UTILIZATION AND BENEFITS OF THE FARM TO SCHOOL PROGRAM IN THE UNITED STATES

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ABSTRACT

Christina Anna Chauvenet: Utilization and Benefits of the Farm to School Program in the United States
(Under the direction of Catherine Sullivan)

Approximately 60% and 90% of children in the United States age 2-18 do not meet recommendations for fruit and vegetable consumption, respectively. School meals influence dietary quality, as these programs provide up to 75% of children's daily caloric intake. These programs are particularly important for children eligible for free or reduced price (FRP) meals, as they rely more on school meals compared to children from higher income households.

F2S is an optional program for school districts that facilitates getting local food procurement and has been shown to improve school meal quality. This dissertation uses the 2015 F2S Census, a survey sent to all school districts in the United States in 2015 about their level of engagement with F2S.

In the first aim, we explored demographic predictors of any F2S participation, and number of activities among participating districts. Compared to urban school districts, suburban and rural school districts were less likely to participate in F2S (aOR 0.53, 95% CI 0.39-0.72; aOR 0.42, CI 0.30-0.57, respectively). A greater percent of FRP eligibility was associated with reduced odds of F2S participation (Z-score OR 0.74, 95% CI 0.64-0.85). State legislation significantly moderated the relationship between free and reduced price (FRP) eligibility and F2S participation. Few district demographic characteristics were significant when exploring level of F2S among participating districts.

In the second aim, we examined the association between frequency of serving local fruits and vegetables (FV) in the cafeteria and self-reported benefits (e.g. reduced food waste) of F2S among participating districts. At least one benefit of F2S participation was reported by 75% of participating F2S districts. Compared to those that did not serve local FV, districts serving local fruit have 1.77 times the odds (95% CI 1.20, 2.60) and local vegetables 3.05 times the odds (95% CI 2.05, 4.53) of reporting a benefit of F2S participation. Each benefit was analyzed individually but generally followed this trend of increased local FV service associated with greater odds of reporting benefits.

The results of this dissertation can inform outreach and technical assistance efforts, which are critical to expanding F2S and promoting equity in access to F2S programs.

This dissertation is dedicated to my friends, former colleagues, and customers at the Columbia Heights Farmers Market, who inspired me to fight for a fair local food system for all people.

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LIST OF ABBREVIATIONS

AOR	adjusted odds ratio
CI	confidence interval
CNDs	child nutrition directors
CSA	community supported agriculture
DOI	Diffusion of Innovation Theory
F2S	Farm to School Program
FINE	Farm to Institution New England
FRP	free or reduced price
FV	fruits and vegetables
HHFKA	Healthy, Hunger-Free Kids Act
IRR	incidence rate ratio
NHANES	National Health and Nutrition Examination Survey
OR	odds ratio
RF	referent group
SEM	Social Ecological Model
USDA	United States Department of Agriculture

CHAPTER 1. INTRODUCTION

1.1 Specific Aims

The 'Farm to School' movement began informally in the 1990s when an increasing number of school districts began to purchase food from local farms for school nutrition programs.[1] In 2010, the United States Department of Agriculture (USDA) established the Farm to School Program (F2S) as part of the 2010 Healthy, Hunger Free Kids Act.[2] Participation in the F2S program is optional, but participation has increased rapidly since the program's inception. According to the USDA F2S Census, 5,254 school districts in the United States participated in F2S during the 2012-2013 school year, representing 42% of school districts.[3]

F2S has been associated with an array of benefits for children in participating schools including increased accessibility to, preference for, and consumption of fruits and vegetables (FV), particularly among those with previously low intakes.[4,5] Knowledge-related outcomes include increased knowledge about agriculture, local foods, healthy foods, and increased willingness to try new foods.[6–8]

Little research has examined what predicts school district participation in F2S. This research is critical to extending benefits of F2S to children in schools across the country. Because F2S participation is a decision made generally by the school district, rather than an individual child or family, it is important to explore what school district demographic characteristics are associated with increased likelihood of participating in F2S. Improving the school food environment is an issue of health equity. Students eligible for free or reduced price (FRP) school lunch consume a greater proportion of their daily calories from the school cafeteria

compared to children not eligible for FRP lunch, so these students are disproportionately affected by the quality of school meals.[9]

One effort to increase equity in F2S has come through state legislation. In addition to the national F2S Program, 36 states have passed legislation to incentivize or support F2S participation, such as providing additional funding or creating policy councils to support programming.[10] While state farm to school laws have been associated with F2S participation at the elementary school level[11], no research has examined whether this association is similar for school districts with high and low levels of FRP eligible students, or across other key demographic characteristics.

Furthermore, the value of F2S participation may depend on the extent to which it is implemented. School districts who invest more heavily in the program by increasing the type and amount of local food they purchase may observe more benefits of participation in F2S. Yet, to the author's knowledge, no national study has explored the perceived benefits of participation from the perspective of the school district, or how breadth of participation influences them. School district administrators, typically child nutrition directors (CNDs), are the key decision makers for school nutrition programs, including F2S participation.[12] Benefits from the administrative perspective, such as reduced food waste or lower school food program costs, can help increase retention and investment in F2S programs among school districts. [13–15]

The primary objective of this dissertation is to explore to what extent school district characteristics predict participation in F2S. This dissertation also explores to what extent, if at all, state legislation moderates the association between demographic characteristics and participation in F2S. Finally, this dissertation examines the association between the amount of local FV served and perceived benefits of F2S from the perspective of school nutrition directors.

This research uses the 2015 USDA F2S Census, a nationally representative survey of CNDs (grades k-12) in the United States.

This project utilizes quantitative methods to achieve the objectives of this dissertation. Considering the importance of F2S to school nutrition, alongside the dearth of data related to both F2S participation and associated outcomes at a national level, this aims of this project are to:

Aim 1: Determine the associations between school district demographic characteristics and participation in F2S, and whether this association is moderated by state F2S legislation.

1a. Estimate the associations between school district demographic characteristics and participation in F2S. School district demographic characteristics include: percentage of students eligible for free and reduced-price school lunch; racial and ethnic school district composition; urbanicity of school district; and number of students in a district.

1b. Explore potential moderation of these associations by amount of Farm to School legislation passed by the state.

Aim 2: Among participating school districts, examine the association of amount of local fruits and vegetables served in the cafeteria and school district nutrition director perceived benefits from participation in F2S: reduced food waste, lower school meal program costs, greater acceptance of the new meal pattern, increased participation in school meals, and greater community support for school meals among participating school districts.

2a. Estimate the association between reported amount of fruits and vegetables purchased and perceived benefits of participating in F2S. Amount of fruits and vegetables served in the cafeteria is measured by self-reported frequency of these foods in the school district.

Aim 2b: Explore potential moderation of the associations between amount of fruits and vegetables served and perceived benefits of F2S participation by auxiliary F2S activities, such as school gardens and promotion of F2S.

By achieving these aims, this research adds to the limited literature of what factors predict school district participation in F2S and the perceived benefits of participation in the program.

1.2 Significance

Dietary quality is associated with a variety of chronic disease outcomes. Poor diet quality is associated with increased risk for diabetes, obesity, heart disease, and other chronic diseases. Meeting dietary guidelines for diet quality is associated with reduced risk of the aforementioned chronic diseases.[16–21] Dietary preferences and consumption patterns are developed throughout childhood and adolescence, and are predictors for dietary consumption later in the life course.[21,22]

Approximately 60% of children in the United States age 2-18 do not meet current dietary recommendations for fruit consumption, while 90% do not meet recommendations for vegetable consumption.[23] While 70% of children age 6-18 meet dietary guidelines for total grains, only 8% meet dietary recommendations for whole grains.[24] According to the Healthy Eating Index, the United States Department of Agriculture (USDA) measure that assesses Americans' eating patterns, the average child's Healthy Eating Index Score was 55.07 (with 0 being a diet that met none of the dietary recommendations and 100 being a diet that met all dietary recommendations).[25]

Because of children's poor dietary quality in the United States, a myriad of nutrition policies have focused on improving dietary intake among children.[22,26,27] Schools are among the most popular intervention settings for improving childhood dietary quality, because children in the United States nearly universally attend school until the age of 16, and thus schools have the

opportunity to reach many children through interventions such as nutrition education or cafeteria food interventions.[9,28–31] In 2010, the Healthy, Hunger-Free Kids Act (HHFKA) improved nutrition standards in schools by requiring a serving of fruits or vegetables and whole grains in school lunches, among other improvements.[2] HHFKA also created funding for environmental-level changes to school food environments, one of which was the F2S program. The F2S program was seen as a way to boost local economies and markets for local farmers while also improving the nutritional quality and taste of school meals. This section discusses the importance of children's dietary habits for short and long-term health and the role of school food environments (and particularly F2S) to children's dietary intakes. It then describes the current state of literature on F2S participation and the relevance of this study to the field of F2S.[1]

1.2A Exposure to Healthy Foods During Childhood is Critical to Healthy Dietary Habits Throughout the Lifecourse

The relationship between exposure to foods during childhood and dietary habits in adulthood has been well-documented. Current literature confirms the association between childhood exposure to foods and subsequent consumption in early adulthood and throughout the life course. [22,32–36] This relationship holds true for "healthy" foods such as fruits and vegetables (FV) and "unhealthy" foods such as sugar-sweetened beverages and candy.[32,34,37–39]

The pathway between exposure to healthy foods in childhood and consumption of foods in adulthood is mediated by childhood dietary consumption. Repeated exposure to foods in childhood is associated with increased consumption of these foods in the short-term, and can abate "neophobia", or the fear of trying new foods.[34,35,38,39] Most of the research on repeated exposure to foods in childhood has focused on FV consumption. In a sample of 360 low-income 3rd and 4th graders, Lakkakula (2010) found that repeated exposure to vegetables increased the

[1] All references cited in this study are significant at $p<.05$ unless stated otherwise.

self-reported liking scores of the majority of vegetable categories, and that liking increased through eight of nine exposures of the vegetable.[39] In a retrospective study of 670 college students, Wadhera et al (2015) found that perceived recollection of foods consumed in childhood was associated with current consumption for a wide variety of foods, including vegetables.[32]

The majority of the literature on the development of taste preference and subsequent consumption of healthy foods has focused on early childhood (preschool and elementary age children), but food preferences and consumption continue to be shaped throughout adolescence. These taste preferences in adolescence continue to shape preferences and consumption into adulthood.[34]

This pattern of food preference and consumption is best understood through the lens of life course perspective. Elder defined the "life course perspective" as "a theoretical orientation (or paradigm) that encourages the study of changing lives in changing contexts."[40(p.661)] The life course perspective has been widely applied to understand patterns of dietary intake, particularly using the concepts of critical and sensitive periods and lifespan development.[41–45] According to Halfon and Hochstein (2002), critical and sensitive periods are the "stage of the functional development when a regulatory pathway is being constructed or modified and the developing organism is particularly responsive and sensitive to favorable or unfavorable environmental factors."[46(p.450)] The difference between critical and sensitive periods is that critical periods have a closed window for intervention; for example, the first 1,000 days are critical periods for nutrition, because malnutrition may lead to irreversible effects on child growth and development.[47,48] Sensitive periods are not deterministic in that health behaviors that occur in sensitive periods may have a stronger effect at some times than others, but these health behaviors can continue to be modified throughout the life course.[49,50] Exposure to and consumption of

foods among school-age children, from elementary to high school, falls into the category of sensitive period. Food preferences and subsequent consumption during this time period have a greater effect of consumption during adulthood, but are not deterministic.

While the effect of exposure on future consumption may be higher in early childhood compared to later childhood, adolescence is still a sensitive period for taste preference, and exposure to healthy foods can help shape this subsequent consumption. For example, in a ten-year longitudinal study of 792 adolescents at baseline through early adulthood, Larson et al (2012) found that FV consumption in adolescence was significantly associated with consumption in early adulthood.[34] Likewise, Larson et al (2010) had similar findings about the association of whole-grain preference and consumption in adolescence and early adulthood.[51]

The relationship between preference development and consumption in childhood and adolescence should not be viewed in isolation. The concept of lifespan development, according to Elder, is that "human development and ageing are lifelong processes."[52(p.11)]. Thus, stages of the life course are interrelated and influence each other. Exposure and taste preference in early childhood influences dietary consumption in adolescence, but these preferences continue to be developed during adolescence and are not fixed during any phase of the life course.[53] Thus, providing exposure and access to healthy foods at school in elementary, middle, and high school settings is important for both short and long term dietary quality and associated health outcomes.

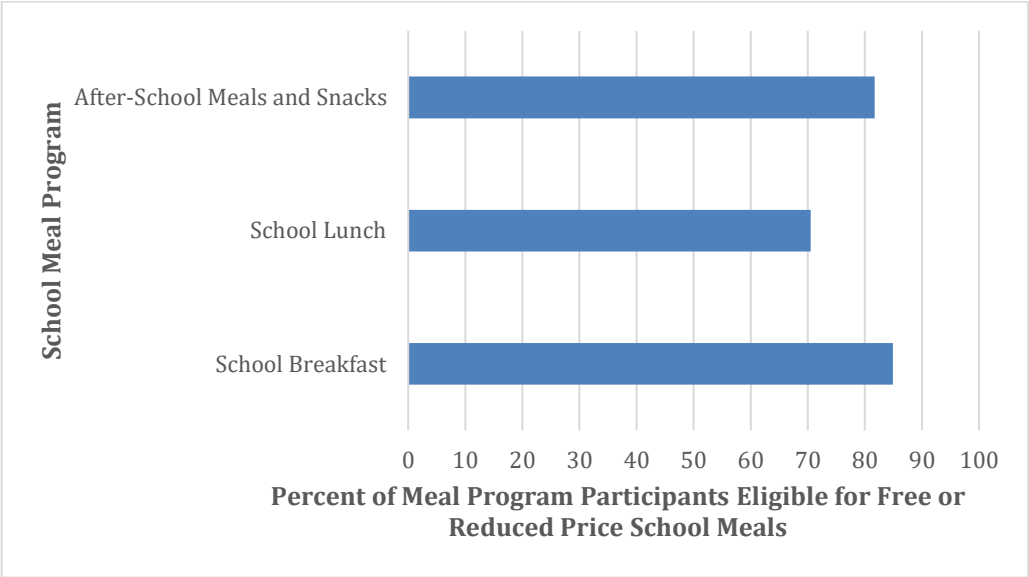
1.2B School Food Environments Provide Exposure to Healthy Foods and Influence Dietary Intake, Particularly Among Children from Low-Income Households and Households of Color

School food environments play a significant role in providing exposures to healthy foods for children. According to the National Health and Nutrition Examination Survey (NHANES), children participating in school breakfast and lunch receive approximately 25% and 33% of their daily energy intake from those meals, respectively.[54] Out of the approximately 50 million

students enrolled in public schools in the 2013-2014 school year,[55] 13.9 and 30.7 million children participated in school breakfast and lunch, respectively. Students in low-income districts may also receive a meal or snack after school as part of the at-risk afterschool meal program.[56] Approximately 3.5 million students participated in at-risk afterschool meals in the 2013-2014 school year.[57] While NHANES data is not available for the amount of calories consumed by children consuming at-risk afterschool meals, I estimate the intake to be 10% for a snack or 25% for a meal (estimated based on school breakfast intake). For students eating breakfast, lunch, and an afterschool snack or meal, approximately 68-83% of their daily caloric intake comes from school meals, while for those eating breakfast and lunch, approximately 58% of their caloric intake comes from school meals.

Given the high percentage of caloric intake that comes from school meal sources, the school food environment plays a critical role in both the diet quality and exposure to healthy foods of school age children. 51% of students enrolled in public schools are eligible for FRP school meals.[58] As shown in Figure 1.1, across school breakfast, lunch, and afterschool meals, between 70% and 85% of students participating in these programs are eligible for FRP meal.[57,59,60] Thus, students that are eligible for FRP school participate in school meal programs at a higher rate than their higher income peers.

Figure 1.1: Percent of School Meals Participants Eligible for Free or Reduced Price School Meals, 2013-2014



Source: United States Department of Agriculture Food and Nutrition Services

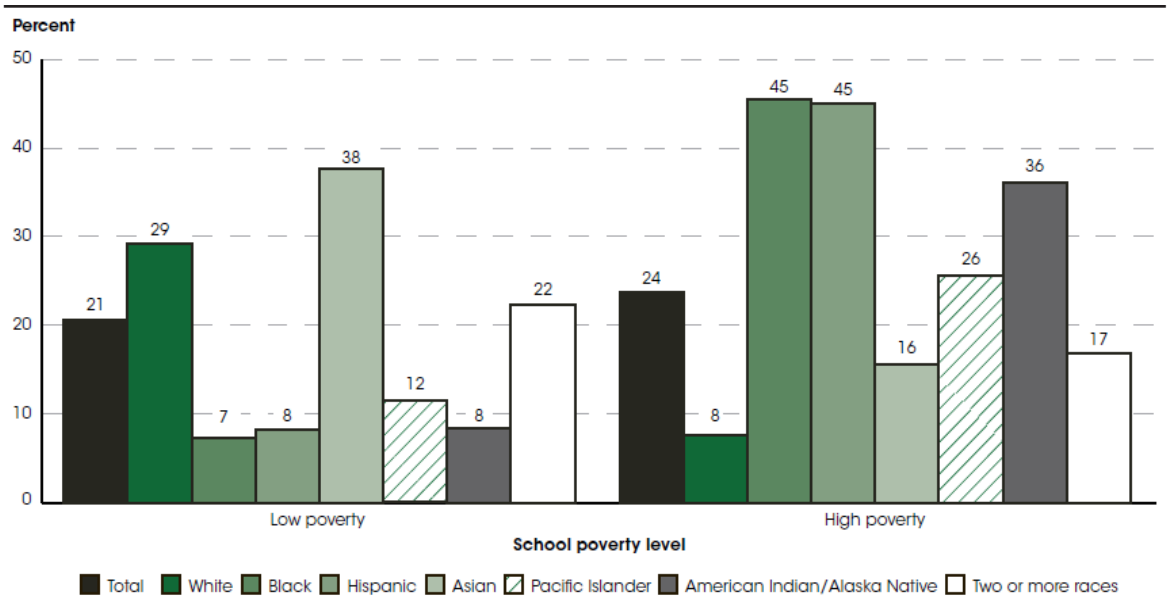
The higher proportion of children eligible for FRP lunch participating in school meals is not surprising given that low-income families rely on these programs for food security, whereas children from higher-income families may be more able to bring food from home.[61] What this proportion does indicate is that on average, lower-income students are getting a higher percentage of their calories from school meals compared to their higher-income peers. In dietary recalls of 1,542 adolescents in New England, Longacre et al (2014) explored the relationship between school food exposure and FV consumption. The authors found that among adolescents with limited to no participation in school meal programs, FV consumption was associated with household income, as measured by number of times per day that adolescents consumed fruits or vegetables. Among adolescents who were completely unexposed to school food, the number of times an adolescent consumed FV per day increased by 1.04 with each increment in household income bracket ($15,001–25,000; $25,001–35,000, etc.). For adolescents who ate 1-5 school meals per week, the number of times per day an adolescent consumed FV increased by 0.22 with

each increment in household income category. Among adolescents who consumed more than 5 school meals per week, FV consumption was not statistically significantly different.[62] These findings further support the notion that school meal programs can help increase equity in FV consumption for children across socioeconomic strata.

Furthermore, children of color are more likely to live in low-income households than white children. In 2014, 13% of white children lived in poverty, compared to 32% of Hispanic children, 36% of Native American children, and 28% of black children.[63] Thus, children of color are more likely to be eligible for free school meals and may be reliant on these meals for food security and caloric intake.

Children of color are also more likely to attend schools that are high poverty, as shown in Figure 1.2. As per the United States Department of Education, high poverty schools are schools where more than 75% of the school is eligible for FRP lunch, while low-poverty schools are schools where fewer than 25% of students are eligible for FRP school lunch.[64,65] This inequity in attendance of high-poverty schools is relevant to school meals programs because high poverty schools often serve universal meals, meaning that all students can receive free meals at school regardless of income level. Breakfast is often served in the classroom as a way to bolster participation, so nearly all students participate in these meals.[29,54,66,67] As a result, nearly all children in high-poverty schools (92% of whom are children of color) are consuming school meals, regardless of income level.

Figure 1.2: Percent of Public School Students in Low Poverty and High Poverty Schools, by Race/Ethnicity



NOTE: High-poverty schools are defined as public schools where more than 75.0 percent of the students are eligible for free or reduced-price lunch (FRPL), and low-poverty schools are defined as public schools where 25.0 percent or less of the students are eligible for FRPL. Race categories exclude persons of Hispanic ethnicity.
SOURCE: U.S. Department of Education, National Center for Education Statistics, Common Core of Data (CCD), "Public Elementary/Secondary School Universe Survey," 2012–13. See *Digest of Education Statistics 2014*, table 216.60.

Given the substantial contribution of school meal programs to child dietary intake, school food environments are critical to taste preference development and dietary consumption.[9,30,68,69] In 2010, the passage of the Healthy, Hunger Free Kids Act (HHFKA) improved school nutrition standards by requiring a serving of fruits or vegetables and whole grains in school lunches, and reduced the allowable sodium content of school meals.[2] The passage of this legislation has been associated with improved dietary quality for children in a variety of dietary categories, including increased FV and whole grain consumption. In a systematic review of the effects of HHFKA, Mansfield and Savaiano found that 14 of 19 longitudinal studies found improvements in dietary quality of students after the legislation's implementation.[70] Among the studies in the systematic review, Johnson et al (2016) was the most comprehensive in terms of exploring dietary quality as a whole.[71] Rather than focusing on a single nutritional outcome (e.g. FV, whole grains, etc.), the authors explored changes on mean dietary adequacy scores on a scale of 0 to 100, 0 being no

nutrition value and 100 being meeting all nutritional targets. The study was conducted over 31 months in 3 middle schools and 3 high schools in Washington state, before and after the implementation of the HHFKA. The authors found that mean dietary adequacy increased from 58.7 to 75.6 following the policy's implementation.[71]

The preponderance of evidence suggested that the HHFKA has created a healthier school food environment for children. Research also supports the notion that changes to cafeteria environments and providing nutrition education can further improve dietary outcomes. Cummings et al (2014) found that breakfast and lunch menu changes in Los Angeles and Cook County public schools based on recommendations by the National Academies of Medicine and the Alliance for a Healthier Generation reduced sodium and sugar consumed by students during school meals.[72] Briefel et al (2009) found that among a nationally representative sample of elementary school students, attending a school that did not offer french fries was associated with a 43 kcal reduction of consumption of low-nutrient, energy-dense foods per school day. Attending a school serving fresh fruits or raw vegetables was associated with a 36 kcal reduction of consumption of low-nutrient, energy-dense foods.[9] A systematic review by Driessen et al (2014) supported this finding, with 17 of 18 studies of school food environments revealing a positive effect of healthier school food environments with a variety of healthier food outcomes, including reduced consumption of low-nutrient, energy-dense foods, and increased consumption of FV and low-fat foods.[73]

Efforts to improve the quality and likeability of school meals have also been associated with improved dietary intake and increased school meals program participation.[71,74–77] Just, Wansick, and Hanks (2014) found that the "Chef's Move to School" initiative (also part of HHFKA) increased the appeal of menu items among high school students.[78] Chef-designed main

dishes were chosen more frequently than non-chef designed alternatives, and participation in school lunch increased by 19.3% after the chef-designed meals were included in the menu compared to before the chef-designed meals were offered.

School food environment initiatives are not universal in implementation or effectiveness. Current research indicates that comprehensive school food environment changes are more effective than single-component interventions.[30,31,73,79,80] Song et al (2016) evaluated a comprehensive school nutrition intervention in six elementary schools in Maryland over an academic year.[81] The intervention that had a cafeteria-only component (improved food presentation and promotion of healthful food choices), as well as a 'comprehensive' condition that included both the cafeteria component and nutrition education, and a control group. Students receiving the cafeteria-only intervention showed some improvements, such as ever eating fruit for lunch, which increased from 30.3% to 39.0%. The comprehensive group had improved outcomes compared to the cafeteria-only and control group in both food preferences (whole-grain noodles, fruits, and vegetables), as well as for ever eating vegetables for lunch (17.6% to 18.3%), and increased self-efficacy for FV preparation (74.1% reported that they could prepare their favorite FV at home at baseline compared to 79.8% at follow-up), while the cafeteria-only group did not have any significant results in these categories. [81] Thus, complimentary nutrition education may enhance cafeteria-based interventions to improve dietary quality.

1.2C Definition of Farm to School

As described above, over the past decade there has been a concerted effort to improve the school food environment. Many of these efforts are related to provisions of HHFKA. One of the provisions of HHFKA was the creation of the Farm to School (F2S) program. As a concept, "farm to institution" refers to the practice of sourcing local foods to serve in institutions, including schools, universities, hospitals, and other institutions.[82] During the 1990s, schools

began to increase their purchasing from local farmers. However, it became difficult to track the results of these programs since unlike the National School Lunch Program, F2S was not a formal program.[1] With the passage of HHFKA, F2S became an official program under the United States Department of Agriculture's Food and Nutrition Services Office of Community Food Systems. F2S was viewed as a 'win-win' for communities and schools, increasing the revenue of local farmers and improving the quality and freshness of school foods.[1,2,6,7]

The USDA F2S Census[3] defines F2S programs as:

> activities [that] generally center around procurement of local or regional foods and food, agriculture or nutrition-based educational activities such as but not limited to:
>
> - Serving local food products in school (meals and snacks)
> - Serving local food products in classrooms (snacks, taste tests, educational tools)
> - Conducting educational activities related to local foods such as farmers in the classroom and culinary education focused on local foods, field trips to farms, farmers' markets or food processing facilities, and educational sessions for parents and community members
> - Creating and tending school gardens (growing edible FV)

The most common activity implemented is serving local food products in schools (meals and snacks). This dissertation analyzes all aspects of farm to school (serving local food products in the classroom, educational activities, and creating and tending school gardens) as defined by the Census. This dissertation also distinguishes between any participation in F2S and the number of activities implemented (Aim 1) and the number of activities implemented as part of F2S (herein referred to as comprehensiveness of F2S programs).

Aim 2 explores the relationship between fruit and vegetable service among districts that participate in F2S and perceived benefits of F2S participation. In other words, this aim examines whether increased frequency of fruit and vegetable service is associated with an increased likelihood of reporting benefits of participation in the F2S program.

1.2D Existing Research Finds Associations Between Farm to School Participation and Improvements in School Food Environments and Child Dietary Preferences and Intake

Participation in F2S has been associated with a myriad of benefits for participating school and district food environments, which in turn is associated with improved student dietary outcomes and preferences.[6,8,83–85] Most of the research on the impact of F2S participation on school food environments has been focused on FV consumption. The majority of studies have looked at elementary age students, though some research has explored middle and high school food environments.

Relating to school food environments, F2S participation has been associated with increased access to healthy foods, particularly FV.[6,7,84,86] Bontrager et al (2014) conducted a quasi-experimental study in nine elementary schools in Wisconsin, and found that children had higher willingness to try FV after participating in F2S programs, and the availability of FV in the cafeteria increased by 6-17%.[4] Although there was no overall population change in dietary intake, there was an increase in FV consumption among children with low levels of consumption at baseline. The percentage of students reporting adequate vegetable consumption doubled from 4.3% to 8.6%, and the percentage of children consuming very low amounts of FV decreased from 56.1% to 24.8% (vegetables) and from 25.1% to 23.4% (fruits).[4] The increase in vegetable consumption over fruit consumption is not surprising given the lower level of vegetable consumption compared to fruit consumption at baseline, and given that children consume more fruits than vegetables.[23]

Most recently, Kropp et al (2017) conducted a quasi-experimental study of 6 elementary schools in Florida and found that children at schools participating in F2S consumed 37% more vegetables and 11% more fruits than they did before the program was implemented.[87] This study

used lunchtime observations and plate waste data to determine FV consumption, which may be more accurate measures than self-reported dietary recalls.

More comprehensive F2S programs (e.g. serving local foods in cafeterias and having a nutrition education program) may have a greater impact than less comprehensive interventions.[8] Evans et al (2012) evaluated a multi-component F2S intervention among middle schoolers including cafeteria, farmer visit, taste testing, and nutrition education components. The authors found that daily FV consumption increased by 0.35 servings (approximately ⅓ of an apple or its equivalent) for each additional component of the intervention received.[88]

In a slightly younger age group, Izumi et al (2015) conducted a multicomponent intervention of a cafeteria intervention and nutrition education among 226 preschoolers in Oregon, measuring willingness to try different vegetables.[71] Participants were either in a control group, a cafeteria-only F2S intervention group, or a cafeteria and nutrition education F2S intervention group. The cafeteria only-group increased willingness to try four out of the nine vegetables, while the cafeteria and nutrition education group increased their willingness to try all of the nine vegetables.[71] For example, willingness to try cabbage increased from 60% to 70% and 59% to 75% among the cafeteria-only and cafeteria plus nutrition intervention group participants, respectively.[89] This research that multi-component F2S interventions are more effective than single component interventions is consistent with broader research about healthy food consumption in elementary schools. This evidence suggests that response to F2S interventions may vary based on the dose of F2S intervention received.

1.2E Limited Research Has Explored What Types of School Districts Participate in Farm to School

Given the benefits of F2S participation on school food environments and children's dietary intake, increasing participation in F2S is important to extend these benefits to students

across the United States. Since decisions in participation in F2S are typically made at the school district level, it is important to explore what district-level characteristics are associated with F2S participation in order to identify inequities in access to these programs and potential areas for technical assistance. In the nationally representative F2S Census, 39% and 41% of school district respondents participated in F2S in waves 1 and 2, respectively.[3] Little research has explored what district-level characteristics predict participation in F2S, and much of this research has been published in grey literature.

Among peer-reviewed literature, Botkins and Roe (2018) is the most comprehensive study of F2S participation that incorporates race/ethnicity and FRP lunch eligibility. The authors use wave 1 of the F2S Census to examine likelihood of F2S participation as a dichotomous outcome (any participation in F2S versus no participation in F2S). The authors found that the percentage of Black and Hispanic students in a school district was positively associated with likelihood of F2S participation, such that a one percentage point increase in percent of Black or Hispanic students in a district was associated with a 11.3% and 15.1% higher likelihood of F2S participation, respectively, when evaluated at racial/ethnic composition means, controlling for other district level covariates.[90] The percentage of students eligible for FRP lunch in a school district was negatively associated with F2S participation. For every one percentage point increase in FRP eligibility, there was a 15.9% lower likelihood of F2S participation when evaluated at FRP eligibility means, controlling for other district level covariates. However, this relationship was only marginally significant in the adjusted model (p=.096). The authors note that the unexpected directionality of the relationship between percentage of Black or Hispanic students in a school district and F2S participation may be explained by recent efforts to increase equity in school food systems.[90]

In a study published by the USDA Economic Research Services, Ralston et al (2017) used wave 1 of the F2S Census to examine the probability of daily access to local foods based on school district demographic characteristics, and did not find FRP eligibility to be a significant predictor of F2S participation (defined in this study as a dichotomous outcome of daily serving of local foods or not), though race and ethnicity were not included as covariates.[91] Raltson et al (2017) found that large school districts (>5,000 students), urban school districts, and school districts in higher-income areas (as measured by census tract) were more likely to participate in F2S compared to smaller, lower-income, more rural districts.[91]

Some peer-reviewed studies have explored participation on a state level. Colasanti et al (2012) conducted a survey of child nutrition directors in Michigan, but the survey looked only at motivations for and barriers to F2S consumption, and did not include demographic predictors for participation in F2S.[15] Motivations for participating in F2S, which may be similar to perceived benefits, reflected several aspects of food quality; 83.9% of respondents reported that higher quality food had a "great influence" on their decision to participate in F2S, while 78.8% and 78.3% of respondents reported that access to fresher foods and a desire to increase student FV consumption was of "great influence".

District size appears to be positively associated with F2S participation. Vo and Holcomb (2011) found that district size was positively associated with participation in F2S in Oklahoma; every additional 1,000 students in a district was associated with a 2.9% increase in the probability of participating in F2S. These findings are consistent with nationally representative findings from Botkins and Roe (2017) and Ralston et al (2017).[90,91]

Based on current literature, it appears that district size is associated with F2S participation, while the relationship between FRP lunch eligibility and the racial/ethnic makeup

of a school district remains unclear. However, the measures of F2S participation that have been published have all been dichotomous, measuring any participation in F2S or serving local foods every day. Furthermore, all the research that has been conducted has been on state-specific samples or using wave 1 of the F2S Census. To the author's knowledge, no studies have explored wave 2 of the F2S Census.

1.2F State Legislation May Facilitate F2S Participation

F2S participation decisions are typically made by the child nutrition director (CND), but the policy environment surrounding the CND may also have great influence. In addition to HHFKA, individual states have implemented additional legislation around F2S. According to the National Farm to School Network, 36 states have passed legislation to incentivize or support F2S participation, such as providing additional funding or creating policy councils to support F2S programs.[92]

In a national analysis of state F2S legislation, Lyson (2016) found that state legislation was not predictive of F2S participation. However, Lyson used a dichotomous model of any existence of F2S legislation, rather than using the categories mentioned above. The author notes that since some forms of legislation may be more effective than others (e.g. unfunded F2S programs may be less effective than funded F2S programs), it may be necessary to explore the type of legislation rather than just presence of F2S legislation.[93]

Analyses that have taken into account different types of F2S legislation have found an association between the strength of legislation and F2S participation. Ralston et al (2017) found that school districts in states that had more laws that facilitated F2S participation were more likely to participate in F2S compared to school districts that had fewer laws that facilitated F2S participation.[91] In this study, the authors looked at how many different types of laws the state had

(e.g. laws to facilitate local food procurement, grants for local food procurement, statewide coordinator of F2S programs, etc.).

Nicholson et al (2014) examined the relationship between state F2S legislation and FV availability in schools, and the mediation of this relationship by school participation in F2S programs.[5] Using a nationally representative sample of 1872 elementary schools, the authors found that schools with the highest FV availability were in states with laws promoting F2S programs and in schools with F2S programs. F2S legislation was measured as having state legislation that required or encouraged F2S participation, having state legislation that facilitates local procurement, or both. Schools located in states with legislation promoting or requiring F2S programs were 9% more likely to participate in F2S compared to schools in states without such laws. In turn, having a school F2S program increased FV availability. Thirteen percent of the relationship between state F2S legislation and FV availability in schools was uniquely explained by school F2S programs. State legislation also had a direct effect on FV availability; schools in states with state F2S laws has 8% greater likelihood of offering fruits or vegetables "most or every day". This study indicates that F2S legislation increases the likelihood of F2S participation, and also has a separate effect on school food environments.

Using the same dataset as Nicholson et al, Schneider et al (2012) examined the association between state legislation around F2S and F2S participation. The authors found that schools located in states with F2S legislation had 2.45 times the likelihood of F2S participation compared to schools in states without F2S legislation.[11] The odds ratio reduced to 1.72 once the year was accounted for, and was marginally significant ($p<.10$). The authors note that the rapid rise of F2S legislation during the study period may have confounded this association; in 2007, 7.3% of school districts were located in states with F2S legislation, which rose to 20.4% in 2009.

To the author's knowledge, no studies have examined how state legislation may modify the relationship between district demographic characteristics and F2S participation. State legislation often cites socioeconomic or racial equity as a rationale for implementing F2S legislation, so this potential modification is important to understand if F2S legislation is creating more equity in school district participation.

1.2G Theoretical Frameworks: Diffusion of Innovation Theory and the Social Ecological Model

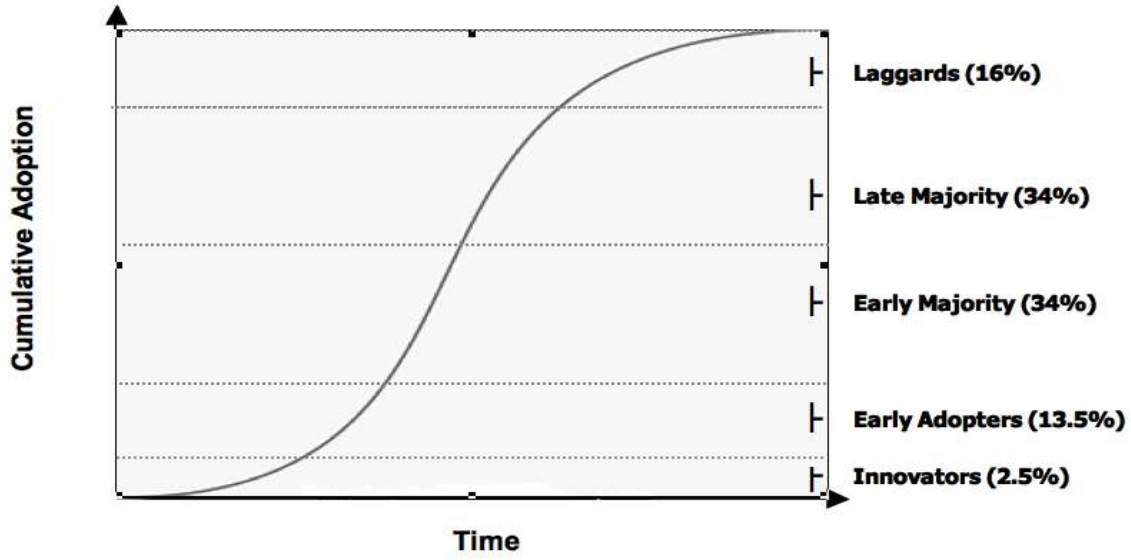
Diffusion of Innovation Theory (DOI) and the Social Ecological Model (SEM) are critical frameworks this research. DOI provides context for understanding how the innovation of F2S spreads across school districts. This theory was conceptualized primarily by Everett Rogers in the 1960s to understand how innovations of agriculture spread in the rural Midwest.[94] As defined by Rogers, diffusion is "the process by which an innovation is communicated through certain channels over time among the members of a particular social system".[94] In this dissertation, the innovation is F2S, and the channel it is communicated through is the USDA and school meal programs. The members of the social system are child nutrition directors and associated administrators who decide whether or not to adopt the F2S program.[95]

DOI notes that different innovations grow at different speeds, and a given intervention may grow at different speeds among different subpopulations. Although DOI was developed and first applied by sociologists, during the 1990s it became popular within the health sciences to understand the implementation of patient care and health policy innovations.[95–97] DOI has frequently been used to understand how innovations are implemented (or not) in organizational settings, and as such have been applied to work-based and school-based interventions.[96,98,99] For example, Haesly et al (2014) used DOI constructs as a framework for a qualitative study about the implementation of "grab and go" school breakfast programs designed to increase

participation from the school staff perspective.[100] The utility of the DOI in the school setting is that typically the decision to adopt an innovation is made by school administrators, not by the children attending a given school. The benefits of F2S participation can only reach students if F2S is implemented by their school district. Thus, it is important to not only study the effect of F2S from the student health perspective, but also what factors predict whether a school district will participate in F2S programs.

DOI suggests that innovations are adopted through a states of change type model: awareness, persuasion, decision, implementation, and confirmation. These stages are similar to the Transtheoretical Model often used in Health Behavior.[101] Rogers also notes that some innovations spread quickly and are adopted at different stages by different types of organizations or individuals, as shown in Figure 1.3.

Figure 1.3: Rogers S-Shared Diffusion Curve



It is unclear whether F2S follows this growth chart. After the passage of HHFKA in 2010, F2S participation grew to 44% of public school districts that responded to the F2S survey when wave 1 of the F2S Census was administered in 2013. This rate increased slightly to 45% in

wave 2, administered in 2015.[3] However, it is difficult to know the exact rate of growth before wave 1 of the F2S Census, because local food purchasing had been occurring informally since before the passage of HHFKA. Rogers does note that different innovations grow at different rates, but that pattern of innovation adopters (innovators, early adopters, etc.) is still helpful to understand the types of people or institutions adopting innovations at different stages .[94] According to current F2S participation as measured in wave 2, F2S is somewhere in the late stages of the 'early majority' phase of adoption. The rate of growth is also difficult to measure because of only two time points, so it may follow the S shaped curve of growth in future.

F2S is at a period of participation where many interventions face challenges; the innovators, early adopters, and early majority have already adopted the innovation, and the question is how to increase the spread of the innovation to the 55% of districts that are not currently participating. DOI provides insights on how to increase rates of adoption of innovation. "Adopter characteristics" are often predictors of the adoption of an innovation.[97] This concept underscores the importance of exploring the demographic characteristics of school districts to identify which types of school districts are more or less likely to participate in F2S.

Brownsen et al (2015) identifies six key concepts of DOI that frequently affect the rapidity of adoption of innovation: cost, relative advantage, simplicity, compatibility, observability, and trialability. Among these constructs, relative advantage and observability are particularly important to this research. *Relative advantage* refers to "the extent to which the innovation works better than that which it will displace."[97(p.308)] Also known as effectiveness, this concept indicates that the more effective an intervention is (either from an outcome or cost perspective), the quicker it will be adopted. In a systematic review, Greenhalgh et al (2004) note that unless an organization sees an advantage to adopting the innovation, they will not consider

implementing it.[96] As it relates to F2S participation, relative advantage underscores the importance of exploring the benefits of F2S participation from a child nutrition director perspective. Relative advantage refers to how well sourcing and serving local foods will work better than standard sourcing of foods in school meal programs. Because F2S exists within the structure of school meal programs, F2S must not only be beneficial to student dietary intake, but also be beneficial to the administration of the school meal programs themselves.

Related to this construct, observability refers to "the extent to which outcomes can be seen and measured."[97(p.308)] Observability refers to how long it will take the innovation to show results. As with relative advantage, observability here refers to how quickly school districts see the benefits of participating in F2S programs from the school meal program perspective. As discussed in section 1.3, these benefits have been documented as it relates to student health, but have not been well-studied from an administrative perspective. Observability is important to the sustainability of the F2S program, because child nutrition directors must be able to see the benefits to their school meal program in order to continue to participate in F2S. Observability is important from an organizational standpoint because it justifies the innovation to key stakeholders in the organization. In the F2S setting, this may mean justifying F2S programs to the district superintendent or other school administrators.

DOI notes that innovations are implemented differently by different individuals or organizations.[95,96,98,102,103] This aspect is important to F2S as F2S implementation varies widely across participating school districts. One way this dissertation allows for this breadth of F2S participation is by measuring F2S as a continuous outcome rather than as a dichotomous outcome in Aim 1. In Aim 3, this breadth of participation styles is analyzed by exploring the moderation of the association between amount of F2S participation and the perceived benefits of

F2S by type of auxiliary F2S activities implemented. F2S participation could mean only the purchase of local foods, or it could entail additional nutrition education or enrichment activities. This modeling is consistent with the DOI construct that the effect of interventions may vary based on how the intervention is implemented.

According to Brownson et al (2015), "the social system affects diffusion, especially the structure of the system, its local opinion leaders, and potential adopters' perception of social pressure to adopt [the innovation]."[97(p.307)] This further underscores the importance of child nutrition directors and their role in F2S programs, since child nutrition directors are the core part of the social system as it relates to adoption of F2S. Another aspect of the social system that may affect diffusion of F2S is state F2S legislation, which under the above definition may be considered part of the structure of the social system and/or may affect child nutrition directors' perception of social pressures to adopt F2S programming.

The complex interactions between decision makers and how innovations spread overlaps with several constructs of the Social Ecological Model (SEM). The SEM holds that individuals interact with their environment, and these interactions are dynamic; individuals both influence their environment and are influenced by their environment. In 1979, Urie Bronfenbrenner developed the first ecological model, and identified three levels of human ecology; the micro system (interactions among family and colleagues), the mesosystem (family, school, and work settings), and the exosystem (the wider economic, political, and cultural system).[104,105] McLeroy et al (1988) created an ecological model specific to health behavior with five levels: intrapersonal factors, interpersonal factors, institutional factors, community factors, and public policy.[106] Subsequent iterations of SEMs have been adapted to specific health behaviors and intervention settings. SEMs are commonly applied to school nutrition settings, since the school

food environment is a determinant of children's dietary intake, and the food environment is in constant interaction with students and the wider state and national policy environment.[107–110]

The 'Inside out' SEM by Golden, McLeroy, and colleagues (2015) is applicable to this research given that the F2S program operates within the auspice of the school meals programs, The inside out model (displayed in Figure 1.4) was created to "consider the development of health-related policies and environments within nested contexts."[107]

Figure 1.4: "Inside out" Social Ecological Model of Policy and Environmental Change

This model is applicable for this dissertation because it places policies and environments that are health promoting at the center of the model. The F2S program is an example of policy that facilitates healthy decisions. In this context, HHFKA, and its subsequent creation of the F2S program, is the policy at the inner circle.

In the next circle, Golden et al defined community as "the immediate infrastructure that identifies different policy or environmental options and chooses among them."[107(S10)] Thus, school districts represent the communities, as the school districts are the unit opting in or out of participation in the programs.

The organizational circle as it relates to F2S is the state level F2S legislation that promotes F2S adoption in a given state. Golden et al note that this circle can be made up of interest or advocacy groups that shape policies. Child health, local agriculture, and other advocacy groups are often involved in the promotion of F2S legislation that manifests itself in the creation of state legislation that strengthens F2S programs.[107]

This dissertation does not directly address the fourth circle of interpersonal connections, though such networks exist within the F2S movement, such as the National Farm To School Network, which provides technical assistance, webinars, and hosts conferences to aid in F2S implementation. The last circle, the resources and distribution of power across individuals, in this context is the equal distribution of local food across school districts. As discussed in section 1.1-1.3, the school food environment is critical to children's dietary intake and taste preference development, particularly for low-income children and children of color. As F2S has been shown to improve school food environments and improve dietary intakes for children, particularly among those with poor dietary quality, F2S is an opportunity to increase equity in the school food environment.

Golden et al's model also has feedback loops to indicate the constant interaction of these levels with one another. This interaction is true of F2S programs, where the national F2S program interacts with school districts who opt to participate (or not) in the program, and state legislation that may further promote F2S.

DOI and SEM provide complimentary theoretical frameworks to understand the factors that influence the adoption of F2S by school districts and to understand how F2S interacts with state policies and school district decisions on whether to adopt F2S.

1.3 Relevance

This dissertation addresses gaps in the literature described in the literature review. As noted in section 1.2C and 1.2D, there has been substantial research regarding the benefits of F2S participation on access to and consumption of healthy foods. However, limited research has explored what demographic factors predicts whether school districts participate in F2S programs, and thus whether these benefits are being equally distributed across demographic groups. Most of the research on F2S participation has been conducted with local or state samples rather than nationally representative samples.[15,111,112]

The two studies conducted using the F2S Census have used only wave 1 of the data.[90,91] This dissertation uses wave 2, collected in 2015. Exploring Wave 2 is critical to expanding the literature on F2S because wave 1 respondents were surveyed shortly after the formal creation of the F2S program, and level of participation and perceived benefits of those participating may change over time, as noted by DOI.

As noted in DOI and SEM frameworks, policy often interacts with decision-making at the school district level.[98,99,109,113] This dissertation explores state legislation as a moderator of the relationship between school district demographic predictors and participation in F2S.

This dissertation is the first study to use the nationally representative sample from wave 2 of the F2S Census to explore F2S participation and associated benefits of participation. The findings from this research will help to better understand what types of school districts participate in F2S, and what the expected benefits of F2S participation are from a school meal program perspective.

Aim 1 will help inform technical assistance by identifying what types of school districts are most likely to participate in F2S. This identification of school districts less likely to participate in F2S based on demographic characteristics may help inform targeted grant

opportunities for outreach to school districts not currently participating in F2S. For example, should this research find that rural school districts are less likely to participate in F2S compared to urban school districts, F2S may increase outreach to rural school districts. Because this research includes participation both as a dichotomous outcome and an ordinal measure of the number of F2S activities implemented, it may inform efforts to increase dosage of participation in F2S among those already participating. The exploration of F2S legislation as a moderator will also help inform advocacy efforts by nonprofit organizations about whether state legislation can increase equity in participation in F2S programs.

Aim 2 also has implications for program initiation and retention. Among those already participating in F2S, if benefits to the program are shown to increase as the dosage of FV increases, this could incentivize higher levels of purchasing of local FV. This aspect of increasing the sales of local foods is important to the USDA, as supporting local farmers is also a priority for the USDA. The F2S program is housed within the Office of Community Food Systems, which helps support the supply and demand sides of local food procurement within the context of federal nutrition programs. Exploring moderation of the relationship between dosage and perceived benefits based on auxiliary programs may also be helpful in order to identify if auxiliary programs enhance the effectiveness of serving local FV in schools.

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CHAPTER 2. AIM 1 MANUSCRIPT: UNDERSTANDING SCHOOL DISTRICT-LEVEL PARTICIPATION IN THE FARM TO SCHOOL PROGRAM: RESULTS FROM A NATIONAL SURVEY

2.1 Introduction

In 2010, the Healthy, Hunger-Free Kids Act (HHFKA) improved nutrition standards in schools by requiring a serving of fruits or vegetables and whole grains in school lunches.[1] HHFKA also created funding for changes to school food environments through programs like Farm to School (F2S). "Farm to institution" practices, such as sourcing local foods to serve in schools, existed prior to HHFKA, but with the passage of HHFKA, F2S became an official program under the United States Department of Agriculture (USDA) Office of Community Food Systems.[2] F2S participation may include serving local foods in schools, conducting nutrition or food education relating to local foods, and school gardening, among other activities.[2] F2S is viewed as a 'win-win' for communities and schools, increasing the revenue of local farmers, improving the quality and freshness of school foods, and providing activities related to food education and food systems knowledge. [2–5]

Implementing F2S programs has been associated with a myriad of benefits for participating school and school district food environments such as increased fruit and vegetable (FV) availability in schools, which in turn is associated with improved student dietary outcomes and preferences. [3,6–9] Given the benefits of F2S programs to school food environments and children's dietary intake, increasing participation in F2S across the United States could improve children's short and long-term dietary intake.

Participation in F2S, however, is optional for schools. Decisions about school nutrition programs, including F2S, are typically made at the school district level. The USDA surveys school nutrition directors as part of the nationally representative F2S Census to monitor participation in F2S. Research using the first wave of these data (from 2013) found early adoption of F2S participation varied by school district sociodemographic characteristics. Specifically, high prevalence of farmer's markets in a county was associated with increased likelihood of F2S participation,[10,11] and large school districts (>5,000 students), urban school districts, and higher-income districts were more likely to serve local fruits and vegetables compared to smaller, lower-income, and more rural districts.[10,13] Area racial and ethnic composition may be important predictors as well. Botkins and Roe (2018) [11] found that as the percent of Black and Hispanic students in a school district increased, so did the likelihood of F2S participation. The authors note that the unexpected directionality of the relationship between percent of Black or Hispanic students in a school district and F2S participation may be explained by recent efforts to increase equity in school food systems.[10]

Current studies of predictors of F2S participation are primarily based on the earliest observations of F2S participation and use a dichotomous measure that captures either any participation in F2S, or simply whether the district serves local foods daily. Whether new predictors have emerged as the national program becomes more established, and differences in adoption of the myriad of other activities under the umbrella of F2S, such as school gardening, have not specifically been examined.

To facilitate F2S participation, 36 states had passed legislation at the time of this survey measurement to incentivize or support F2S participation, such as providing additional funding or creating policy councils to support programming.[12] Research suggests these efforts have been

successful, at least in elementary schools, where state F2S laws have been associated with F2S participation.[13] State legislation often cites socioeconomic or racial equity as a rationale for implementing F2S legislation. Whether legislation promotes more equitable engagement with F2S by encouraging F2S participation more among school districts who need it most (e.g. children eligible for FRP meals) is unknown.

The primary aim of this study is to estimate associations of key school district demographic factors with any participation in F2S, as well as greater number of F2S activities, using the most recent wave of the F2S Census data. We also test whether these associations are stronger or weaker in states with different levels of enacted F2S legislation. Examining which district-level characteristics predict participation in F2S, and the role of state legislation in offsetting participation disparities, could highlight types of districts that would benefit from more information about F2S, legislative F2S support, and technical assistance with F2S implementation.

2.2 Methods

2.2A Participants

This study is a secondary analysis of the 2015 F2S Census. The unit of analysis for this study is the school district. [14] The F2S Census is a self-reported survey of school district child nutrition directors that assesses whether school districts participate in F2S and if so, the types of F2S activities (e.g. serving local food in meals, nutrition education, taste-testing, field trips to farms) in which the district engages. All school districts were eligible to participate, regardless of whether they participate in F2S.

2.2B Instrumentation

This study uses data from four different datasets: The F2S Census, [10] the United States Department of Education's Common Core of Data (Common Core)[16], the USDA Food

Environment Atlas (Atlas)[18], and the Farm to School Network State Legislation Survey.[12] The Common Core measures demographic and financial characteristics of school districts, while the Atlas measures aspects of the local food environment at the county level. A description of the variables is provided below, and details of measurement of these variables is provided in Appendix A. The F2S Census was first merged with the Common Core of Data using school district identification numbers. The Atlas was merged using county identifiers, and finally the Farm to School Network legislative survey was merged using state identifiers.

Dependent Variable: F2S Participation

We created two dependent variables measuring F2S participation, based on two questions from the F2S Census. A dichotomous measure of any participation was identified based on responses to a question about whether the school district participated in any type or amount of F2S in the 2013-2014 school year (the full question is available in Appendix B). The response categories included 'Yes' 'No, but started in the 2014-2015 school year' 'No, but hope to start in the future' and 'No, and no plans to start'. We collapsed these responses, with districts starting current F2S participation or initiation of F2S in the 2014-2015 school year classified as participants, since these districts were already participating in the F2S program. The latter two categories as non-participants as they had not begun participating in F2S.

School districts that participated in F2S were asked subsequent questions about what types of activities they implemented as part of their F2S program. Respondents could indicate participation in up to 24 different F2S activities, such as serving local foods in meals, integrating local foods into educational curriculum, and promotion of local foods. The full list of activities is available in Table 2.1 and was measured as a 'Check all that apply' question. To measure the amount of F2S participation, we created a count variable to capture the number of participation activities reported by the district respondent. An 'Other' category provided participants an

opportunity to describe other F2S activities; these responses were reviewed manually and were counted as an activity unless responses were invalid (e.g. stating 'No other activity'.)

Table 2.1: Summary of Activities Implemented by Districts Participating in the Farm to School Program (n=4112)

Activity	**Frequency**	**%**
Serving locally produced foods in the cafeteria	3748	91.85
Promoting locally produced foods at school in general (e.g. via cafeteria signs, posters, newsletters, etc.)	1545	37.57
Holding taste tests/cooking demonstrations of locally produced foods in the cafeteria, classroom or other school-related setting	1381	33.58
Using Smarter Lunchroom strategies to encourage student selection and consumption of locally produced foods (e.g., product placement, food prompts, creative signage, etc.)	1344	32.68
Conducting student field trips to farms or orchards	1185	28.82
Promoting local efforts through themed or branded promotions (e.g. Harvest of the Month, Local Day, Taste of Washington, etc.)	1012	24.61
Celebrating Farm to School Month	966	23.49
Conducting edible school gardening or orchard activities as part of a school curriculum	964	23.44
Serving products from school-based gardens or school-based farms in the cafeteria	941	22.88
Serving locally produced foods as a Smart Snack (a la carte, as fundraisers, etc.)	876	21.30
Serving locally produced foods or providing farm to school activities as part of afterschool programs	815	19.82
Having farmer(s) visit the cafeteria, classroom or other school-related setting	725	17.63
Holding taste tests/demos of products from school-based gardens or school-based farms in the cafeteria, classroom or other school-related setting	700	17.02
Providing training to school food service staff on farm to school or school gardens	671	16.32
Using cafeteria food coaches to promote the consumption of local foods (e.g. adults or students in the cafeteria encouraging kids to eat healthy/local foods)	649	15.78
Integrating farm to school concepts, including school gardening activities, into educational curriculum (math, science, language arts, etc.)	551	13.40

Activity	Frequency	%
Using USDA Team Nutrition materials (such as *The Great Garden Detective Adventure* or *Dig In!*) as part of taste testing or educational activities	547	13.30
Generating media coverage of local foods being used in schools (e.g. press interviews or other activities that resulted in local coverage)	509	12.38
Working with local food producers to develop a specific food product using local foods	500	12.16
Evaluating changes in student acceptance and food waste as a result of implementing farm to school activities	398	9.68
Hosting farm to school related community events (e.g. invited parents to lunch, corn shucking contests, etc.)	378	9.19
Conducting edible school gardening or orchard activities as part of an after school program	302	7.34
Implementing farm to school activities as part of overall school efforts to reduce food waste	287	6.98
Other (please specify)	25	0.61

Independent Variables

The focal independent variables for this study are demographic characteristics of the school district,[15] reported in the Common Core for the 2013-2014 school year. The number of students enrolled in all district schools measured district size. The students of color variable was measured as the percent of students in the school district identified as either a race other than white and/or of Hispanic ethnicity. Due to skewed distribution, both variables were divided into quartiles for analysis. Two variables, the percent of students eligible for FRP school lunch and percent of students in the district that were elementary age, were measured continuously. In order to make their results more easily interpretable, they were standardized and analyzed using Z scores. Urbanicity was measured using the 12-category classification used by the National Center for Education Statistics.[16] Urbanicity groups were then tested for differences between

these 12-category groups and those that were not significantly different were collapsed to create three groups: Urban, Suburban, and Rural.

Moderating Variable: State F2S Legislation

Information about state F2S legislation was obtained from the F2S Network State Legislation Survey (2017).[12] The survey listed all legislation enacted by states in 16 different categories such as funding F2S programs, promotional events, or supporting nutrition education (Table 2.2). The total amount of F2S legislation addressing each category was summed ordinally, with one point given for each piece of legislation as categorized by the F2S Network State legislative survey. In order to best reflect the full range of level of legislation passed, each category was measured ordinally. For example, if a state passed two different pieces of legislation allocating grants to F2S programs, that would result in two points. Likewise, if a single bill addressed more than one category (e.g. created grants and created a statewide F2S coordinator), it would create two points, one for each category of legislation.

The timepoint for the measurement of the legislation varied based on the category of F2S. Those that participated in the 2013-2014 school year were measured based on the level of legislation passed by the end of 2012. For those that began participating in the 2014-2015 school year or those not participating in F2S, the level of legislation was measured as legislation passed by the end of 2013. These different timepoints were estimated to best capture the legislative environment at the time the school district made the decision to participate (or not) in F2S. For districts that participated in the 2013-2014 school year, we assumed that legislation would need to be passed by the end of 2012 in order to impact decision making in the following school year. For districts beginning in 2014-2015, we allowed 2013 legislation to count in the legislative score since 2013 legislation may have impacted their decision. For those not participating in F2S,

we also assigned the 2013 legislative score, because those districts could have started as late as 2014-2015, but did not. Thus, 2013 legislation had the potential to influence these decisions.

After scores were assigned using the above method, they were divided into four ordinal groups: None, low, medium, and high levels of legislation. These categories were created using visual and descriptive inspection of the distribution of the total number of pieces of legislation passed. This categorization captures the comprehensiveness of F2S legislation in the state.

Table 2.2: Types and Definition of Farm to School (F2S) Legislation

Category of State Legislation	**Definition**
F2S Coordinator	Legislation that establishes a statewide farm to school program coordinator position.
Appropriations and Other Revenue Streams	Legislation that allocates money or creates a fund for farm to school activities
Grant Programs	Legislation that authorizes grants to support farm to school activities
Reimbursement Programs	Legislation that provides schools additional money for meal served that include local foods
Statewide F2S Programs	Legislation that establishes a farm to school program within a state agency
School Gardens	Legislation that establishes or supports school gardens
Local Preference Bills	Legislation that directs schools to purchase foods locally
Food Education	Legislation that supports food-based, agriculture-based, and garden-based educational activities for students
State Databases or Directories	Legislation that directs state agencies to track and publish the names of parties interested in participating in farm to school activities
Pilot programs	Legislation that creates a temporary F2S Program
Task forces, councils, and working groups	Legislation that Creates a task force, council, or working group to recommend, assess, or implement policies and programs that support farm to school activities
Food Hubs	Legislation that supports infrastructure development for local food aggregation, processing, and distribution

Category of State Legislation	Definition
Economic Development, Food Security, and Health Policies	Legislation that encourages farm to school activities as part of a broader state policy
Economic, Health, and Racial Equity	Legislation that lists economic, health, or racial disparities as factors motivating farm to school activities
Promotional Programs or Events	Creates a statewide program or event that celebrates F2S Activities
Resolutions	Legislation that celebrates or encourages F2S activities

Control Variables: School District Financial Information, Local Environment and Region

Additional control variables measured food service and other district related expenditures and revenue. [6] The variables are based on Common Core Data, and provided by the School Funding Financial dataset from Rutgers University.[16] Each of the variables was measured in thousands of dollars, transformed into per capita measurements by dividing the variable by the total district enrollment, and divided into quartiles for analysis. These variables were included because a district's financial status may play a role in accessing F2S programming, as cost is often reported as a barrier to participating in F2S.

Variables from the Atlas[17] measuring the number of farmer's markets, number of farms that offered direct sales to consumers, number of farms offering community supported agriculture (CSA) programs, number of farms offering agro-tourism, and the presence of a food hub were also included as control variables. These variables were measured at the county level, divided into quartiles, and merged with F2S responses and demographic data using county indicators. Variables from the Atlas are measured at different timepoints, and the most proximate year to 2013 was used for each variable (2011-2013).

The study also controlled for region where each school district was located, as defined by the USDA Office of Food and Nutrition Services definitions of regions: Mid-Atlantic, Mid-West, Mountain Plains, Northeast, Southeast, Southwest, and Western.

2.2C Data Analysis

Analytic Sample

The analytic sample is based on observations in Wave 2 of the F2S Census. The F2S Census was sent to all public school districts, charter schools, and private schools in the United States and territories in 2015. There were 12,584 respondents to Wave 2. Given substantial differences in provision of meal programs and school district management, private and charter schools (n=2,524), state-operated institutions, regional education service agencies, or supervisory unions (n=175), as well as districts from U.S. territories (n=3) were excluded from analyses. Some responses could not be used (n=491) because of errors in entering district names that meant they could not be matched to demographic data and/or ineligible respondents (e.g. individual schools responding instead of school districts or duplicate entries). Listwise deletion was used for observations that had missing values on independent or control variables (n=410). All other variables had low levels of missingness (5% or less).

For the negative binomial model, observations were dropped if they indicated they participated in F2S but had missing values on the number of activities implemented (n=193). The final analytic sample of 8,966 observations represents approximately 68.6% of public school districts in the United States.

Analytic Methods

All statistical analyses were performed in Stata 14 (version 14, Statacorp LLC).[18] To examine associations of demographic characteristics and any F2S participation, we used logistic regression. A separate negative binomial model was used to assess predictors of the number of

F2S activities among districts participating in F2S. For both sets of analyses, hierarchical model building was used. Four groups of control and independent variables were created based on contextual similarity. Each group was regressed on F2S participation, moving from most distal control variables to independent variables. Starting with the local food environment, each subsequent regression was examined via post estimation goodness of fit tests to see whether the addition of that group of variables improved the model fit. The three groups of variables described above (local food environment, school district financial variables, and demographics) each improved goodness of fit and were kept in the final model. Another group, farm acreage measures, was not included because it did not improve model fit or explain additional variance compared to the local food environment variables.

Interaction of associations between demographic characteristics and F2S participation by state F2S legislation was tested using the process described by Hayes.[19] A full 'null' model was estimated including all independent variables, moderators, and control variables. Then, interactions between the state legislation and the focal independent variables (percent of students eligible for FRP meals, percent of elementary school students, urbanicity, school district size, and percent of students of color) were added. A likelihood-ratio test found the entire group of interactions to be significant ($p<.05$) in the logistic regression, but not for the negative binomial model. For the logistic regression, we then performed likelihood ratio tests on individual interaction terms and removed nonsignificant terms. In both models, nonsignificant control variables were dropped from the final models reported here. After estimation, tests were performed to examine differences in predicted probabilities between quartiles of students of color at each level of legislation (e.g. among districts with no legislation, differences were tested between each quartile of students of color).

2.3 Results

Descriptive statistics for the dependent, independent, and moderator variables are displayed in Table 2.3. Overall, 46% of school districts in this study participated in F2S. Among participating districts, the mean number of activities implemented was 5.39, with a range of 1-23. The most common activity was serving local food in school meals (92%), promoting locally sourced food (38%), and holding taste tests or cooking demonstrations (34%). Participating districts had a lower mean FRP eligibility (46%) compared to nonparticipants (50%). Participating districts were also more urban or suburban and were larger in school district size compared to non-participants that were more rural and had a smaller district size.

Table 2.3: Demographic Characteristics of Public School Districts Participating in the Farm to School Census in 2015 by Participation in Farm to School (N=8,966)[2]

School District Characteristics			**Values**			
	All		**Participating in Farm to School**		**Not Participating in Farm to School**	
	8,966 (100%)		4,112 (45.86%)		4,854 (54.14%)	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Percent of Students Eligible for Free and Reduced Price School Lunch^	48.22	21.19	46.04	21.77	50.08	20.51
Percent of Elementary School Students^	48.94	11.99	48.69	11.68	49.15	12.23
Percent of Students of Color*	27.18	26.19	28.4	26.37	26.15	25.99
Number of Students*	4077.25	14115.84	5945.22	19295.82	2494.83	6872.18
Urbanicity+	**N**	**%**	**n**	**%**	**N**	**%**
Large city	131	1.46	94	2.29	37	0.76
Midsize city	123	1.37	86	2.09	37	0.76
Small city	307	3.42	199	4.84	108	2.22
Large suburb	1591	17.74	902	21.94	689	14.19
Medium suburb	250	2.79	158	3.84	92	1.9
Small suburb	185	2.06	103	2.5	82	1.69
Fringe town	401	4.47	215	5.2	187	3.85
Distant town	812	9.06	413	10.04	399	8.22
Remote town	599	6.68	246	5.98	353	7.27
Rural fringe	1064	11.87	515	12.52	541	11.31
Distant rural	2100	23.42	751	18.26	1349	27.79
Rural remote	1403	15.65	431	10.48	972	20.02
Region						
Mid atlantic	844	9.41	469	11.41	375	7.73
Mountain plains	1628	18.16	536	13.04	1902	22.5
Midwest	2314	25.81	992	24.12	1322	27.24

[2]*These variables were highly skewed in distribution and could not be transformed. Thus, they were categorized into 4 quartiles for analysis.

+ This represents the original measurement of the variable in the Common Core of Data. Categories were later collapsed into 3 categories after testing for differences between categories post model-estimation. When categories were not significantly different at $p<.05$, they were combined. The new categories were slightly different for the two models. For the logistic model, the categories are: Urban, Suburban, and Rural. For the negative binomial, distant town could not be combined with other categories and so categories were: Urban, suburban, distant town, and rural.

^This variable was standardized for analysis

School District Characteristics			Values			
	All		Participating in Farm to School		Not Participating in Farm to School	
	8,966 (100%)		4,112 (45.86%)		4,854 (54.14%)	
	Mean	SD	Mean	SD	Mean	SD
Northeast	973	10.85	696	16.93	277	5.71
Southeast	829	9.25	464	11.28	365	7.52
Southwest	1199	13.37	319	7.76	880	18.13
Western	1179	13.15	636	15.47	543	11.19
Level of State Legislation Where School District is Located						
No legislation	1901	21.20	787	19.14	1114	22.95
Low level of legislation	2479	27.85	1195	29.06	1302	26.82
Medium level of legislation	2822	31.87	1197	29.11	1625	33.48
High level of legislation	1746	19.47	933	22.69	813	16.75
Number of Farm to School Activities Implemented By School District	--		5.39	4.21	--	

2.3A Logistic Regression Results

Table 2.4 contains the results of the logistic regression estimating the association of demographic characteristics with any participation in F2S. Unadjusted odds ratios (OR) and 95% confidence intervals (CIs) are presented in column 1. Model 1 presents the full logistic regression with the level of state legislation as an independent variable. Model 2 is the final model, and presents the results when legislation is modeled as a moderator for percent of students eligible for FRP and quartiles of students of color in the district (other independent variables were tested for interactions with legislation and were not found to be significant).

Table 2.4: Odds Ratios of Demographic Characteristics Associated with Any Farm to School Participation (n=8,966)

Variable	Unadjusted Odds Ratios	Model 1 Adjusted Odds Ratios (Logistic Regression without Interaction Terms)	Model 2 Adjusted Odds Ratios (Logistic Regression Including Interaction Terms)
	Odds Ratio (95% Confidence Interval)	Odds ratio (95% Confidence Interval)	Odds ratio (95% Confidence Interval)
Level of State Legislation			
No legislation	RF	RF	RF
Low level of legislation	1.29 (1.15, 1.47)***	1.01 (0.86, 1.18)	0.99 (.73, 1.34)
Medium level of legislation	1.04 (0.93, 1.17)	0.88 (0.77, 1.01)	0.76 (.61, .96)*
High level of legislation	1.62 (1.42, 1.85)***	0.62 (0.50, 0.76)***	0.49 (.34, .72)***
Free and Reduced Price Lunch Eligibility+	0.82 (0.79, 0.86)***	0.85 (0.77, 0.94)**	0.74 (.64, .85)***
Interaction (Free and Reduced Price Lunch Eligibility*State Legislation)			
No legislation	RF	RF	RF
Low level of legislation	--	--	1.03 (.87, 1.22)
Medium level of legislation	--	--	1.05 (.89, 1.24)
High level of legislation	--	--	1.30 (1.09, 1.55)**
Quartiles of Percent of Students of Color in District			
1st Quartile	RF	RF	RF
2nd Quartile	1.02 (0.91, 1.15)	1.15 (1.01, 1.31)*	0.94 (.74, 1.20)
3rd Quartile	0.98 (0.87, 1.10)	1.21 (1.05, 1.41)*	1.21 (0.91, 1.61)
4th Quartile	0.73 (0.65, 0.82)*	1.28 (1.06, 1.53)**	1.16 (0.80, 1.70)
Interaction (Quartiles of Students of Color*State Legislation)			
1st Quartile#No legislation	RF	RF	RF
2nd Quartile#Low level of legislation	--	--	1.00 (0.69, 1.46)
3rd Quartile#Low level of legislation	--	--	0.82 (0.54, 1.22)
4th Quartile#Low level of legislation	--	--	1.12 (0.69, 1.82)
2nd Quartile#Medium level of legislation	--	--	1.67 (1.21, 2.29)**
3rd Quartile#Medium level of legislation	--	--	1.04 (0.73, 1.49)
4th Quartile#Medium level of legislation	--	--	0.93 (0.59, 1.46)

Variable	Unadjusted Odds Ratios	Model 1 Adjusted Odds Ratios (Logistic Regression without Interaction Terms)	Model 2 Adjusted Odds Ratios (Logistic Regression Including Interaction Terms)
	Odds Ratio (95% Confidence Interval)	Odds ratio (95% Confidence Interval)	Odds ratio (95% Confidence Interval)
2nd Quartile#High level of legislation	--	--	1.21 (0.77, 1.87)
3rd Quartile#High level of legislation	--	--	1.40 (0.88, 2.22)
4th Quartile#High level of legislation	--	--	1.39 (0.83, 2.34)
Region Where School District is Located#			
Northeast	RF	RF	RF
Mid Atlantic	0.50 (0.41, 0.60)***	0.44 (0.35, 0.57)***	0.39 (0.30, 0.51)***
Mountain Plains	0.20 (0.17, 0.24)***	0.31 (0.25, 0.38)***	0.26 (0.21, 0.34)**
Midwest	0.30 (0.25, 0.35)***	0.35 (0.28, 0.43)***	0.30 (0.23, 0.38)***
Southeast	0.49 (0.41, 0.60)***	0.47 (0.36, 0.62)***	0.43 (0.33, 0.57)***
Southwest	0.14 (0.12, 0.17)***	0.20 (0.16, 0.27)***	0.18 (0.14, 0.24)***
Western	0.47 (0.40, 0.57)***	0.63 (0.50, 0.78)***	0.49 (0.38, 0.63)***
Quartiles of Size of School District in Number of Students			
2nd Quartile	1.37 (1.21, 1.55)***	1.33 (1.15, 1.53)***	1.35 (1.17, 1.56)***
3rd Quartile	2.31 (2.04, 2.61)***	2.00 (1.70, 2.35)***	2.04 (1.74, 2.40)***
4th Quartile	3.88 (3.42, 4.40)***	3.41 (2.83, 4.11)***	3.46 (2.88, 4.16)***
Urbanicity of District			
Urban	RF	RF	RF
Suburban/Populous Rural	0.53 (0.40, 0.69)***	0.54 (0.40, 0.72)***	0.53 (0.39, 0.72)***
Rural	0.25 (0.19, 0.33)***	0.41 (0.30, 0.57)***	0.42 (0.30, 0.57)***
Percent of Elementary Students+	0.96 (0.92, 1.00)	1.05 (1.00, 1.10)*	1.05 (0.99, 1.07)
Quartiles of Food Expenditure Per Capita			
1st Quartile	RF	RF	RF
2nd Quartile	0.90 (0.79, 1.00)*	1.20 (1.04, 1.39)*	1.15 (1.00, 1.32)*
3rd Quartile	0.80 (0.72, 0.90)***	1.41 (1.20, 1.67)***	1.34 (1.15, 1.57)***
4th Quartile	0.66 (0.58, 0.74)***	1.54 (1.27, 1.87)***	1.45 (1.22, 1.73)***

Variable	Unadjusted Odds Ratios	Model 1 Adjusted Odds Ratios (Logistic Regression without Interaction Terms)	Model 2 Adjusted Odds Ratios (Logistic Regression Including Interaction Terms)
	Odds Ratio (95% Confidence Interval)	Odds ratio (95% Confidence Interval)	Odds ratio (95% Confidence Interval)
Quartiles of Revenue from School Lunch Per Capita			
1st Quartile	RF	RF	RF
2nd Quartile	0.94 (0.83, 1.06)	1.17 (1.02, 1.34)*	1.19 (1.03, 1.37)*
3rd Quartile	1.16 (1.03, 1.31)*	1.19 (1.12, 1.49)***	1.33 (1.15, 1.53)***
4th Quartile	1.53 (1.36, 1.72)***	1.56 (1.35, 1.81)***	1.53 (1.32, 1.77)***
Quartiles of Farm to Consumer Direct Sales in the County Per Capita			
1st Quartile	RF	RF	RF
2nd Quartile	0.82 (0.72, 0.92)**	0.90 (0.78, 1.04)	0.91 (0.79, 1.05)
3rd Quartile	0.97 (0.86, 1.09)	1.02 (0.87, 1.19)	1.01 (0.86, 1.18)
4th Quartile	1.49 (1.32, 1.67)***	1.42 (1.19, 1.70)***	1.36 (1.14, 1.63)***
Quartiles of Farms Offering Community Supported Agriculture Per Capita			
1st Quartile	RF	RF	RF
2nd Quartile	1.61 (1.43, 1.81)***	1.15 (0.99, 1.32)	1.13 (0.98, 1.31)
3rd Quartile	1.56 (1.38, 1.76)***	1.23 (1.06, 1.43)**	1.21 (1.05, 1.41)**
4th Quartile	1.39 (1.23, 1.56)***	1.23 (1.05, 1.44)*	1.21 (1.04, 1.42)*
Quartiles of Farms Offering Agro-Tourism Per Capita			
1st Quartile	RF	RF	RF
2nd Quartile	0.97 (0.86, 1.09)	1.01 (0.87, 1.16)	1.00 (0.87, 1.16)
3rd Quartile	0.99 (0.88, 1.12)	1.14 (0.98, 1.34)	1.15 (0.98, 1.35)
4th Quartile	0.62 (0.55, 0.70)***	1.20 (1.01, 1.43)*	1.21 (1.02, 1.44)**
Quartiles of Farmers Markets in County Per Capita			
1st Quartile	RF	RF	RF
2nd Quartile	1.61 (1.43, 1.81)***	1.02 (0.89, 1.18)	1.04 (0.90, 1.20)
3rd Quartile	1.82 (1.61, 2.04)***	1.25 (1.08, 1.45)**	1.24 (1.07, 1.43)**
4th Quartile	1.46 (1.30, 1.65)***	1.30 (1.12, 1.51)**	1.27 (1.10, 1.48)**

Variable	Unadjusted Odds Ratios	Model 1 Adjusted Odds Ratios (Logistic Regression without Interaction Terms)	Model 2 Adjusted Odds Ratios (Logistic Regression Including Interaction Terms)
	Odds Ratio (95% Confidence Interval)	Odds ratio (95% Confidence Interval)	Odds ratio (95% Confidence Interval)
Presence of a Food Hub in County			
Food Hub in County^	2.09 (1.83, 2.40)***	1.25 (1.07, 1.47)**	1.27 (2.08, 1.48)**
Model Pseudo R2	N/A	0.11***	0.11***

+ Continuous variables were standardized, so the odds ratio represents the effect of a one Z score increase in the independent variable

^ This variable is binary, so odds ratio represents the odds ratio of having a food hub to not having a food hub

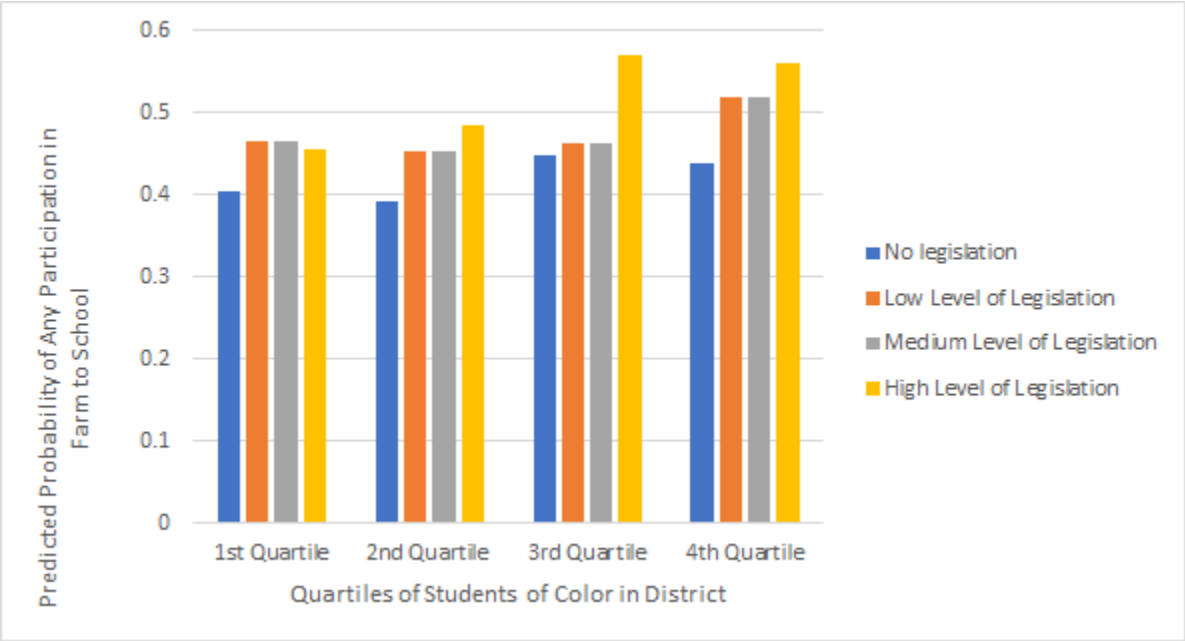
RF=referent group

Some covariates were included in initial models but were dropped from the final model because they were not significant and did not improve model fit. These variables include: Total school district expenditure per student, school food service revenue per student, and Title 1 revenue per student.

Unadjusted ORs show that districts located in states with low or high levels of legislation are associated with higher odds of participating in F2S compared to districts in states with no legislation. This relationship reverses once other variables are included in Model 1, with higher levels of legislation associated with lower odds of participating in F2S.

Figures 2.1 and 2.2 illustrate interactions between legislation and demographic characteristics. Figure 2.1 presents the change in the predicted probabilities of F2S participation for each quartile of students of color in school district based on level of F2S legislation. In states with no F2S legislation, the ORs for the quartiles of students of color as a predictor are not significantly different from the reference group (lowest quartile). Among districts located in states with at least some legislation, however, the odds of F2S participation are generally higher in districts in quartiles representing a higher proportion of students of color.

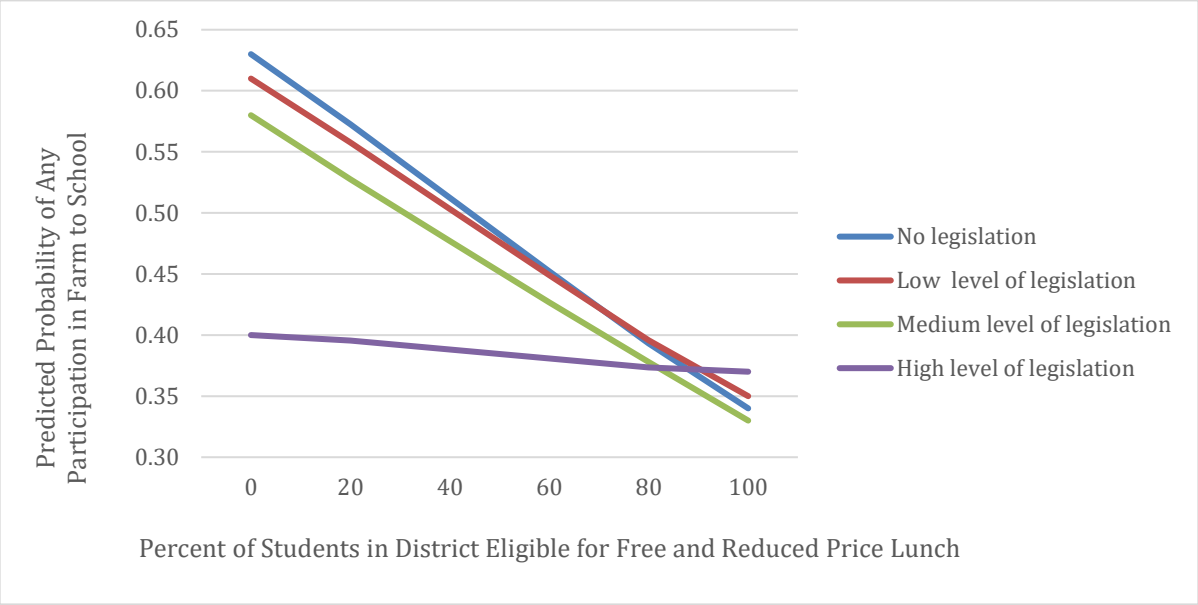
Figure 2.1: Conditional Effects of Legislation on the Predicted Probability of Any Farm to School Participation Based on Quartiles of Students of Color in School District



Among districts in states with no, low, or high levels of legislation, however, there were no significant differences in predicted probabilities of F2S participation across quartiles of students of color, indicating that legislation did not moderate the relationship between quartiles of students of color and likelihood of F2S participation in these legislative categories.

FRP eligibility was measured with a continuous, standardized variable. Thus, the OR of 0.74 (CI 0.64-0.85, $p<.001$) represents the change in odds of participating in F2S for an approximately 20% increase in the percent of students eligible for FRP meals. Figure 2.2 presents the predicted probabilities of participating in F2S across levels of FRP eligibility, with four different slopes illustrating these associations under different legislation contexts. Post-hoc tests of each category of legislation showed that the slopes of no, low, and medium levels of legislation were not different from each other; in all cases, greater FRP eligibility was associated with lower odds of F2S participation.

Figure 2.2: Conditional Effects of Legislation on Predicted Probability of Any Farm to School Participation Based on Percent on School District Students Eligible for Free and Reduced Price Lunch



The slope for high legislation was significantly different from each of the other categories, but not significantly different from zero. In other words, in districts located in states with high levels of legislation, FRP was not significantly associated with F2S participation. In Model 2, suburban and rural school districts had 0.53 and 0.25 times the odds of participating in F2S compared to urban school districts, respectively ($p<.001$). Compared to the lowest quartile of school district size, the odds of participating in F2S across quartiles of size of school district increased ordinally (OR, 1.35, 2.05, and 3.46, respectively, $p<.001$).

2.3B Negative Binomial Regression Results: Number of F2S Activities Implemented

The results of the negative binomial regression on the number of F2S activities implemented among participating districts is presented in Table 2.5. The focal independent variables in this model are the same as the logistic regression. There are fewer covariates in the negative binomial models because fewer covariates were significant in the negative binomial regression. The results are presented using incidence rate ratios (IRRs), which have similar

interpretability as ORs, but are appropriate for count models. In this case, the "incident" is a F2S activity.

Table 2.5: Incident Rate Ratios of Demographic Characteristics Associated with Number of Farm to School Activities Among Participating School Districts (n=3919)

Variable	**Unadjusted Incident Rate Ratios**	**Model 1 Adjusted Incidence Rate Ratios (Logistic Regression without Interaction Terms)**
	Unadjusted Incident Rate Ratio (95% Confidence Interval)	Incident Rate Ratio (95% Confidence Interval)
Level of State Legislation		
No legislation	RF	RF
Low level of legislation	1.21 (1.13, 1.29)***	1.16 (1.06, 1.26)**
Medium level of legislation	1.12 (1.04, 1.20)**	1.11 (1.04, 1.19)**
High level of legislation	1.30 (1.21, 1.40)***	1.20 (1.09, 1.33)***
Free and Reduced Price Lunch Eligibility+	1.01 (0.98, 1.03)	0.94 (0.90, 0.99)*
Quartiles of Percent of 1st Students of Color in District		
2nd Quartile	1.07 (1.00, 1.14)	1.03 (0.96, 1.11)
3rd Quartile	1.15 (1.08, 1.23)***	1.09 (1.01, 1.18)*
4th Quartile	1.19 (1.11, 1.28)***	1.07 (0.97, 1.17)
Region Where School District is Located		
Mid-atlantic	RF	RF
Mountain Plains	0.88 (0.80, 0.97)**	1.07 (0.95, 1.19)
Midwest	0.90 (0.83, 0.98)*	1.05 (0.95, 1.14)
Northeast	1.15 (1.06, 1.26)**	0.92 (0.82, 1.03)
Southeast	1.02 (0.92, 1.12)	0.96 (0.85, 1.08)
Southwest	0.78 (0.70, 0.87)***	1.01 (0.87, 1.17)
Western	1.12 (1.02, 1.22)*	1.04 (0.91, 1.18)
Quartiles of Size of School District in Number of Students		
1st Quartile	RF	RF
2 Quartile	1.03 (0.95, 1.12)	1.02 (0.94, 1.11)
3rd Quartile	1.09 (1.01, 1.17)*	0.98 (0.89, 1.07)
4th Quartile	1.25 (1.16, 1.34)***	0.95 (0.85, 1.07)

Variable	Unadjusted Incident Rate Ratios	Model 1 Adjusted Incidence Rate Ratios (Logistic Regression without Interaction Terms)
	Unadjusted Incident Rate Ratio (95% Confidence Interval)	Incident Rate Ratio (95% Confidence Interval)
Urbanicity of School District		
Urban	RF	RF
Suburb	0.79 (0.73, 0.86)***	0.89 (0.82, 0.98)**
Distant Town^	0.70 (0.63, 0.78)***	0.82 (0.73, 0.91)**
Remote Town or Rural	0.74 (0.68, 0.80)***	0.97 (0.88, 1.07)
Percent of Elementary Students in School District+	1.03 (1.01, 1.06)	0.97 (0.92, 1.01)
Quartiles of Total School District Expenditure		
1st Quartile	RF	RF
2nd Quartile	1.05 (0.98, 1.13)	1.05 (0.98, 1.13)
3rd Quartile	1.13 (1.06, 1.21)***	1.10 (1.03, 1.23)**
4th Quartile	1.14 (1.06, 1.21)***	1.04 (0.95, 1.14)
Quartiles of Revenue from School Food Service Per Capita		
1st Quartile	RF	RF
2nd Quartile	1.04 (0.97, 1.11)	1.10 (1.02, 1.18)**
3rd Quartile	1.02 (0.95, 1.09)	1.13 (1.06, 1.28)**
4th Quartile	1.11 (1.04, 1.19)**	1.24 (1.10, 1.40)***
Prediction from Logistic Model		3.13 (2.38, 4.13)***
Model Pseudo R2	N/A	0.01***

+ Continuous variables were standardized, so the odds ratio represents the effect of a one Z score increase in the independent variable
RF=referent group
^ Distant town is defined as a territory inside an urban cluster that is more than 10 miles and less than or equal to 35 miles from an urbanized area
Some covariates were included in initial models but were dropped from the final model because they were not significant and did not improve model fit. These variables include: Total school lunch revenue per student, school food service expenditure per student, and Title 1 revenue per student.

Level of state legislation was included as an independent variable in final models and was found to be significantly associated with higher activities implemented as part of F2S (IRRs of 1.16, 1.11, and 1.20 for low, medium, and high levels of legislation ($p<.01$). Independent variables significantly associated with the number of F2S activities were: percent of students eligible for FRP, urbanicity, and quartiles of students of color. However, the magnitude of these relationships was small; a one z-score increase in FRP eligibility was associated with 0.94 times (CI 0.90-0.99, $p<.05$) the number of F2S activities. Being in a suburban or distant town setting was associated with 0.89 and .082 times the F2S activities, respectfully, compared to urban districts ($CI_{suburban}$ 0.82-0.98, CI_{town} 0.73-0.91, $p<.01$). Rural districts did not have a significantly different IRR compared to urban districts.

The 3rd quartile of students of color was associated with a slightly higher rate of activities (IRR 1.09, CI 1.01-1.18, $p<.05$) compared to the 1st quartile, but the 2nd and 4th quartiles were not significant. Moderation of independent variables by state legislation was tested but no interaction effects were found to be significant.

2.4 Discussion

The results from this study identify key school district demographic characteristics associated with participation in the F2S program. To the authors' knowledge, this study was the first to use the 2015 F2S Census to explore F2S participation. This study adds to the current literature by exploring how state legislation affects demographic characteristics' association with F2S participation.

The pattern of moderation of the relationship between quartiles of students of color and F2S participation by state legislation is unclear. The medium level of legislation is the only category that showed significantly different likelihood of participating in F2S based on quartiles of students of color. While there seems to be a visual pattern (See Figure 2.1) of higher predicted

probability of F2S participation when districts were in states with medium or high level of legislation, these differences were not statistically significant. Furthermore, as a direct predictor, more legislation was associated with greater odds of F2S participation in unadjusted models, but with lower odds of F2S participation once other demographic variables were included. This finding suggests that there may be other factors occurring at the state level that also influence F2S characteristics. Future research should explore multilevel modelling approaches to F2S participation in order to examine these other state-level influences on F2S participation.

As shown in Figure 2.2, for districts in states with no, low, or medium levels of legislation, increasing FRP eligibility was associated with a decrease in predicted probability of F2S participation. This pattern of decreased likelihood of participation in F2S as FRP eligibility increases is not surprising. F2S is an optional program, and it may be more accessible to higher income school districts with more resources to devote to school food programming. This relationship disappears when school districts are in states with high levels of legislation; these districts do not have differential predicted probabilities as FRP eligibility increases. This suggests that legislation might have an equalizing effect. However, the predicted probability for districts in states with high levels of legislation is *lower* than it is in states with less legislation for each level of FRP eligibility, except when FRP eligibility nears 100%. This finding is contrary to the hypothesis that legislation would function as a stimulant for F2S participation.

We might be observing a relationship due to reverse causation such that states pass more legislation when F2S participation levels are low, while states that have higher levels of participation do not need to pass legislation to incentivize F2S participation. Our cross-sectional study design does not allow for an examination of the temporality of the legislation and F2S participation. Temporality is particularly important since there was an increase in F2S legislation

around 2010.[12] It is possible that while F2S legislation has been passed, not enough time has passed to allow this legislation to affect participation rates. Future research should examine the passage of legislation and trends in F2S participation after F2S legislation has had more time to exert possible influences on school districts.

It is also possible that our F2S legislation variable did not capture policy nuances that may be important predictors. This study summed pieces of any F2S legislation passed to create the level of legislation variable. There is a breadth of type of F2S legislation, as visible in Table 2.2. Some types of legislation may be more effective than others in promoting F2S. Furthermore, this study used the F2S Network State Legislation Survey for analysis. This report did not contain city or county legislation around F2S, which could also be influencing F2S participation. This information is not nationally available and is difficult to track. However, creating such a database may provide a clearer picture of the role of different levels of legislation on F2S participation. Further research may also explore a different conceptualization of legislation (e.g. type of legislation rather than amount) to see if another definition offers additional explanation of how legislation affects participation in F2S.

We believe there may be an alternative explanation to our results relating to legislation due to our differing results in bivariate and adjusted models. We observed a positive relationship in the bivariate analysis of F2S legislation and F2S participation in unadjusted odds ratios; school districts in states with high levels of legislation were more likely to participate in F2S (AOR 1.62 (95% CI 1.42, 1.85). This relationship reversed when we added in other covariates. This reversal of relationship suggests that there may be some omitted variable bias as noted above. It is also possible that another measurement of state legislation may more accurately capture the effect of legislation on participation. Factor analysis or latent class analysis may help

identify the types of legislation that are most influential in determining F2S participation status. Qualitative research with districts about the influence of policy on their decision to participate in F2S, may help to further elucidate this relationship.

It is worth noting that this same relationship of state legislation was not seen in the negative binomial models exploring level of amount of F2S participation (Table 2.5). There was no statistically significant moderation of the relationships between demographic characteristics and amount of F2S participation. When included as an independent variable, districts in states with low, medium, and high levels of legislation implemented more activities than districts in states with no legislation, but the effect size was small; 1.16 (CI 1.06, 2.26), 1.11 (CI 1.04, 1.19), and 1.20 (1.09, 1.33) for low, medium, and high levels of legislation respectively.

We found that suburban and rural schools were significantly less likely to participate in F2S compared to urban school districts. This relationship is consistent with the analysis of the 2013 F2S Census by Botkins and Roe. [11] This finding may seem counterintuitive, since rural areas contain more farmland than urban areas. However, F2S activity does not require farming to occur within the immediate area; F2S activity could involve acquiring local food from a nearby county, which may be more rural. F2S activities can also include school gardens or other educational activities that do not require large spaces. Urban school districts may also be able to utilize services that facilitate F2S, such as nonprofit organization programs, more easily than suburban or rural school districts. While this analysis accounted for state F2S legislation, it did not account for local F2S policies, which could also facilitate F2S participation.

Larger school districts were also more likely to participate in F2S compared to smaller districts, with school districts in the largest quartile of size having 3.46 times the odds (CI 2.88-4.16, $p<.001$) of participating in F2S compared to the smallest quartile of school districts. This

finding is also consistent with the 2013 F2S Census. There are likely economies of scale involved in local food procurement as well as supplemental F2S activities. As school district funding and resources are often per capita (such as federal reimbursement for school lunch), larger school districts have larger budgets for food purchasing which may facilitate local food purchasing. Per pupil school district spending was included as a confounding variable in this analysis, so the association of district size and F2S participation is separate from differences in per pupil measures.

Compared to the Northeast, all other regions were less likely to participate in F2S. This difference is not surprising given the strong local agricultural movement in the region. The small size of the Northeast region also allows local food to move more quickly than in larger regions such as the Mountain Plains. Separate from the official F2S program, Vermont is home to Farm to Institution New England (FINE), a nonprofit promoting local sourcing in a variety of institutional settings such as hospitals, universities, and schools. FINE has facilitated the growth of F2S in New England.

Given the lack of significant associations and small effect sizes, the results of the negative binomial analysis offers limited explanation of the number of activities implemented as part of F2S. The amount of participation in F2S may depend on variables other than district demographics and resource characteristics. Increasing F2S activities may require additional investment or an F2S champion such as a legislator or district superintendent. No other research has explored amount of F2S activities, and as such additional exploratory research may be necessary to determine what influences level of F2S participation. Qualitative interviews with school nutrition directors or other decision makers may be able to inform future measurement.

2.4A Strengths and Limitations

To the authors' knowledge, this study is the first to use the 2015 F2S Census to explore F2S participation. This study is also the first to explore amount of F2S participation by exploring the number of activities implemented by participating districts. This study has high generalizability for regular public school districts, as the Census was sent to all school districts in the United States. Our sample represents 68.8% of the public school districts in the United States, and an abbreviated set of questions sent to Census non-respondents found that non-respondents did not have differential rates of F2S participation compared to respondents.[5]

This study is a cross-sectional analysis of the 2015 F2S Census. We were not able to explore trends in participation over time. Reverse causality is typically a concern in cross-sectional studies, but in this study, the independent variables are demographic characteristics. F2S is unlikely to cause a district's demographic characteristics to change. Reverse causation is a threat to internal validity for the patterns of state legislation, as described in the discussion.

F2S is a complex program to measure, and its' flexible definition of local food service, educational activities, gardening, etc. makes it difficult to concisely measure extent of participation. Between the 2013 to 2015 Census, the number of response categories included in the activities question increased from 15 to 24. If respondents are fatigued from reading 24 options, their accuracy in reporting activities could drop. Finally, some activities occurring at the individual school level may be unknown to the school nutrition directors at the district level, leading to misclassification of F2S participation.

2.4B Conclusion

This study has implications for F2S policy and outreach for districts currently not participating in F2S. In 2015, districts in more rural settings, smaller districts, and districts with a higher percent of students eligible for FRP meals were less likely to report participation.

Targeted marketing of the program to these schools could lead to more equity in utilization of the program by these districts. However, these types of school districts may be facing additional barriers to F2S participation. Further research is needed to identify what types of technical assistance these districts may need to overcome these barriers to F2S. Decreasing these disparities in F2S participation is critical to extending the benefits of F2S participation, such as improved diet quality and fruit and vegetable consumption, to as many students as possible.

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CHAPTER 3. AIM 2 MANUSCRIPT: DISTRICT-LEVEL BENEFITS ASSOCIATED WITH PARTICIPATION IN THE FARM TO SCHOOL PROGRAM: RESULTS FROM THE 2015 FARM TO SCHOOL CENSUS

3.1 Introduction

Fruit and vegetable (FV) consumption is a critical part of a healthy diet and is protective for a myriad of health related outcomes such as cardiovascular disease and healthy body mass indecies.[1–3] FV consumption is particularly important during childhood for growth and development.[4] Approximately 60% of children in the United States age 2-18 do not meet current dietary recommendations for fruit consumption, while 90% do not meet recommendations for vegetable consumption.[2]

School food programs are influential in children's dietary intake, particularly among students eligible for free or reduced price (FRP) school meals. Out of the approximately 50 million students enrolled in public schools in the 2013-2014 school year,[5] 13.9 and 30.7 million children participated in school breakfast and lunch, respectively.[6,7] Students in low-income districts may also receive a meal or snack after school as part of the at-risk afterschool meal program. Students eligible for FRP meals participate in school meals at a greater rate than students from higher-income households; approximately 50% of students in the United States are eligible for FRP meals, but 70% and 85% of students participating in school lunch and breakfast, respectively, are FRP-eligible.[5-7]

Given the need to increase FV consumption (as well as improve other aspects of dietary intake), several improvements were made to school meal programs through the Healthy, Hunger-Free Kids Act (HHFKA) in 2010.[8] One of these initiatives was funding a national Farm to

School (F2S) program. F2S is an optional program administered by the United States Department of Agriculture (USDA) Food and Nutrition Services Office of Community Food Systems.[9] F2S is an umbrella term for a variety of local food activities, such as serving local food in schools, operating school gardens, and conducting nutrition education that incorporates F2S. Approximately 40% of all school districts in the United States currently participate in F2S.[10]

Local food procurement is the most common F2S activity, with 78% of schools participating in F2S serving local food.[9] Serving local foods is associated with improved school meal quality, particularly related to FV availability, which in turn improves child FV consumption.[11–13] Using lunchtime observations and plate waste data, Kropp et al (2017) found that children at elementary schools in Florida participating in F2S consumed 37% more vegetables and 11% more fruits than they did before the program was implemented.[14]

Because F2S is an optional program, however, school districts may be more likely to participate if they view benefits to their overall operation in addition to child health benefits. Roger Evans' Diffusion of Innovation (DOI) theory[14] suggests that organizations are more likely to adopt new programs when they present a relative advantage over current practices, and when positive outcomes can be observed by organizations relatively quickly after program trial or implementation. Dissemination of F2S programs to new districts may therefore depend on staff and community perceptions of the program as beneficial, and observable improvements in district level outcomes, like more efficient school meal programs.

This study is the first to explore district-level benefits of F2S; we use data from a national survey of school district nutrition directors who participate in F2S to examine whether F2S participation is positively associated with perceived school district benefits. We focus on local

FV service as the key measure of F2S participation, but also explore whether participation in auxiliary F2S activities, such as school gardens, enhances the hypothesized positive relationship between local FV service and district benefits.

3.2 Methods

3.2A Participants and Analytic Sample

The participants in this study were respondents to the 2015 F2S Census. The 2015 F2S Census surveyed school district nutrition directors to assess participation in F2S program in the previous school year, including frequency of service of local foods, types of F2S activities implemented, and the perceived benefits of F2S participation.[6,10] These data were collected at the district level, rather than the school level, as school meal programs are administered by districts.[6,10] All school districts in the United States were sent the survey; 12,584 responded, which represents a 70% response rate.[10] Benefits of F2S participation were only assessed among the 4,719 schools districts that indicated participation in any F2S activity in the 2013-2014 school year. Given the differences in administration of meal programs, private and charter schools, state-operated institutions, regional education service agencies, or supervisory unions (n=836), as well as districts from U.S. territories (n=3) were excluded from analyses. Districts were also removed from the sample if responses were ineligible, such as multiple responses per district or error entering district name so it could not be matched with demographic data (n=54). Finally, districts with missing values on the frequency of FV service were removed (n=281). Thus, the final analytic sample was 3,381 districts.

3.2B Instrumentation

Dependent Variable: Benefits of F2S Participation

Benefits of F2S were measured using the following question from the F2S: “Which of the following benefits have you enjoyed as a result of participating in farm to school activities?

(Please check all that apply.)" Response options were: Reduced food waste, lower school meal program costs, greater acceptance of the new meal pattern, increased participation in school meals, greater community support for school meals, and other (with an option to write in benefit).

Five dichotomous variables were created to measure positive response to each of the options, except for 'other', as the diversity of responses in that response category is heterogeneous. An additional indicator variable was created to capture any benefit, as indicated by checking at least one benefit option, including 'other' benefits.

Independent Variables: Local Fruit and Vegetable Service Frequency

The F2S Census collected information about FV service through two questions that assessed whether the district provided any local FV service and, if so, the frequency of service. The frequency of serving local fruits and vegetables were measured through separate questions, and as such, two independent variables were created, one measuring fruit service and another measuring vegetable service. Service was measured using the following categories: daily, more than weekly, weekly, more than monthly, monthly, occasionally, and never. After examining the response categories descriptively and visually, they were collapsed into four ordinal categories for analysis: daily, weekly/more than weekly, occasionally/monthly/more than monthly, and never.

Fruit and vegetable frequency were measured separately for two reasons. Firstly, fewer children are meeting recommended vegetable intake (10%) compared to fruit (40%). Thus, there is a stronger imperative to increase vegetable consumption in children compared with fruit. Exploring these relationships separately allows us to isolate the effect of serving local vegetables from local fruit. This separation is also important from the supply chain aspect; because fruits are

grown in different areas than vegetables, sourcing of these foods are often different and merit separate treatment. This separate treatment of fruit and vegetable service did lead to moderate collinearity (variance inflation factors between 5 and 8). The consequence of this collinearity is to widen standard errors and thus confidence intervals.

Moderation Variable: Auxiliary Farm to School Activities

F2S activities (e.g. nutrition education, school gardens) were measured in the F2S Census through a 'check all that apply' question with 24 potential responses. Nineteen of these options represented non-food service activities, and an additional 'other' option provided participants an opportunity to describe other F2S activities not listed (Table 3.1). The most common activities reported were holding taste tests and promoting local foods at school.

Table 3.1: Summary of Auxiliary Farm to School Activities as Defined by the 2015 Farm to School Census and Frequency of Implementation (n=3,381)

Activity	**School Districts Implementing this Activity**
	n (%)
Promoting locally produced foods at school in general (e.g. via cafeteria signs, posters, newsletters, etc.)	1,447 (42.67)
Holding taste tests/cooking demonstrations of locally produced foods in the cafeteria, classroom or other school-related setting	1,282 (37.81)
Using Smarter Lunchroom strategies to encourage student selection and consumption of locally produced foods (e.g., product placement, food prompts, creative signage, etc.)	1,246 (36.74)
Conducting student field trips to farms or orchards	1,086 (32.03)
Promoting local efforts through themed or branded promotions (e.g. Harvest of the Month, Local Day, Taste of Washington, etc.)	940 (27.72)
Celebrating Farm to School Month (October 2013)	899 (26.51)
Conducting edible school gardening or orchard activities as part of a school curriculum	835 (24.62)
Having farmer(s) visit the cafeteria, classroom or other school-related setting	672 (19.82)

Activity	**School Districts Implementing this Activity**
	n (%)
Holding taste tests/demos of products from school-based gardens or school-based farms in the cafeteria, classroom or other school-related setting	654 (19.29)
Using cafeteria food coaches to promote the consumption of local foods (e.g. adults or students in the cafeteria encouraging kids to eat healthy/local foods)	621 (18.31)
Providing training to school food service staff on farm to school or school gardens	617 (18.20)
Using USDA Team Nutrition materials (such as *The Great Garden Detective Adventure* or *Dig In!*) as part of taste testing or educational activities	509 (15.01)
Integrating farm to school concepts, including school gardening activities, into educational curriculum (math, science, language arts, etc.)	506 (14.92)
Generating media coverage of local foods being used in schools (e.g. press interviews or other activities that resulted in local coverage)	490 (14.45)
Working with local food producers to develop a specific food product using local foods	459 (13.54)
Evaluating changes in student acceptance and food waste as a result of implementing farm to school activities	368 (10.85)
Hosting farm to school related community events (e.g. invited parents to lunch, corn shucking contests, etc.)	363 (10.70)
Conducting edible school gardening or orchard activities as part of an after school program	280 (8.26)
Implementing farm to school activities as part of overall school efforts to reduce food waste	269 (7.93)
Other (please specify)	14 (0.41)

We created a count variable of the number of non-food service activities reported by the district, including 'other' unless response specification suggested otherwise (e.g. stating 'No other activity'). After examining the variable's distribution, four ordinal categories were created capturing no (0), low (1-2), medium (3-5) and high (6+) participation in auxiliary activities.

Control Variables: Other Types of F2S Activity and Demographic Characteristics

The F2S Census measured 10 other categories of local food purchasing (e.g. dairy, grains, meat). Because school districts may be serving other types of local food concurrently with local FV, dichotomous indicators of each type of local food purchasing are included as covariates to better isolate the association of local FV service with F2S benefits. As with FV frequency, districts with missing values for the measurement of the food category were assigned a 'no service' value.

Demographic characteristics from the 2013-2014 school year, measured in the United States Department of Education's Common Core of Data (Common Core), [5] were also employed as covariates. The Common Core collects demographic data for school districts and enrolled students annually. These data are publicly available and were accessed through the School Funding Financial dataset from Rutgers University. [15] Four demographic variables included: the number of students enrolled in the districts; the percent of students in the school district identified as either a race other than white and/or of Hispanic ethnicity; the percent of students eligible for FRP school lunch; and the percent of students in the district who were elementary age. Given distributions, the first two (school size and students of color) were divided into quartiles for analysis, whereas the other two (FRP lunch and elementary age), were analyzed using Z scores. Finally, urbanicity was measured using the 12-category classification used by the National Center for Education Statistics.[16]

3.2C Data Analysis

We conducted a series of logistic regressions to assess associations between FV service frequency and each of the benefit categories: reduced food waste, lower school meal program costs, greater acceptance of the new meal pattern, increased participation in school meals, and greater community support for school meals. Greater acceptance of the new school meal pattern

refers to the new meal requirements from the Healthy, Hunger Free Kids Act (including requiring a serving of fruit or vegetables with school meals).[8] A model was also estimated for reporting any benefit in F2S.

We used a hierarchical model building approach for all models. First we assessed bivariate relationships of potential control variables with each independent and dependent variable. In each model, covariates were retained only if they were statistically significantly associated with the dependent variable for that model and one or both focal independent variables ($p<.05$). Groups of variables that were significant in bivariate analyses were then regressed on F2S participation, moving from most distal control variables to independent variables. For each type of perceived district benefit, demographic characteristics were regressed first, followed by other local food service, fruit and vegetable frequency, and auxiliary F2S activities. Each regression was examined via post estimation goodness of fit tests to see whether the addition of that group of variables improved the model fit. Model fit was improved at each stage except for local food service, which only improved model fit in the results for any benefit. Thus, local food service was not included in the other benefit models.

Interaction of associations between FV service frequency and F2S benefit by auxiliary activity was tested using the process described by Hayes.[16] A full 'null' model was estimated including FV service frequency, all covariates, and the outcome. Then, interaction terms between FV frequency and level of auxiliary F2S activities were added. Likelihood-ratio tests were then conducted to examine the statistical significance of the interaction at $p<.05$. When at least one category of local FV service was significantly different than no local FV service, posthoc tests were conducted to explore differences in odds between FV frequency categories (low vs. medium, low vs. high, and medium vs. high).

3.3 Results

The descriptive statistics for the focal independent variables, the moderator variable, and the dependent variable are shown in Table 3.2. Most school districts participating in F2S served local FV. Only 13% and 16% of districts never served local fruits or vegetables, respectively, and approximately 25% and 19% of districts participating in F2S served local fruits and vegetables daily.

Table 3.2: Frequencies of Local Fruit and Vegetable Service and Auxiliary Programs Among School Districts Participating in Farm to School (n=3,381)

Characteristic	Values	%
Frequency of Local Fruit Service		
Never	285	8.40
Low (<1/week)	1226	36.15
Medium (≥Weekly ≤Daily)	986	29.08
High (Daily)	894	26.36
Frequency of Local Vegetable Service		
Never	329	9.70
Low (<1/week)	1379	40.67
Medium (≥Weekly ≤Daily)	978	28.84
High (Daily)	705	20.79
Percent of Participants Reporting Benefits as a Result of Farm to School Participation		
Any Benefit	2654	78.27
Increased Community Support for School Meals	1459	43.03
Increased Acceptance of New School Meal Pattern	1009	29.76
Reduced Cost of School Meals	714	21.06
Increased Participation in School Meals	558	16.46
Reduced Food Waste	552	16.28
Number of Auxiliary Farm to School Activities Implemented by School District*	**Mean**	**Range**
	3.99	0-19

*Four ordinal groups were created to analyze this variable

Approximately 75% of districts reported some benefit of F2S participation. Community support for school meals was the most common benefit reported, with 41% of F2S participants listing it as a benefit. Additionally, 80% of districts were implementing at least one auxiliary activity, with the mean number activities implemented just under 4.

The descriptive statistics for all variables, including covariates, are available in Appendix C. School districts in this study had an average FRP eligibility rate of 46% and had an average of 29% of students of color in the district.

Results from logistic regressions are available in Table 3.3. Adjusted Odds Ratios (AORs) are presented along with 95% confidence intervals (CIs) for local FV service frequency and reported benefits.

Table 3.3: Adjusted Odds Ratios of Reporting Benefits of F2S Participation Associated with Level of Local Fruit and Vegetable Service (n=3,391)[3]

Frequency of Fruit or Vegetable Service	Model 1: Any Benefit	Model 2: Increased Community Support for School Meals	Model 3: Increased Acceptance of the New School Meal Pattern	Model 4: Reduced Cost of School Meals	Model 5: Increased Participation in School Meals	Model 6: Reduced Food Waste
	AOR (95%CI)	**AOR (95%CI)**	**AOR (95%CI)**	**AOR (95%CI)**	**AOR (95%CI)**	**AOR (95%CI)**
Frequency of Serving Local Fruits						
Never	RF	RF	RF	RF	RF	RF
Low (<1/week)	1.87 (1.36, 2.57)***	1.28 (0.96, 1.74)	1.43 (1.02, 2.00)*	1.23 (0.88, 1.72)	0.98 (0.66, 1.44)	1.92 (1.27, 2.91)**
Medium (≥Weekly ≤Daily)	1.79 (1.25, 2.57)**	1.18 (0.85, 1.62)	1.37 (0.96, 1.95)	1.67 (1.16, 2.40)**	0.68 (0.45, 1.03)	1.75 (1.13, 2.72)*
High (Daily)	2.14 (1.43, 3.21)***	1.07 (0.72, 1.51)	1.63 (1.12, 2.38)*	1.90 (1.29, 2.80)***	0.70 (0.45, 1.09)	1.93 (1.22, 3.02)**
Frequency of Serving Local Vegetables						
Low (<1/week)	1.88 (1.36, 2.57)***	1.53 (1.16, 2.02)**	1.18 (0.86, 1.61)	1.35 (0.99, 1.84)	1.21 (0.82, 1.79)	0.99 (0.68, 1.43)
Medium (≥Weekly ≤Daily)	2.77 (1.95, 3.92)**	1.63 (1.20, 2.21)**	1.79 (1.28, 2.49)***	1.29 (0.91, 1.84)	2.03 (1.34, 3.09)***	1.33 (0.90, 1.98)
High (Daily)	3.04 (2.02, 4.57)***	1.38 (0.98, 1.94)	1.91 (1.33, 2.75)***	1.39 (0.94, 2.06)	2.89 (1.85, 4.52)***	2.20 (1.45, 3.34)***
Level of Auxiliary Activities Besides Local Food Service+						
Never	RF	RF	RF	RF	RF	RF
Low level of auxiliary activity (1 or 2 activities)	1.14 (0.90, 1.44)*	1.45 (1.16, 2.02)**	1.35 (1.04, 1.73)*	0.84 (0.66, 1.07)	1.21 (.89, 1.67)	0.94 (0.70, 1.27)

[3] Models had different covariates based on bivariate associations with the outcome. For any benefit, covariates included region and other type of local food service. For community support, covariates included quartiles of number of students in district, quartiles of the percent of students of color in district, urbanicity, and percent of students eligible for free or reduced-price school meals. For acceptance of the new school meal pattern, covariates included quartiles of the percent of students of color in district, urbanicity, and percent of students eligible for free or reduced price school meals. For cost, covariates included region, quartiles of number of students in district, urbanicity, and percent of students eligible for free or reduced price school meals. For participation in school meals, covariates included region, percent of students eligible for free or reduced price school meals, and percent of elementary school students in district. For waste, covariates included percent of students eligible for free or reduced price school meals, urbanicity, and quartiles of the number of students in district.

Frequency of Fruit or Vegetable Service	Model 1: Any Benefit	Model 2: Increased Community Support for School Meals	Model 3: Increased Acceptance of the New School Meal Pattern	Model 4: Reduced Cost of School Meals	Model 5: Increased Participation in School Meals	Model 6: Reduced Food Waste
	AOR (95%CI)	**AOR (95%CI)**	**AOR (95%CI)**	**AOR (95%CI)**	**AOR (95%CI)**	**AOR (95%CI)**
Medium level of auxiliary activity (3-5 activities)	1.93 (1.50, 2.49)***	2.35 (1.87, 2.97)***	1.98 (1.53, 2.55)***	0.88 (0.69, 1.13)	1.35 (0.98, 1.85)	1.07 (0.79, 1.45)
High level of auxiliary activity (6 or more activities)	3.81 (2.81, 5.16)***	4.69 (3.68, 5.97)***	3.27 (2.52, 4.24)***	0.84 (0.65, 1.08)	2.89 (2.15, 3.95)***	1.91 (1.44, 2.56)***
Pseudo R2	0.0957	0.1082	0.0735	0.0372	0.054	0.0602

3.3A Frequency of Serving Local Fruit

The patterns of adjusted ORs and frequency of local fruit served varied across different benefit models. Serving at least some local fruits was associated with a significantly higher odds of reporting both any benefit and reduced food waste compared to districts who did not serve local fruit (Models 1 and 6); posthoc tests indicate no other significant difference in odds of reporting the benefit between different frequency categories. Models of the acceptance of the new school meal pattern followed a similar pattern (Model 3), except that the medium category of service (more than weekly but less than daily) was not significant. Districts serving local fruits at least weekly had 1.67 times the odds (95% CI 1.16, 2.40) of reporting lower school meal costs, while districts serving local food daily had 1.90 times the odds (95% CI 1.29, 2.80) of reporting lower school meals cost compared to districts not serving local vegetables (Model 4).

Serving local fruits at any frequency level was not significantly associated with reported benefits of increased community support for, and participation in, school meals.

3.3B Frequency of Serving Local Vegetables

Local vegetable service generally had larger effect sizes compared to fruit service, particularly when districts served local vegetables at least weekly. School districts serving local vegetables daily had 2.83 (95% CI 1.95, 4.11) times the odds of reporting any benefit compared to districts that did serve local vegetables (Model 1). Districts serving local vegetables at least weekly (OR 2.53; 95% CI 1.86, 3.45) and less than weekly (OR 1.76; 95% CI 1.36, 2.28) also had higher odds of reporting a benefit compared to districts not serving local vegetables. Post-hoc analyses suggest a dose-response effect; those districts serving vegetables at least weekly had significantly higher odds of reporting a benefit compared to districts that served vegetables less frequently. The same pattern held for acceptance of the new meal pattern (Model 3) and participation in school meals (Model 5). For reduced food waste, only daily service of local FV

was associated with higher odds compared to no service (OR 2.20, 95% CI 1.45, 3.34). (Model 6) There were no differences in reporting community support (Model 2) or reduced cost of school meals (Model 4) across vegetable frequency categories.

3.3C Auxiliary Farm to School Activities

Auxiliary F2S activities did not significantly moderate the relationship between FV service and any of the reported benefit categories (results not shown). However, greater numbers of auxiliary activities were independently associated with greater odds of reporting any benefit, as well as with each specific benefit other than cost. For the likelihood of reporting any benefit, increased community support, or greater adherence to the new meal pattern, likelihood of reporting the benefit increased with each ordinal category. For example, districts with a low level of auxiliary activity had 1.35 (95% CI 1.04, 1.73) times the odds of experiencing increased acceptance of the new meal plan compared to districts with no auxiliary activity. These odds increased to 1.98 (95% CI 1.53, 2.55) when auxiliary activity was medium, and 3.27 (95% CI 2.52, 4.24) when auxiliary activity was high. Posthoc test showed significant differences between each group when comparing the odds of 6 or more activities to no activities, ancillary activities increased the odds of reporting every benefit category except for cost.

3.4 Discussion

This study adds to the limited literature on district-level outcomes of F2S. To our knowledge, no other studies have explored the benefits of F2S participation from the school district perspective. Because F2S is an optional program operating within the school system, district-specific benefits may partially drive decisions about F2S participation over time. Children cannot experience the benefits to FV preference and consumption associated with F2S participation if their districts are not participating in the program. To increase F2S participation, it is critical that nutrition directors, the respondents to the survey analyzed in this study, perceive

a relative advantage of participating in F2S over continuing in the "status quo" (i.e. not participating in F2S). Research on school meal programs affirms that school nutrition directors are key decision makers in the allocation of school food budgets.[17–19] In qualitative work on districts participating in F2S programs in Pennsylvania and Nebraska, respectively, Bagdonis et al (2009)[20] and Pinard et al (2013)[21] identified school nutrition directors as "champions" for F2S because they are typically responsible for food purchasing decisions.

The benefits explored by the F2S Census represent important issues in school food programming, such as increasing participation in school meals, which gives school districts greater revenue for their programs.

In some cases, odds of reporting several benefit categories were greatest among districts with *daily* local FV service or *high* levels of auxiliary activity compared to districts with no service or auxiliary activities. For example, compared to districts that did not serve local vegetables, serving local vegetables daily was associated with greater odds of reporting a benefit in four of six benefit categories. Serving vegetables less than weekly was associated with a greater odds of reporting two out of the six categories. This finding suggests that not only should local FV sourcing be promoted, but increasing the frequency of this service may reap more benefits.

Effect sizes in the higher dosage categories were also higher; compared to districts not serving local vegetables, the odds of reporting any benefit were 3.05 (95% CO 2.05, 4.53) times the odds among districts serving daily vegetables, while the odds of reporting any benefit were 1.76 (95% CI 1.36, 2.28) times the odds among districts serving local vegetables less than weekly. Further research is needed to explore the dose response of F2S programs and reported benefits.

Our moderation hypotheses that increased levels of auxiliary activity would strengthen the positive association between local FV service and perceived benefit of F2S were not supported. However, more auxiliary programs was associated with more perceived benefits; this is consistent with the limited literature on the comprehensiveness of F2S programs. Evans et al (2012) evaluated a multi-component F2S intervention among middle schoolers including cafeteria, farmer visit, taste testing, and nutrition education components, and found that daily FV consumption increased by 0.35 servings (approximately ⅓ of an apple or its equivalent) for each additional component of the intervention received.[22] Izumi et al (2015) had similar findings of a multicomponent cafeteria and nutrition education intervention among preschoolers in Oregon.[23]

Another Diffusion of Innovation concept, observability, is applicable here. Observability is "the extent to which outcomes can be seen and measured"[24(p.308)], and there is often a lag between implementation of the intervention and the impact of the innovation being perceived by the system. This study uses cross-sectional data, and the F2S Census did not include information about the year that F2S programs were initiated. Benefits of F2S participation were also not included as a question on the 2013 Census, which makes it difficult to assess this temporal relationship. Upon collection of future waves of F2S data, this relationship between time since program initiation and benefits should be explored.

3.4A Strengths and Limitations

This study leverages data from a large national dataset that serves as a Census of all school districts. The Census measured all school districts, both F2S participants and non-participants. The Census measured approximately 70% of public school districts in the United States. The analytic sample represents 28% of the school districts in the United States (because non-participating districts were excluded from this study as they did not report benefits of F2S). This analytic sample likely represents a proportion of around 70% of districts participating in

F2S, since follow-up with non-respondents showed that they were not differential based on F2S participation.

However, the F2S Census is entirely self-reported by nutrition directors, and as such, may contain measurement error. The benefits analyzed here have not been independently validated by, for example, measuring plate waste directly at schools. Observational measurement of benefits like reduced food waste is time intensive and costly; a smaller scale validation study would help identify the precision of the self-report measurement that is practical for a national survey. Furthermore, the school food environment is complex and school nutrition directors are often balancing multiple changes to the school food environment at once. The F2S Census did not gather information about other initiatives occurring at the school district level that may lead to the same benefits as F2S participation. However, the questions about benefits from F2S asks what benefits the nutrition director perceives *as a result* of F2S participation, so the question does attempt to isolate the effect of F2S on benefits.

The F2S Census does not ask when schools began implementing F2S programs. As a result, these analyses cannot distinguish those districts that have been implementing F2S for many years from those who began in the same year that perceived benefits were assessed. Diffusion of Innovation theory recognizes there can be a lag between implementation of a new initiative and perceived impact on the system; future research should consider whether perceived district benefits increase following long-term program intervention. Finally, while FV service dosage was assessed, auxiliary activities, such as nutrition education or promotional activities, were assessed dichotomously. These individual categories of activities likely also have variance in their extent of implementation. Thus, the relationship between ancillary activities and F2S benefits may be more precisely estimated if dosage is measured.

3.4B Conclusion

This study identifies a positive association between frequency of serving local FV in schools and district-level benefits of F2S participation using data from a national sample. While this relationship did not vary by auxiliary programming, additional F2S programs were also positively associated with reporting benefits of F2S participation. Marketing the specific benefits that might be expected from F2S identified in this study to district nutrition directors could result in expansion of a program with clear health benefits to students. Further research is needed to examine time trends between F2S participation and associated benefits.

3.5 Implications for School Health

This study identifies district-level benefits associated with local FV service, as well as auxiliary programs, that comprise F2S participation. Extensive research indicates participation in F2S is positively associated with FV access, consumption, and likeability among children. Yet fewer than half of all school districts currently participate in the program. FV consumption remains low among children in the United States, with 60% and 90% of children not meeting recommended daily intake of fruit and vegetables, respectively.[2] The findings from this study suggest that F2S can be a win-win for improving FV preference and consumption as well as providing benefits to districts implementing the program. Identification of these additional district-level benefits may help school nutrition directors advocate for greater adoption of the program, and in turn, health benefits for students. School nutrition directors are often juggling logistical and budgetary responsibilities necessary to administer nutrition programs. Although likely motivated by potential impacts on child health outcomes, the data provided in this study about perceptions of reduced costs may help to justify F2S implementation.

The benefits in this study cover a breadth of areas of school meal service, and represent distinct constructs that are important to the success of school meal programs. Several of these

benefits are related to the passage of the Healthy-Hunger Free Kids Act; changes resulting from this bill were implemented beginning in the 2012-2013 school year.[8] One of the changes to meal programs was the requirement of serving a fruit or vegetable with school meals. This study found that local FV service was associated with greater acceptance of the new school meal pattern and reduced food waste, two critical issues for school nutrition programs. Increasing participation is a priority for nutrition directors, as it allows school districts to receive additional revenues to administer nutrition programs. Community support for school meals was the most frequently reported benefit (41%); this may be important for building partnerships with local agencies to sustain F2S and other nutrition program. The results of this study can be used by state agencies and other non-school actors to promote F2S activities.

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CHAPTER 4. CONCLUSION

5.1 Summary of Key Findings

The objective of this dissertation was to understand school district demographic characteristics and benefits associated with participation in the F2S program. This research used the national F2S Census, which surveyed all school districts in the United States about their participation in F2S. We excluded private and charter schools in our analysis because of the differences in school district structure and implementation of meal programs in private and charter schools compared with public schools.

In the first paper, we estimated associations of school district demographic characteristics with participation in F2S. We also examined state legislation as a moderator of the relationship between district demographics and F2S participation. We found that as the percent of students eligible for FRP meals in a school district increase, the likelihood of participating in F2S decreases.

State legislation moderated this relationship,; school districts located in states with high levels of state legislation were less likely to participate in F2S compared to school districts in states with no, low, or medium levels of state legislation regardless of the percent of students eligible for FRP lunch. In states that had high levels of legislation, FRP eligibility was not predictive of F2S participation, but the intercept (when FRP eligibility is at 0) was lower than states with less than high levels of legislation. In all other levels of legislation, districts were less likely to participate in F2S as percent of students eligible for FRP increased. We did expect that

high levels of legislation would not be predictive of F2S participation but anticipated that the intercept would be higher than districts in states with lower levels of legislation.

While it is possible that state legislation somehow inhibits F2S participation, we think there is likely an alternative explanation. The time needed for legislation to affect F2S participation may not have been reached, and states that have existing low levels of participation may be more likely to pass laws promoting F2S compared to states that have an already thriving F2S programs. If the latter is true, that may explain the lower intercept of the districts in states with a high level of legislation. It may be that high levels of legislation

Other findings were consistent with research using the 2013 F2S Census; larger and more urban school districts were more likely to participate in F2S compared to smaller, more rural school districts.[4]

We also explored amount of F2S participation as the number of activities implemented by districts participating in F2S. In general, fewer variables were significant in this model and effect sizes were smaller compared to the models of any participation in F2S. An interesting finding here was that the pattern of legislation observed in the dichotomous model was not observed in this model. Among districts participating in F2S, increasing levels of legislation were associated with additional activities implemented. However, the effect size was quite small (IRR 1.16, 1.11, and 1.20 for low, medium, and high levels of legislation, respectively). It may be that districts already participating in F2S are more readily able to take advantage of F2S legislation compared to those not participating in F2S.

The second paper focused on the most common F2S activity, serving local foods in schools. We explored the associations between level of local FV service and the likelihood of reporting a variety of benefits from participating in F2S. The benefits explored included:

increased community support for school meals, increased acceptance of the new school meal pattern, reduced cost of school meals, increased participation in school meals, and reduced food waste. In general, serving local FV was associated with an increased likelihood of reporting benefits as a result of participating in F2S. These associations tended to increase in effect size as frequency of service increased, but the pattern varied across different benefit categories. Odds ratios were highest for the likelihood of reporting any benefit, which indicates that while different districts may benefit from different aspects of F2S, increasing the frequency of FV service does make the program more beneficial for districts. We tested for moderation by level of auxiliary activity, but this moderation was not significant among any of the benefits. However, implementing these activities, such as school gardens, was also associated with increased likelihood of reporting benefits.

5.2 Areas for Future Research

This dissertation builds on the limited literature exploring district level characteristics of participation and perceived benefits of F2S. There were several limitations to this work due to lack of longitudinal data and lack of history of participation trends in F2S. As more waves of the Census are collected, more analysis can be done to assess how districts' participation status changes over time. The 2019 F2S Census is currently being collected, and this wave will give an opportunity for these relationships to be explored longitudinally. It will allow researchers to explore the trends of state legislation over time; this wave will be particularly helpful because of the increased time gap between wave 2 (2015) and wave 3 (2019). Because the gap between waves 1 and 2 was only 2 years, the four-year gap may lead to more districts changing their F2S status, and allow a closer examination of what factors caused this change. As states continue to pass more legislation, it will also present an opportunity to explore types of legislation, rather than just presence of legislation, as a predictor of F2S legislation.

Some measures of participation, such as types of activities implemented as part of F2S, changed from Wave 1 to Wave 2.[1] These measures should be standardized moving forward so that changes in types of participation can be measured more accurately. F2S is a difficult construct to measure. The F2S program keeps the definition of F2S as broad as possible to allow districts to participate in ways that make sense to them. Thus, the Census captures a very broad group of related activities. Further research should be done on the creation of a validated scale of F2S activities to reduce the number of response categories that may also reduce participant burden. Currently, there are 24 types of F2S activities measured on the F2S Census. It is possible that the high number of options is resulting in underreporting. Factor analysis may be used to identify a minimally sufficient number of activities that could be used to create a F2S scale.

Additional qualitative research is needed to better understand why disparities exist in F2S participation rates. Qualitative research may also explain how policy influences districts' participation in F2S, and what activities are implemented once a district decides to participate. Multilevel models incorporating state level variables, such as FRP eligibility, financial spending on school meals, and other variables included at the district level in our models, may offer additional explanation of district-level participation in F2S. Other demographic characteristics of the county where the district is located, such as the tax base in the county where the district is located, may explain participation in F2S. Exploring these additional characteristics may more precisely identify the factors most influential in a school district's participation in F2S.

This dissertation did not explore barriers to F2S participation, although this data is available in the F2S Census. More research is needed integrating perceived benefits and barriers to F2S participation. The Health Belief Model may be applicable here, which states that held behaviors are the result of weighing both benefits and barriers of an action.[2]

Regarding benefits of participation, more research is needed to integrate individual-level benefits (e.g. child FV consumption) and district-level benefits explored in this model. While the research on individual outcomes is more robust than district-level benefits, it would be valuable to cross validate these benefit levels to see to what extent they co-occur and whether district or individual-levels are more frequently reported. Likewise, additional qualitative research is needed to better understand whether individual or systems level benefits are more important to district officials in their decision to participate in F2S.

At the time of writing, (August 2019), the Child Nutrition Reauthorization Act (CNR) is being considered for renewal in Congress. CNR is the governing legislation for all school meals programs, and will update provisions of the Healthy, Hunger Free Kids Act (HHFKA). Two pieces of legislation have been introduced relating to F2S; the Farm to School Act of 2019 and the Kids Eat Local Act.[3] The Farm to School Act will expand the amount of money available for grants for F2S from $5 million annually to $15 million annually. One of the key provisions of this bill is providing grants to low-income school districts and Native and tribal schools, among other underrepresented groups.

The Kids Eat Local Act would streamline the way that districts source local foods. Currently, schools are allowed to use "geographic preferences" in their food procurement, but they are not allowed to explicitly specify locally grown products in their bid requests to farmers. The Kids Eat Local Act would allow schools to specify "local" in their procurement language, which may help more local farmers be able to respond to these bids. If these acts pass, it could reduce disparities in F2S participation. Future research could use the 2015 Census and future Census timepoints to evaluate if this legislation changes F2S participation.

APPENDIX A. DESCRIPTION AND MEASUREMENT OF VARIABLES USED IN ANALYSIS

Variable Category	Source	Variable	Measurement
Dependent Variable: Participation in Farm to School	United States Department of Agriculture Farm to School Census	Any Farm to School participation	Dichotomous: 0: Does not Participate in Farm to School 1: Participates in Farm to School
	United States Department of Agriculture Farm to School Census	Number of Activities Implemented as part of Farm to School.	Ordinal: 0-23 based on the number of activities implemented by school district
Independent Variables: School District Demographics	Department of Education Common Core	Percent of students in a district eligible for free or reduced price school lunch	Continuous: 0-100. Variable was standardized for analysis.
		Percent of elementary school students in district	Continuous: 0-100. Variable was standardized for analysis.
		Urbanicity of school district	Categorical: Urbanicity measured using the 12 categories from the National Center for Education Statistics. These categories range from "city, large", the most urban category, defined as: "territory inside an urbanized area and inside a principal city with a population of 250,000 or more" to "Rural, remote", the most rural category, defined as "Census-defined rural territory that is more than 25 miles from an urbanized area and is also more than 10 miles from an urban cluster."[16]

Variable Category	Source	Variable	Measurement
			After analysis, categories were collapsed into three categories after testing for difference between categories.
		Percent of students of color in the school district	Ordinal: This variable (measured as a percent of total student population) was measured using the 7 exclusive race/ethnicity categories used by Common Core: White, Black, Hispanic, American Indian/Alaska Native, Asian, Hawaiian/Pacific Islander, Two or More Races. All categories besides White were summed and then split into quartiles for analysis.
		Total number of students in the school district	Ordinal: Variable was measured continuously and grouped into quartiles for analysis.
Moderation Variables	United States Farm to School Network State Farm to School Legislative Survey	Level of state legislation passed in state where school district is located	Ordinal: Number of pieces of legislation were summed and divided into four groups after examination of natural cutpoints. in the data: 0=No state legislation 1=Low level of legislation 2= Medium level of legislation, 3=High level of legislation.
Control Variable: School District Region	United States Department of Agriculture (USDA) Farm to School Census	Region where school district is located, as defined by USDA Food and Nutrition Services' Regional Offices of Service	0=Mid-Atlantic region: Delaware, District of Columbia, Maryland, New Jersey, Pennsylvania, Puerto Rico, Virgin Islands, Virginia, West Virginia 1=Mountain Plains region: Colorado, Iowa, Kansas, Missouri, Montana, Nebraska, North Dakota,

Variable Category	Source	Variable	Measurement
			South Dakota, Utah, Wyoming 2=Midwest region: Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin 3=Northeast region: Connecticut, Maine, Massachusetts, New Hampshire, New York, Rhode Island, Vermont 4=Southeast region: Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee 5=Southwest region: Arkansas, Louisiana, New Mexico, Oklahoma, Texas 6=Western Region: Alaska, Arizona, California, Guam, Hawaii, Idaho, Nevada, Oregon, Washington
Control Variables: School District Financial Characteristics	Department of Education Common Core via the School Funding Fairness Dataset, Rutgers University	Total school district expenditure on food services per student	Ordinal: Variable measured in thousands of dollars. Variable was then divided by total students in district to create a per capita measure. Variable was then grouped into quartiles for analysis.
		Total school district expenditure per student	Ordinal: Variable measured in thousands of dollars. Variable was then divided by total students in district to create a per capita measure. Variable was then grouped into quartiles for analysis.
		Revenue a district generates from school lunch per student	Ordinal: Variable measured in thousands of dollars. Variable was then divided by total students in district to create a per capita measure. Variable was then

Variable Category	Source	Variable	Measurement
			grouped into quartiles for analysis.
		Revenue a district generates from all food services per student	Ordinal: Variable measured in thousands of dollars. Variable was then divided by total students in district to create a per capita measure. Variable was then grouped into quartiles for analysis.
		Revenue a district receives from Title I per student	Ordinal: Variable measured in thousands of dollars. Variable was then divided by total students in district to create a per capita measure. Variable was then grouped into quartiles for analysis.
Control Variables: Local Food Environment	United States Department of Agriculture Food Environment Atlas	Number of farmer's markets in county per capita	Ordinal: Variable measured the number of farmers markets in the county per 1,000 residents. Variable was then grouped into quartiles for analysis.
		Number of farms that sell products directly to consumers in county per capita	Ordinal: Variable measured the number of farmers selling products directly to consumers in the county per 1,000 residents. Variable was then grouped into quartiles for analysis.
		Number of farms offering community supported agriculture (CSA) schemes in county per capita	Ordinal: Variable measured the number of farms offering CSAs in the county per 1,000 residents. Variable was then grouped into quartiles for analysis.
		Number of farms offering agro-tourism in county per capita	Ordinal: Variable measured the number of farms offering agro tourism in the county per 1,000 residents.

Variable Category	Source	Variable	Measurement
			Variable was then grouped into quartiles for analysis.
		Presence of a food hub in the county	Dichotomous: Variable measured the number of food hubs in a county. A food hub is a third party, such as a nonprofit, that facilitates distributions of local foods to institutional or retail settings. This variable was dichotomized due to the skewed distribution of the variable (only 10% of counties had a food hub in the county).

APPENDIX B. SELECT QUESTIONS FROM THE FARM TO SCHOOL (F2S) CENSUS

Question About Any Participation in F2S:

1. Farm to school activities generally center around procurement of local or regional foods and food, agriculture or nutrition-based educational activities such as but not limited to:

    - Serving local food products in school (meals and snacks)
    - Serving local food products in classrooms (snacks, taste tests, educational tools)
    - Conducting educational activities related to local foods such as farmers in the classroom and culinary education focused on local foods, field trips to farms, farmers' markets or food processing facilities, and educational sessions for parents and community members
    - Creating and tending school gardens (growing edible fruits and vegetables)

Based on the definition above, did your district or any schools in your district participate in farm to school activities during the 2013-2014 school year? (Please check one.) *

- Yes **SKIP TO QUESTION 10**
- No, but started activities in 2014-2015 school year **SKIP TO QUESTION 3**
- No, but plan to start activities in the future **SKIP TO QUESTION 6**
- No activities currently and no plans for the future **SKIP TO QUESTION 9**

Question measuring number of activities implemented as part of Farm to School:

To the best of your knowledge, please check the activities that any of your district's schools engaged in during school year 2013-2014. (Please check all that apply.)

- Serving locally produced foods in the cafeteria
- Serving locally produced foods as a Smart Snack (a la carte, as fundraisers, etc.)
- Serving locally produced foods or providing farm to school activities as part of afterschool programs
- Serving products from school-based gardens or school-based farms in the cafeteria
- Holding taste tests/cooking demonstrations of locally produced foods in the cafeteria, classroom or other school-related setting
- Holding taste tests/demos of products from school-based gardens or school-based farms in the cafeteria, classroom or other school-related setting
- Using Smarter Lunchroom strategies to encourage student selection and consumption of locally produced foods (e.g., product placement, food prompts, creative signage, etc.)
- Using cafeteria food coaches to promote the consumption of local foods (e.g. adults or students in the cafeteria encouraging kids to eat healthy/local foods)
- Using USDA Team Nutrition materials (such as *The Great Garden Detective Adventure* or *Dig In!*) as part of taste testing or educational activities
- Conducting edible school gardening or orchard activities as part of a school curriculum
- Conducting edible school gardening or orchard activities as part of an after school program

- Conducting student field trips to farms or orchards
- Having farmer(s) visit the cafeteria, classroom or other school-related setting
- Promoting local efforts through themed or branded promotions (e.g. Harvest of the Month, Local Day, Taste of Washington, etc.)
- Promoting locally produced foods at school in general (e.g. via cafeteria signs, posters, newsletters, etc.)
- Generating media coverage of local foods being used in schools (e.g. press interviews or other activities that resulted in local coverage)
- Hosting farm to school related community events (e.g. invited parents to lunch, corn shucking contests, etc.)
- Celebrating Farm to School Month (October 2013)
- Integrating farm to school concepts, including school gardening activities, into educational curriculum (math, science, language arts, etc.)
- Providing training to school food service staff on farm to school or school gardens
- Working with local food producers to develop a specific food product using local foods
- Implementing farm to school activities as part of overall school efforts to reduce food waste
- Evaluating changes in student acceptance and food waste as a result of implementing farm to school activities
- Other: (please specify)

APPENDIX C. DEMOGRAPHIC CHARACTERISTICS OF FARM TO SCHOOL CENSUS RESPONDENTS PARTICIPATING IN FARM TO SCHOOL (N=3,381)

Characteristic	**Number (%)**
Sample Size	N=3,381
Frequency of Local Fruit Service	
Never	285 (8.40)
Occasionally	636 (18.74)
Monthly	178 (5.25)
More Than Monthly	412 (12.15)
Weekly	432 (12.74)
More Than Weekly	554 (16.34)
Daily	894 (26.36)
Frequency of Local Vegetable Service	
Never	329 (9.70)
Occasionally	754 (22.24)
Monthly	193 (5.69)
More Than Monthly	432 (12.74)
Weekly	442 (13.03)
More Than Weekly	536 (15.81)
Daily	705 (20.79)
Percent of Participants Reporting Benefits as a Result of Farm to School Participation	
Any Benefit	2654 (78.27)
Reduced Food Waste	552 (16.28)
Increased Participation in School Meals	558 (16.46)
Increased Community Support for School Meals	1459 (43.03)
Increased Acceptance of New School Meal Pattern	1009 (29.76)
Reduced Cost of School Meals	714 (21.06)
Number of Auxiliary Farm to School Activities Implemented by School District*	**Mean (Range)**
	3.99 (0-19)
	Mean (SD)
Percent of Students Eligible for Free and Reduced Price School Lunch^	46.23 (21.87)
Percent of Elementary School Students in School District^	48.69 (11.72)
Percent of Students of Color in District*	29.16 (26.68)
Number of Students in School District*	6189.66 (20063.37)

Urbanicity of School District+	n (%)
Large city	84 (2.48)
Midsize city	75 (2.21)
Small city	179 (5.28)
Large suburb	769 (22.68)
Medium suburb	132 (3.89)
Small suburb	89 (2.62)
Fringe town	168 (4.95)
Distant town	329 (9.72)
Remote town	208 (6.13)
Rural fringe	406 (11.97)
Distant rural	594 (17.52)
Rural remote	358 (10.56)
Region Where School District is Located	
Mid Atlantic	397 (11.71)
Mountain Plains	444 (13.09)
Midwest	785 (23.15)
Northeast	598 (17.63)
Southeast	402 (11.85)
Southwest	229 (6.75)
Western	536 (15.81)
Type of Other Local Food Served	
Milk	1682 (49.60)
Baked Goods	949 (27.99)
Dairy Products (Not Fluid Milk)	937 (27.63)
Meat	892 (26.30)
Herbs	782 (23.06)
Grains	731 (21.56)
Eggs	700 (20.64)
Vegetable Protein	665 (19.61)
Seafood	335 (9.88)
Other items	135 (3.98)

*These variables were highly skewed in distribution and could not be transformed. Thus, they were categorized into 4 quartiles for analysis.

^This variable was standardized for analysis