technologies (Bieberstein et al., 2013; Grunert, Bredahl, and Scholderer, 2003; Henson, 1995; Honkanen and Verplanken, 2004; O'Connor et al., 2006; Sparks, Shepherd, and Frewer, 1994).

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Importance of Perceived "Naturalness" to the Success of Urban Farming

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Is Urban Farmed Food More "Natural"?

Urban farming is the practice of growing, processing, and distributing food within city limits (Bailkey and Nasr, 1999)—for example, community gardening in vacant lots and parks (U.S. Department of Agriculture, National Agricultural Library, 2016; University of California, Urban Agriculture, 2016). Urban farming provides many benefits to consumers and their communities, including learning how to farm and enhancing ties among people in a neighborhood (U.S. Department of Agriculture, 2016). However, for urban farming to be successful, consumers need to prefer food products sold at urban farms over those sold at more traditional shopping outlets such as grocery stores. Why might consumers prefer food from one outlet over another?

In this regard, Rozin et al. (2004) and Rozin (2006) show that consumers prefer "natural" entities and believe that naturalness influences the health value of food (Siipi, 2013). In other words, consumers feel that natural food is healthy (Rozin et al., 2004; Rozin, 2005; Saher, 2006). At the same time, they believe that urban farms offer access not only to nature but also to organic food and that products sold at urban farms provide perceived health benefits (Kolodinsky and Pelch, 1997; Armstrong, 2000). Considering this, we test whether consumers prefer urban farms as shopping outlets because they perceive urban farming to be natural. Specifically, our aim is to examine consumer preferences for produce from urban farming while considering the perceived naturalness of production methods. Given that consumers tend to believe that urban farming uses organic production methods, we also examine consumers' preferences for urban farming when organic production is perceived as natural.

Our findings are useful to farmers and marketers planning to grow and offer produce at urban farms. Knowledge about consumers who prefer food from urban farms enables stakeholders to market their products to those who are looking for them and develop target-oriented marketing and promotional activities. Our results will also allow us to identify consumers who do not yet prefer produce from urban farms but might be open to consider it when provided with more information.

Consumers Prefer "Natural"

To date, a number of food-related studies have examined the effect of "natural" on consumer willingness to pay and preferences. For example, Gifford and Bernard (2011) find that consumers are willing to pay significantly more for chicken labeled as "natural." Similarly, Lusk and Schroeder (2004) show a higher willingness to pay for beef products with a "natural" label. Umberger, Thilmany McFadden, and Smith (2009) find that consumers prefer "natural" and regionally produced beef. They point out that these preferences are caused in part by the perception of personal benefits.

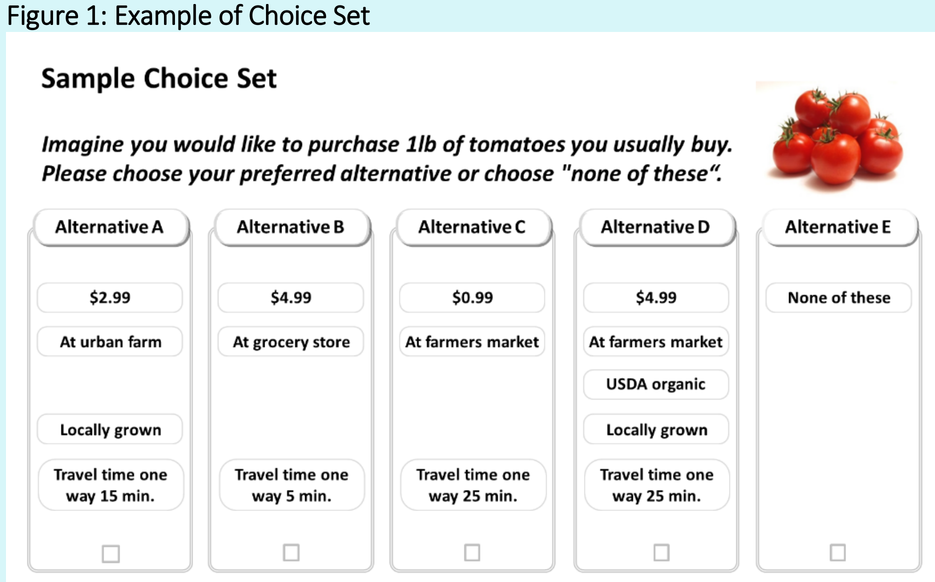
We extend the work by Umberger, Thilmany McFadden, and Smith (2009) by introducing "perceived naturalness" as a psychological construct that drives preferences for produce from various retailing outlets. In addition, we examine whether perceived naturalness influences preferences for produce from urban farms or if it is linked to organic production, since organic is often associated with a natural way of producing food (Davies, Titterington, and Cochrane, 1995; Harper and Makatouni, 2002). For example, Gifford and Bernard (2011) find a relationship between natural and organic, as do Rushing and Ruehle (2013), who state that one of the underlying reasons for increasing demand for organic and local food is the opportunity to purchase food options that are (perceived to be) more natural and healthier. Finally, given that consumers increasingly prefer locally produced food (Loureiro and Hine, 2002; Naspetti and Bodini, 2008; Costanigro et al., 2011; Meas et al., 2014), we test whether produce labeled as "local" will be preferred more by those consumers who are biased toward perceiving certain production methods as more natural compared to others.

What is Perceived Naturalness?

Most consumers prefer "natural" food that has been produced without synthetic or modified inputs (Rozin et al., 2004). This preference can be motivated by the combination of instrumental and ideational beliefs. Instrumental beliefs include the belief that natural is better because the product was not altered or created by people and because it is healthier, superior, and purer, making it safer for consumption. At the same time, ideational beliefs include the belief that natural is just better by default. Rozin (2006) suggests that the process that a certain food undergoes is the most important influencer of the judgment of naturalness. In our case, consumers might think that produce from urban farms is grown more naturally—for example, without the use of pesticides—whether that is true or not. If so, they might believe that this produce is healthier and consequently develop a preference for it. Furthermore, consumers might prefer produce from urban farms over produce sold at grocery stores because studies show an increasing uncertainty about the nutritional value of food produced by multinational firms (Adams and Salois, 2010).

Finally, an underlying reason for consumers' positive perceptions and preferences for produce from urban farming may be the "halo effect," which is a tendency to use an existing opinion about a person or an object to make additional assumptions and judgments about that person or object (Smith, Read, and López-Rodríguez, 2010). In the context of the current research, the halo effect is a process in which an initial perception about the way products are grown at urban farms (for example, being "pesticide free") affects perceptions about other attributes of the products grown and/or produced at these venues, such as their naturalness, healthiness, and freshness. Based on this, we hypothesize that produce from urban farms might benefit from a halo effect and, therefore, will be more preferred by consumers. Furthermore, we hypothesize that perceiving urban farming as natural will enhance this effect, given that Rozin (2005) found that the production process of food has the greatest influence on consumers' judgments of naturalness.

Figure 1: Example of Choice Set



Examining Consumer Preferences

To test the influence of perceived naturalness on consumer preferences for produce from urban farms, we conducted an online survey in Spring 2016 that included 173 student participants. About 45% of the respondents were female, with an average household size of three and an average household income of $48,650. In order to simulate purchase decisions, we used a choice experiment in which participants were asked to choose a product (in this case, 1 pound of tomatoes) from a set of alternatives. This allows us to determine their preferences for certain product attributes.

Our experimental design contained 36 choice sets. In order to avoid participant fatigue (Savage and Waldman 2008), we divided the choice sets into four blocks. Each participant was randomly assigned one of the blocks, so that each participant answered only nine choice sets. Each choice set asked participants to choose from among four alternatives. Participants were also provided with an option to not purchase any of the alternatives ("none-of-these").

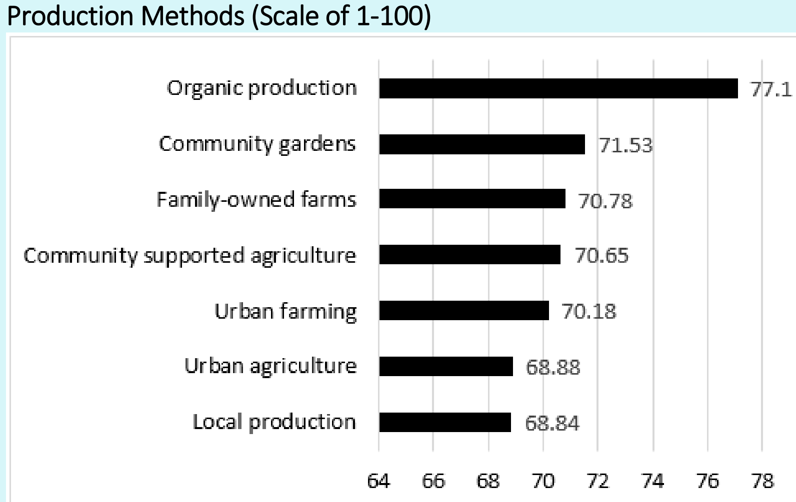
Our study included five attributes—price, local production, organic certification, retailing outlet, and distance to reach the outlet. The price attribute included three levels chosen based on current prices for fresh tomatoes. Since distance to reach the outlet is strongly related to food shopping convenience (e.g., Briesch, Chintagunta, and Fox, 2009), it was included in the study in terms of the time needed to travel to the store (but not to return from the store). A retailing outlet attribute reflected different venues where tomatoes can be purchased (grocery stores, farmers' markets, and urban farms). Finally, organic or local production labels were either present or absent on the alternatives. Since no formal definition of local food is available to consumers (Onken, Bernard, and Pesek, Jr., 2011; Meas et al., 2014), we followed Lim and Hu (2013) and did not provide participants with a definition for "locally grown," allowing them to use their own beliefs about what constitutes "local." Figure 1 provides an example choice set.

Perceived Naturalness of Production Methods

In order to measure perceived naturalness, we followed the approach used by Rozin (2005, 2006). Participants had to consider the naturalness of different ways of producing food and rate their naturalness on a scale from 0 (not natural at all, like a plastic toy model of a car) to 100 (completely natural, like a tree growing on a mountain peak that has never been visited by humans). We included seven production methods: (i) organic production, (ii) local production, (iii) community gardens, (iv) family-owned farms, (v) community supported agriculture (CSA); (vi) urban farming, and (vii) urban agriculture.

Figure 2 displays the ratings, ranging from 68 to 77, which show that local production is generally perceived to be least natural, with a mean of 68.84. Urban agriculture is rated similarly at 68.88. Urban farming, community supported agriculture, and family-owned farms all range around 70. Community gardens are perceived to be slightly more natural at 71.53. Organic production is perceived to be most natural at 77.10. These ratings are consistent with previous research that also found a high score for organic production (Rozin, 2005).

Figure 2: Consumer Perception of Naturalness of Different Production Methods (Scale of 1-100)



Perceived Naturalness Index

To further our investigation, we created a *Perceived Naturalness Index*, an average of the perceived naturalness measures for the seven different production methods equal to 71. We then split participants into two groups, with strong and weak *Perceived Naturalness*, as indicated by the index. We assume that participants with a *Perceived Naturalness Index* greater than or equal to 71 perceive tested production methods to be natural, while participants with an index of less than 71 do not perceive the tested production methods to be very natural. Similarly, using the mean of 70, we split participants into two groups based on their strong and weak perception of *urban farming being natural*. Finally, since organic production was rated as the most natural way to produce food, we split participants into two groups based on their strong and weak perception of organic production being natural. The mean of *perceived naturalness of organic production* was 77.

Does Perceived Naturalness Bias Consumer Preferences?

We use six mixed logit models to analyze the choice experiment data (for further information, see Train, 2009). The first two models we estimate investigate differences in consumer preferences based on perceived "naturalness" of various production methods (Perceived Naturalness Index). Furthermore, models three through six estimate consumer preferences based on perceived naturalness of organic production and perceived naturalness of urban farming.

A number of findings are consistent across models. For example, consumers are less likely to prefer tomatoes from an urban farm compared to tomatoes from the grocery store, but they do not have a significantly different preference for tomatoes sold at the farmers' market. This could be because consumers expect to get a better value for their money when shopping at the grocery store.

Though there are not many differences between the models based on the Perceived Naturalness Index, one substantial difference in consumer preferences becomes evident in the last four models, which compare participants' perceived naturalness of organic production and urban farming. The results suggest that consumers who strongly perceive organic production and urban farming to be natural have a significant and positive preference for local tomatoes. On the other hand, participants who weakly perceive those production methods to be natural do not differentiate between local and non-local tomatoes. One explanation for this could be that consumers who strongly perceive organic production to be natural might believe that local food possesses the benefits of organic production (Naspetti and Bodini, 2008; Onozaka, Nurse, and Thilmany McFadden, 2010). Another explanation might be that consumers who strongly perceive urban farming to be natural believe that food labeled as local comes from farms located within city limits. This seems to be supported by the fact that—even though an official USDA definition is available of what constitutes organic food—there is still no official definition of local food (Onken, Bernard, and Pesek, Jr., 2011; Meas et al., 2014).

The results also indicate that consumers have heterogeneous preferences, as suggested by significant standard deviation estimates (Hensher, Rose, and Greene, 2005). However, these preferences vary between participants with weak and strong perceptions about naturalness. Significant standard deviation estimates for urban farm and farmers' market show preference heterogeneity, with some consumers having significantly higher or significantly lower preferences for a product with these attributes, implying that taste heterogeneity exists among consumers with strong perceived naturalness, but there is no difference among consumers with weak perceived naturalness. Similarly, we find that tastes for local production differ among consumers who weakly perceive organic production or urban farming to be natural. This also holds for consumers with weak general perceptions about naturalness.

In Summary

Urban farming is the latest movement in food production, transforming vacant lots in cities into agricultural landscapes. However, for urban farming to be successful, consumers have to prefer it as a source of produce over other retail outlets. This research investigated consumer preferences for tomatoes sold at different retail outlets while considering perceived naturalness of production methods. Our findings can provide insight for farmers and marketers when developing a pricing strategy for their products or identifying their target market. More specifically, our research highlights one of the motivations for buying local food from urban farms—perceived naturalness.

What becomes evident from our results is that, on average, consumers with strong or weak perceptions about naturalness do not vary much in their preferences. However, we do find that consumers who perceive organic production and urban farming to be natural have strong preferences for local food, suggesting that urban farms might benefit greatly by catering to consumers with high interest in organic production and those who consider urban farms to be a natural way of producing food.

Future studies might investigate how perceived naturalness affects consumers' willingness to pay for local food. Also, future research could test whether consumer preferences as they relate to perceived naturalness differ between various types of local food products, such as processed and unprocessed food or produce and animal products such as dairy, eggs, and meat. Finally, future research could study how the actual retail outlet influences preferences of consumers for choosing locally produced food. This seems a promising avenue for research given that previous literature (Ellison et al., 2016a; Ellison et al., 2016b) has identified that retailing venues have a significant effect on consumer perceptions and willingness to pay for organic food.

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