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Planting the Seeds of Security: The Influence of Agricultural Products on Food Security Levels in U.S. Counties

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Abstract

The United States produces, imports, and widely distributes incredible amounts of food every day. Despite the country's abundance and availability of food, a prevalence of people with low food security levels exists. In 2015, 42.2 million U.S. citizens, including children, lived in food insecure households. The source of food insecurity is complexly rooted in the mechanics of America's economic and food systems. Understanding that the fundamental causes of food insecurity are systemic, this study focuses on the impact of one of these potential elements: agriculture. Using economic analysis, this research explores the relationship between various agriculture products and food insecurity levels of counties in the United States. In considering the existing research on the topic, this study hypothesizes that more vegetables grown for fresh market as well as corn grown for grain in counties will have a negative relationship with food insecurity while corn grown for livestock feed will further food insecurity. This research will help to inform policy choices attempting to improve and prevent food insecurity.

I. Introduction

The melting pot culture of the United States is centered on traditions of overindulgence: from Thanksgiving feasts and Halloween candy to southern barbeque, greasy burgers and fries, and "comfort food", like apple pie and macaroni and cheese. Complementing its culture, the U.S. produces, imports, and widely distributes incredible amounts of food every day. Most American grocery stores overflow in abundance with a variety of packaged goods as well as staple and exotic produce. Grocery store shelves are restocked almost as soon as goods are taken from them and shortages of a food item are practically unheard of. Not only is food in the United States extensively available, food prices are relatively low and inexpensive food options are plentiful. Fast food chains litter urban and suburban areas and convenience stores seem to be on every corner. Given the United States' food system, discussion on hunger usually refers to other countries. Physiological hunger is not an appropriate indication of hardship experienced by American people of lower socioeconomic status, as it has been historically, and still is in some less-developed countries. "Food security" and "food insecurity" are the more relevant terminologies to discussion of the United States today. It is important to understand that food insecurity and hunger are not interchangeable terms and to distinguish the two from each other. While food insecurity is an economic and social condition, hunger is an individual-level physiological condition that may result from food insecurity (Definitions of Food Security, 2016).

Food security is a measure of one's ability to provide him or herself with food to adequately meet caloric and nutritional needs. A person's level of food security reflects the resources available to him or her to access and afford healthful food, as well as knowledge about nutrition, residential location, and provisioning for others. A prevalence of people with low food

security levels exists in the U.S. despite the country's abundance and availability of food. In 2015, 42.2 million U.S. citizens, including children, lived in food insecure households (Food Security in the U.S.: Key Statistics and Graphs, 2015). Recognizing the food insecurity of citizens, the United States Department of Agriculture (USDA) has made the alleviation of food insecurity the primary goal of the Supplemental Nutrition Assistance Program (SNAP), which is the largest food assistance program in the country (Gunderson, Kreider, & Pepper, 2011).

Food insecurity reflects the hardships in the lives of individuals and families, and can lead to a number of health issues as well as problems within the community. Processed and packaged foods are often the choices of food insecure individuals and families over wholesome and healthier foods because they are accessible and affordable. Since diets play a large role in human health, this puts food insecure citizens at higher risk for health conditions such as obesity or diabetes (Ploeg & Rahkovsky, 2016). In addition to physical health, food insecurity is correlated with social and psychological health issues for both adults and children. These include behavioral issues, anxiety, depression, and poor academic performance. Apart from health, food insecurity can have consequences of political conflict and instability. Examples include food protests and riots, like the "tortilla riots" in 2007 where Mexican citizens violently protested rising food costs (David J. Tenenbaum, 2008).

The negative consequences of food insecurity in the United States should prompt policymakers to take action in the interest of public health. Federal food assistance programs have shown to be effective in reducing food insecurity by providing relief to those experiencing it. However, these programs do not make changes that would prevent food insecurity from developing because they do not address its origin or driving factors. In the effort to reduce instances of food insecurity, the U.S. government should prioritize providing relief to food

insecure Americans, but also identifying the underlying causes of food insecurity and working towards improving these.

Addressing the source of food insecurity is complex because it is rooted in the mechanics of America's economic and food systems. Poverty, combined with socioeconomic and political problems, is a primary driver of food insecurity (The State of Food Insecurity in the World, 1999). Other important driving factors are food distribution practices, political-agricultural practices, environmental factors, and other political and economic components, which occur on production, distribution, and consumption levels (Food Security and Food Access: What Does "Food Security" Mean?, 2016).

Understanding that the fundamental causes of food insecurity are systemic, this paper focuses on the impact that one of these potential elements, agriculture, has on food insecurity. Using economic analysis, this research will explore the relationship between various agricultural products and food insecurity in U.S. counties. In considering the existing research on the topic, this study hypothesizes that more vegetables grown for fresh market as well as corn grown for grain in counties will reduce food insecurity while corn grown for livestock feed will further food insecurity. This research will help to inform policy choices attempting to improve and prevent food insecurity.

II. Background: Food Insecurity in the United States

Before exploring the question posed by this research, first defining food security and insecurity is necessary. According to the USDA, food insecurity is a household-level economic and social condition of limited or uncertain access to adequate food. Food security, by contrast, is the access by people at all times to enough food for a healthy and active life. The USDA

describes a range of food security and insecurity classification levels. The first is high food security, a condition of no reported indications of problems or limitations to food access. The second category is marginal food security, where one or two indications of food-access issues are reported. These are typically anxiety over food sufficiency or shortage of food in the household, but little or no indication of change in diets or food intake exists. Both of these categories indicate food security, while low food security and very low food security are both measures of food insecurity. Low food security indicates reported reduction in quality, variety, or desirability of diet, but little or no reduction of food intake. Finally, very low security is when multiple indications of disrupted eating patterns and reduced intake is reported. Both of these are due to the individual or household lacking the resources for food. The indicators that determine low levels of food security for an individual or household reported in the annual food security survey include worry that food would run out, food bought did not last, inability to afford a balanced meal, skipping meals or whole days of eating, eating less than felt was adequate, not eating when hungry, weight loss, and more (Definitions of Food Security, 2016).

The status of food security in the U.S.A. is reflected in the results of the 2015 Food Security Supplement of the Current Population Survey (CPS-FSS). Food insecurity rates have been on a downward year-to-year trend since 2011, from nearly 15% to under 13%, but they are still higher than 2007 rates. Out of the food insecure households in the United States, 59% receive assistance from one of the federal government's major food programs. Households with low food security made up 7.7% of the total 12.7% of households in the U.S. that were food insecure, and the remaining 5% had very low food security (Coleman-Jenson, Rabbitt, Gregory, & Singh, 2016).

The CPS-FSS is the method used by the Economics Research Service (ERS) under the USDA to collect data on food security in the country. It is a national survey that has been sent out to households in the United States annually since 1995 and its results are publically available (Food Security in the United States: Food Security Data Access and Documentation Downloads, 2016). Through the Food Security Supplement of the CPS, and the analysis of the results provided by the ERS, the USDA monitors the extent and severity of food insecurity within the country (Coleman-Jenson, Rabbitt, Gregory, & Singh, 2016). With this data, economists have been able to provide insight for policymakers through information on how existing USDA food assistance programs impact food insecurity (Gunderson, Kreider, & Pepper, 2011). These food assistance programs aim to help increase levels of food security through providing low-income households increased access to food, healthful diets, and nutrition education. They include SNAP benefits, the Special Supplemental Nutrition Program for Women, Infants, and children (WIC), the National School Lunch Program (NSLP), and the School Breakfast Program (SBP) (Coleman-Jenson, Rabbitt, Gregory, & Singh, 2016). While USDA food assistance programs, as well as programs within the private sector, help to reduce the incidence of food insecurity in the United States, food insecurity rates will most likely remain high and the consequences of food insecurity will concurrently remain. Therefore, further research on the causes and consequences on food insecurity, as well as the efficacy of different approaches in alleviating it, is needed to address the issue (Gunderson, Kreider, & Pepper, 2011).

Existing economic literature on the issue provides insight to the socioeconomic and demographic factors that serve as the determinants of food security. Households are more likely to be food insecure if they are headed by an individual who is African American, Hispanic, has never been married, is divorced or separated, a renter of the home, younger in age, or less

educated, and if the household has children. A crucial component of food insecurity is the resources available to households (Gunderson, Kreider, & Pepper, 2011).

Research on food security in the United States reveals that it is a complex phenomenon. One reason for this is that the relationship between food security and income, which embodies employment and education level, is somewhat surprising since the probability of food insecurity declines with income, except in the cases of very low food insecurity. High proportions of households close to the poverty line are food secure, and a fairly significant proportion of households above the poverty line are food insecure. Not only is food insecurity not synonymous with hunger but also not with poverty. This demonstrates that food insecurity is not an issue being experienced only by poor people. Income alone does not adequately portray household ability to be food secure, and so several other factors are necessary to determine this (Gunderson, Kreider, & Pepper, 2011).

III. Agriculture's Impact on Food Insecurity

Industrial Agriculture

Agricultural production in the United States has shifted from small, traditional farms to large, industrial operations over the last one hundred years (Rafael Harun & Ogneva-Himmelberger, 2013). Industrial agriculture is large-scale farming using practices such as monocropping (growing only one type of crop in an area), heavy application of chemical fertilizers and pesticides, genetically engineered seeds, intensive irrigation, and mechanized farming methods. Industrial crops are usually commodities and are often used as the raw material for industrial goods, such as processed foods and animal feed, as opposed to direct human consumption (Altieri, 2009).

Large industrial farms in the United States overproduce commodity crops, like corn, soy, and wheat, because they are heavily subsidized by the federal government. According to OECD, total support to agriculture in the United States, an annual monetary value of gross transfers to agriculture from consumers and taxpayers that result from government policies that support agriculture, represented 0.5% of US GDP in 2015 (Producer and Consumer Support Estimates database, 2015). Given the GDP in 2015 was $17.947 trillion, agricultural support amounted to approximately $89.57 billion dollars (National Income and Product Accounts, 2016). Although subsidization programs are intended to ensure American farmers with business and citizens with a supply of food, in reality they hurt food security levels. This is because subsidized commodity crops are usually highly processed into ingredients like high fructose corn syrup, white flour, hydrogenated soybean oil, and more, which are then used to produce packaged food and fast food. Thus, subsidies drive down the prices of foods that are not healthy for the consumer relative to fresh and wholesome foods. When the most affordable food options are those that do not provide the necessary nutrition to be food secure, people stretching their dollars to feed themselves and their families are more likely to be food insecure. Soy and corn are also the main food source for livestock in industrial animal product production, therefore directly influencing the price of meat and dairy. Subsidies are thus focused on commodities that produce unhealthful foods, which contribute to food insecurity, according to its definition. This is especially true in low-income areas because it is easiest to access cheap, unhealthful foods. In addition, cheap production costs push farmers to produce commodity crops, such as corn, soy, and wheat, over fruits, vegetables, and grains that are denser in micronutrients and therefore improve food security. As a result of lower production and lack of subsidies, these healthy foods are much more expensive for the consumer than commodity crops and processed foods (Fields, 2004).

Another modern attempt to increase agricultural yield, in addition to subsidizing commodity crops, is the use of genetically modified crops (GM crops). These are exclusively commodity crops grown on large, mechanized farms. GM seeds are designed to increase crop resistance to the chemical herbicides and pesticides or to produce a pesticide themselves. Genetic modification of crops reduces the need for labor and streamlines production further, but contrary to widespread belief, GM crops do not increase agricultural yield. At the most, they may prevent crop losses under good management, but so can conventional and organic pest control as well as agroecological management, which cost much less and usually better meet small farmer needs. In actuality, increases in yield over the last 15 years have been due to advances in conventional crop breeding as opposed to genetic modification. A study conducted by the European Commission found that GM and conventional hybrid crops had no significant difference in yield and concluded that the adoption of GM crops had no clear benefit. The billions of dollars that go towards GM research could be allocated to more effectively address poverty or other known underlying causes of food insecurity (Shattuck & Holt-Gimenez, 2009). In addition, GM crops could be dangerous for food security in the long run since weeds and insects may evolve with time to overcome the stronger herbicide and pesticides on or in these crops. Achim Steiner, UN Under-Secretary General and Executive Director of UNEP said, "Simply cranking up their fertilizer and pesticide-led production methods of the 20th Century is unlikely to address the challenge (of the food crisis). It will increasingly undermine the critical natural inputs and nature-based services for agriculture" (The Environmental Food Crisis, 2009).

Accompanying industrial production is the long-distance food trade, a long and complex marketing chain used to get food from farmer to consumer. Economists argue that the long-distance food trade is efficient and beneficial, because it provides the lowest food costs to

communities, however it has been determined to be inefficient in several ways. Greater food trade replaces the reliance on local food production, which comes with hidden costs that are not fully reflected in the price of the food. Longer distances require more fuel, packaging, processing, and refrigeration. When food is distributed farther, less of its value is retained locally. The share of the consumer's food dollar that is put back into the farming community has decreased from 40 cents in 1910 to about 7 cents in 1997, while the share going to the many stages between farmer and consumer, including processing, shipping, brokering, advertising, and retailing, continues to grow. In addition, subsidies for gas and roads is provided by taxpayers, separate from the cost of food itself. Long-distance food trade also comes with hidden, non-monetary costs to society and the environment. It creates more waste and pollution, which affect smog and climate change and impacts ecology (Halweil, 2002).

The inefficiency of long distance food trade can be illustrated by areas often importing the same goods that it produces and exports. Analysts of trade date from the United Kingdom found that the country imports similar, large quantities of the many commodities that it exports. This "food swap" is a product of subsidized transportation, centralized buying of food by supermarkets and manufacturers, and import quotas set by trade agreements, and is inefficient and illogical (Lucas, 2001). In addition, researchers at Cornell University found New York farmers were over producing commodity crops, such as corn and soy, according to N.Y. demand and largely under producing nutritious crops, green leafy vegetables, relative to New York demand. These are the same foods most lacking in New Yorkers' diets (Peters, Bills, Wilkins, & Smith, 2003).

Small farmers are disadvantaged by long distance food trade because national and international policies are biased towards large, specialized farms that specialize on broad markets

(Halweil). Communities suffer with this system because it hurts food security. Exporting farmers often go hungry and urban areas are unable to attract grocery stores with healthy options. Farmers do not make enough money to purchase food when enticed into commodity crop production, and therefore their own food security suffers (Halweil, 2002). Additionally, poor distribution creates food deserts, an area lacking food providers with healthy, whole food options, such as grocery stores and supermarkets. Areas qualifying as food deserts used to be mostly urban, but remote rural areas increasingly fit the description as well. Low income people in the Midwestern United States are surrounded by thousands of acres devoted to agriculture whose product gets shipped and processed around the country while they must rely on food banks and convenience stores with limited food options, few nutritious selections, and high prices (Kaufman, 1999).

Industrial agriculture practices are resource intensive and its inputs and infrastructure are expensive and degrade environment. Subsidies and policies encourage industrial production of commodity crops, which in turn makes less healthful foods, such as processed food and animal products, more accessible while simultaneously decreasing accessibility of fresh, micronutrient-dense foods. The long-distance trade of industrial food products requires even more resources and causes inefficient food distribution. For these reasons, industrial agriculture practices hinder the well-being of small farmers and communities and plays a systemic role in food insecurity (Shattuck & Holt-Gimenez, 2009).

Small Scale Agriculture

Agricultural and developmental economists have observed an inverse relationship between farm size and farm productivity since the late 1970's, and so this is now widely

accepted (Barrett, 1993). Research on small-scale agriculture provides that this inverse relationship is due to small farms being more productive due to more efficient use of resources, such as land, water, biodiversity, and other inputs, than large, industrial farms. When total yield from a unit of land is considered, as opposed to the yield of a single type of crop, small farms have yield advantages of 20-60% with the same level of management (Altieri, 2009). Research also shows that small polyculture productions also make more profit per unit of output, even if the production of each single commodity is less than that on large farms (Rosset, 1999). In the United States, the smallest category of agricultural production, two hectare (200 acre) farms, produced $15,104 per hectare and made a profit of $2,902 per hectare while the largest farms, averaging 15,581 hectares, yielded only $249 per hectare with profits of $52 per hectare (Altieri, 2009). In addition, resource conserving agriculture often increases yields. A policy analysis reviewing 286 recent agriculture interventions in 57 poor countries found that they increased productivity on 12.6 million farms while improving the supply of critical environmental services through sustainably enhancing practices. The sustainable enhancement of these farming techniques included increased water efficiency, carbon sequestration, and decreased pesticide use. The researchers found that the average crop yield on the farms in this study increased by 79% and in addition, poor households benefitted substantially (Pretty, et al., 2006).

Small farms are likely to use multiple cropping systems, or polycultures, as opposed to the monocropping techniques of industrial agriculture, in which only one type of plant is grown on a large plot of land. Decreased agricultural biodiversity with monocropping disadvantages productivity because it increases crop vulnerability to pests and diseases, which also increases the need for chemical fertilizers and pesticides. Yields decrease over time using monocropping techniques because it depletes soil of nutrients and causes more soil erosion. Polycultures use

water, light, and nutrients more efficiently than monocropping systems. In addition, the presence of multiple species and efficient occupation of space make multiple cropping systems less vulnerable to the crop loss from weeds, insects, and diseases (Altieri, 2009). Altieri, professor of agroecology at University of California at Berkeley and author, says, "In terms of converting inputs to outputs, society would be better off with small-scale farmers" (2009).

In addition to production efficiency, small-scale agriculture is better for food security levels and the local economy because farmers more often sell directly to the public and receive premium prices for their products (Altieri, 2009). Small-scale farming is more beneficial for food security than industrial farming in the long run as well. Studies show that rural communities that use traditional farming techniques are less vulnerable to catastrophic loss due to variety of crops as well as spatial and temporal arrangements (Lin, 2006). This is important because it demonstrates that small-scale agriculture is better equipped to cope with weather extremes to protect food security, which is increasingly valuable as our population faces climate change (Browder, 1989).

Animal Agriculture

Industrial animal agriculture could be another driver of food insecurity because the production of animal products is an inefficient and wasteful use of natural resources in an effort to feed the population. Pimentel and Pimentel (2003) analyses the environmental sustainability of meat-based diets versus plant-based diets, given the resources required for each and their implications for food availability. The researchers compiled agricultural data on the resource inputs and outputs of crop and livestock production to compare the environmental impacts of the two diets. *One of Pimentel and Pimentel's primary findings was that the seven million livestock*

animals in the United States consume five times as much grain as the human population. This amounts to 41 million tons of plant protein fed to livestock annually, however this produces only 7 million tons of animal protein per year for human consumption. The average livestock animal requires an average six kilograms of feed for every one kilogram of animal protein provided. Alternatively, animal agriculture requires 28 kilocalories of feed crops for every kilocalorie of protein produced for human consumption. However, different types of animals have different rates of converting feed to animal product. Broiler chickens are the most efficient, requiring 2.3 kilograms of grain to provide one kilogram of meat, and lambs to be the most inefficient, requiring 21 kilograms of feed. In addition, eggs are relatively inefficient as a source of protein because 11 kilograms of feed are needed to produce one kilogram of eggs (Pimentel & Pimentel, 2003).

In addition to grains, fuel was analyzed as an input in the production of the two diets. The authors demonstrate that livestock production is a costly use of fuel in comparison to the production of crops. While the fossil fuel energy input to protein output ratio for grains is 3.3 to 1, it is 26 to 1 for eggs, 14 to 1 for milk, 4 to 1 for chicken, 13 to 1 for turkey, 50 to 1 for lamb, and 54 to 1 for beef. Water was another agricultural input researched with similar findings. Crop production naturally requires large amounts of water, as one kilogram of wheat requires 900 liters of water and one kilogram of potatoes needs 500 liters of water to grow. These numbers are trumped by the water resources required to produce one kilogram of chicken or beef, 3,500 and 100,000 liters, respectively. Implications of water inefficiencies are intensified by the current shortages in the U.S. and around the globe. Pimentel also includes land as a resource in the research, providing that 302 million hectares of land in the United States is devoted to producing grain for livestock feed to produce comparatively small amounts of animal protein. This

excessive cultivation of the land contributes substantially to soil erosion, another serious environmental concern (Pimentel & Pimentel, 2003).

An article in the Cornell Chronicle highlighted key implications for the United States' meat-based diet given David Pimentel's research on the waste created by industrial animal agriculture. It emphasizes that the country's animal product production consumes resources out of proportion to yield, accelerates soil erosion, and affects food world supply. More than half of the grain produced in the United States, and approximately 40% of grain produced globally, is being fed to livestock instead of to humans directly. *According to Pimentel's calculations, the reallocation of grain from a source of livestock feed to a direct source of food for citizens would feed 800 million more people* (U.S. could feed 800 million people with the grain that livestock eat, Cornell ecologist advises animal scientists, 1997). This is nearly twenty times the amount of people who were food insecure in the U.S. in 2015 (Coleman-Jenson, Rabbitt, Gregory, & Singh, 2016). Alternatively, if the U.S. exported these excess crops, then the country's trade balance would increase by $80 billion per year (U.S. could feed 800 million people with the grain that livestock eat, Cornell ecologist advises animal scientists, 1997). In addition, the demand for animal products in the United States has grown since Pimentel's study, and so these numbers have since enlarged (Statistics & Information, 2016). As demand for animal products continues to expand and grain supply per capita decreases, even given efforts in increasing total production, the inefficient resource use in animal agriculture will be increasingly important for resource supply and food security (U.S. could feed 800 million people with the grain that livestock eat, Cornell ecologist advises animal scientists, 1997).

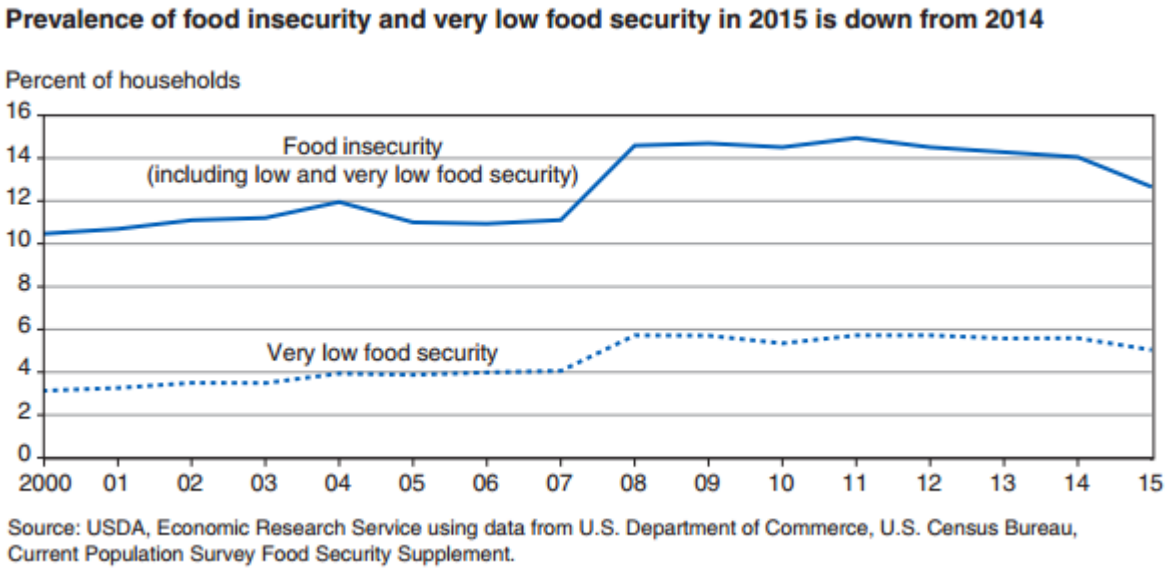
IV. Literature Review

With a background of food insecurity and agriculture established, literature on the subjects can be discussed. The most recent study conducted by the Economics Research Service (ERS) under the United States Department of Agriculture (USDA) on food security in the United States available is from 2015 and official report from September 2016. The data of food security is collected using a supplement to the monthly Current Population Survey conducted by the U.S. Census Bureau which is then compiled and analyzed by the ERS. The supplemental food security survey covered 39,948 of the 125 million U.S. households in December 2015 and one adult completed it for the household. The survey included a series of questions about conditions and behaviors that characterize households if and when meeting basic food needs is difficult. To assess the food security of households, ten questions were asked, and additional eight if the household included children (see sample of these questions in Appendix A). If three or more of the food insecurity conditions are reported, the household is classified as *food insecure.* Households with fewer than three of these conditions are classified as *food secure*. If two or more food insecure conditions for the children are reported, then households qualify as having *food-insecure children*. The category of food insecure was further broken down into *low food security* and *very low food security*, where at least six food insecure conditions were met (Coleman-Jenson, Rabbitt, Gregory, & Singh, 2016).

Illustrated in Figure 1 below, the United States has experienced a downward trend in food insecurity since 2011, however food insecurity is still above 2007 levels. The general findings from analysis of the 2015 food security supplement to the CPS support this trend because they were below 2014 levels. In 2011, 14.9% of U.S. households classified as food insecure whereas 12.7% did in the 2015 results. Out of the 12.7% of food insecure households, 7.7% had low food

insecurity and 5% had very low food insecurity, which was down from 5.6% in 2014. The percentage of children in households who were at times food insecure declined from 9.4% of households in 2014 to 7.8%. Further, households with both adults and children experiencing very low food insecurity at times decreased from 1.1% in 2014 to 0.7% (274,000 households) in 2015. Given citizen reports, the researchers found that food insecurity is typically recurrent, occurring in episodes during some months but not others, as opposed to chronic (Coleman-Jenson, Rabbitt, Gregory, & Singh, 2016).

Figure 1



This study also found that food insecurity rates were substantially higher for households with incomes near or below the poverty line for women or men living alone and for households with children headed by a single woman or man. This is also true for households with black or Hispanic residents. In addition, the ERS found that the median food secure household spent 27% more on food than the median food insecure household of the same size and composition, with food purchases using SNAP assistance included. Out of food insecure households, 59% had participated in one of the three largest USDA food assistance programs in the last month from

when they completed the survey. Researchers found that these findings varied by state (Coleman-Jenson, Rabbitt, Gregory, & Singh, 2016).

With food insecurity as the most important nutrition-related public health issue in the United States, economists Gundersen, Kreider, and Pepper wrote an article that acts as an overview to how economic insights and models have improved understanding the determinants of food insecurity as well as its effects on health and the impacts of food assistance programs on food insecurity rates. Some major determinants of household food insecurity have been found to be when household heads are African American, Hispanic, younger, less educated, have never been married, and have been divorced or separated. These are all conditions that make households more likely to be food insecure, in addition to households with children (Gundersen, Kreider, & Pepper, 2011).

Gunderson, Kreider, and Pepper say that perhaps the most important factors of food security level is the resources available to a household. The relationship of household income to food insecurity found by this research is somewhat unexpected, with probability of food insecurity declining with income. However, this trend applies to food insecure and marginally food secure households, but not households of very low food security. A point emphasized is that research finds poverty to be not synonymous with food insecurity, as high proportions of households in the United States are simultaneously food secure and poor (65% of households close to the poverty line are food secure). In addition, a non-trivial portion of households above the poverty line are food insecure. Rates are over 20% as the income-to-poverty ratio approaches two, and around 10% as it reaches three. The large number of households below the poverty line that are food secure and above the poverty line that are food insecure was surprising. Due to these findings, income levels do not adequately reflect the ability of a household to be food

secure, and further research shows that income over a two-year period is a better predictor. Other economic determinants of food insecurity are found to be low or no value in liquid assets, income volatility, and negative income shocks (Gundersen, Kreider, & Pepper, 2011).

Addressing some of the suggestions from the previous article for further research into food insecurity in the effort to better understand the issue, and ultimately identify strategies to relieve people from hunger, Gundersen, a researcher at the University of Illinois, paired with Feeding America to create *Map the Meal Gap*. The purpose of the *Map the Meal Gap* project is to learn more about food insecurity in the population, and among children, its distribution based on income, and the approximate needs at the local level. This study used state-level data from the Core Food Security Module (CFSM) in the December Supplement of the Current Population Survey (CPS) for the year 2001-2014. All respondents out of the 50,000 households that completed the CPS that provided information on income and food security status. The county-level data on the labor force and children used in *Map the Meal Gap* was from the 2010-2014 five-year ACS estimates and unemployment data from the BLS (Gundersen, Dewey, Crumbaugh, Kato, & Engelhard, 2014).

To estimate food-insecurity rates of individual counties in the U.S., a two-step process was used. Food-insecurity levels in each state was first determined with a regression model using variables that were available in the state-level and county-level data. The explanatory variables used to determine food-insecurity of a household of a given year and state were unemployment rate, poverty rate, median income, percent Hispanic, percent African-American, percent of individuals who were homeowners, a fixed year effect variable, a state fixed effect variable. A household was categorized as food insecure if they answered affirmatively to three or more of the questions from the CFSM. This model was used to estimate food-insecurity rates for

individuals at the county level using the coefficients from the state-level model combined with information on the same variables for counties. The researchers also used the data to determine the budget shortfall of food-insecure households, the cost-of-food index for individual counties, and the national average meal cost (Gundersen, Dewey, Crumbaugh, Kato, & Engelhard, 2014).

The results of the *Map the Meal Gap* project includes the relationships seen between explanatory variables and food insecurity from the regression analysis at the state level. Some of these were that the effects of unemployment and poverty are especially strong indicators of food insecurity, a 1% increase in unemployment rate leads to a 0.53% increase in food insecurity and a 1% increase in poverty rate leads to a 0.17% increase in food insecurity. Another relationship found was that median income and the state's population proportion that is African-American do not have a statistically significant effect on food insecurity levels. However, the state's proportion of population that is Hispanic does have a statistically significant effect on food insecurity, as does the proportion of the population that are homeowners, with a negative relationship to food insecurity (Gundersen, Dewey, Crumbaugh, Kato, & Engelhard, 2014).

Gunderson's results reveal that the trends of food insecurity on the county level is consistent with the historically high national levels in 2014. The food insecurity in U.S. counties ranged from a 37.5% high in Jefferson County, Mississippi, to a 4.3% low in Loudon County, Virginia. Another finding was that between 2013 and 2014, less than 1% of counties saw a significant change in their general food insecurity, the majority being decreases. In addition, this study found the average cost to be food secure in the United States in 2014 was $16.82 per person, per week. The *Map the Meal Gap* project also resulted in the creation of an equation to calculate the cost-of-food index for counties, which is incorporated into another equation, which calculates the value to alleviate food insecurity in each county. A final equation was created, one

that calculates the meal gap, which is the number of meals needed in a county for all individuals to be food secure, while recognizing that the meal gap is descriptive of a food budget shortfall, rather than a literal number of meals (Gundersen, Dewey, Crumbaugh, Kato, & Engelhard, 2014).

The authors conclude with key concepts from existing literature that provide insight for addressing food insecurity. First, growing evidence supports that the Supplemental Nutrition Assistance Program (SNAP) reduces food insecurity, and that the National School Lunch Program (NSLP) may as well. Policy makers should keep in mind the potential of these programs to limit food insecurity and avoid further restriction of the food options under these programs. Secondly, research has established the negative health outcomes of food insecurity, and medical expenditure reduction should be incorporated into relevant cost-benefit considerations of food assistance programs. Next, millions of food insecure households have income levels that are too high to qualify them for federal food assistance. The article concludes by stating that there is critical need for further credible research into the causes and consequences of food insecurity and the efficacy of various approaches for its alleviation in the United States (Gundersen, Kreider, & Pepper, 2011).

V. Theoretical Models

With the guidance of various studies on food security, and their findings on factors that determine food security level, we are able to create theoretical models to predict cases of food insecurity. Three models will be used within the study that will be used against three different dependent variables: the proportion of households within counties with low food security statuses (COUNTYLOW), the proportion of households with very low food security statuses (COUNTYVERYLOW), and county food insecurity rate (FOODINSECURITYRATE). Low and

very low food security statuses are given to households that scored the lowest on a Food Security Rasch Scale, which took the presence or absence of children into account. Low food security indicates reported reduction in quality, variety, or desirability of diet, but little or no reduction of food intake and very low security is when multiple indications of disrupted eating patterns and reduced intake is reported. The food insecurity rate is the percentage of households within a county that qualified as food insecure.

The first model is a food insecurity model, including only variables that explain food insecurity alone. The second and third models include agricultural variables to the food insecurity model to explore their influences on the three food insecurity indicators that serve as dependent variables. The second model includes acres of lettuce, tomatoes, and squash harvested to look at the influence of fresh vegetables grown in counties to be sold unprocessed on food insecurity. The third model looks at the influence of corn grown in counties for grain and for animal feed on food insecurity. Table 1 outlines the variables that make counties most susceptible to food insecurity. The expected signs of each explanatory variable are broken down in Table 1 by all three dependent variables: proportion of low food secure households, proportion of very low food security households, and food insecurity rate. The agricultural variables in the second and third models are located in Table 1 under the dashed line.

Table 1

Variable Definitions		Dependent		
Explanatory		LOW	VERYLOW	RATE
Name	Description	Expected Sign		
COSTPERMEAL	Average cost per meal in a county	+	+	+
COSTOFLIVING (%)	The percentage of median household income that housing and transportation costs make up	+	+	+
POPULATION	Number of people living in a county	+	+	+
HHNUMBER	Total number of persons living in a household (county average)	+	+	+
CHILD	Dummy Variable; 1 if children live in a household, 0 if else (county average)	+	+	+
NOTCITIZEN	Dummy Variable; 1 if household head is not a citizen of the United States, 0 if else (county average)	+	+	+
LOWINCOME	Dummy Variable; 1 if household family income is less than or equal to $22,500 per year, 0 if else (county average)	-	+	-
BLACK	Dummy Variable; 1 if race of household head is African American, 0 if else (county average)	+	+	+
HISPANIC	Dummy Variable; 1 if race of household head is Hispanic, 0 if else (county average)	+	+	+
RENT	Dummy Variable; 1 if household living quarters are being rented, 0 if else (county average)	+	+	+
FEMALEHH	Dummy Variable; 1 if household head is an unmarried female, 0 if else (county average)	+	+	+
SINGLEFEMALE	Dummy Variable; 1 if the household is one female primary individual, 0 if else (county average)	+	+	+
SINGLEMALE	Dummy Variable; 1 if the household is one male primary individual , 0 if else (county average)	+	+	+
UNEMPLOYED	Dummy Variable; 1 if unemployed, 0 if else (county average)	+	+	+
NODIPLOMA	Dummy Variable; 1 if household head's highest level of school is less than graduating high school, 0 if else (county average)	+	+	+
LETTUCEFRESH	Acres of lettuce harvested for fresh market in a county	-	-	-
TOMATOESFRESH	Acres of tomatoes harvested for fresh market in a county	-	-	-
SQUASHFRESH	Acres of squash harvested for fresh market in a county	-	-	-
GRAINCORN	Bushels of corn for grain produced in a county	-	-	-
FEEDCORN	Bushels of corn for siliage or greenchop (animal feed) produced in a county	+	+	+

VI. Theoretical Equations

Testing three models against three separate dependent variables, this study runs regression analysis on nine total models. The theoretical equations of these nine models are listed below, grouped by model type. The first group of three equations are food insecurity models, each with one of the three food insecurity determinations. The second set of three equations are models including the vegetables for fresh market variables and each one is being tested against one of the three food insecurity dependent variables. The third and final group of three theoretical equations are models including the corn for grain and corn for feed variables, each with one of the three food insecurity determinations.

County-level Food Insecurity

$$COUNTYLOW_i = \beta_0 + \beta_1(COSTPERMEAL) + \beta_2(COSTOFLIVING) + \beta_3(POPULATION) + \beta_4(HHNUMBER) + \beta_5(CHILD) + \beta_6(NOTCITIZEN)_i - \beta_7(LOWINCOME)_i + \beta_8(BLACK)_i + \beta_9(HISPANIC)_i + \beta_{10}(RENT)_i + \beta_{11}(FEMALEHH)_i + \beta_{12}(SINGLEFEMALE)_i + \beta_{13}(SINGLEMALE)_i + \beta_{14}(UNEMPLOYED)_i + \beta_{15}(NODIPLOMA)_i + \varepsilon_i$$

$$COUNTYVERYLOW_i = \beta_0 + \beta_1(COSTPERMEAL) + \beta_2(COSTOFLIVING) + \beta_3(POPULATION) + \beta_4(HHNUMBER) + \beta_5(CHILD) + \beta_6(NOTCITIZEN)_i + \beta_7(LOWINCOME)_i + \beta_8(BLACK)_i + \beta_9(HISPANIC)_i + \beta_{10}(RENT)_i + \beta_{11}(FEMALEHH)_i + \beta_{12}(SINGLEFEMALE)_i + \beta_{13}(SINGLEMALE)_i + \beta_{14}(UNEMPLOYED)_i + \beta_{15}(NODIPLOMA)_i + \varepsilon_i$$

$$FOODINSECURITYRATE_i = \beta_0 + \beta_1(COSTPERMEAL) + \beta_2(COSTOFLIVING) + \beta_3(POPULATION) + \beta_4(HHNUMBER) + \beta_5(CHILD) + \beta_6(NOTCITIZEN)_i + \beta_7(LOWINCOME)_i + \beta_8(BLACK)_i + \beta_9(HISPANIC)_i + \beta_{10}(RENT)_i + \beta_{11}(FEMALEHH)_i + \beta_{12}(SINGLEFEMALE)_i + \beta_{13}(SINGLEMALE)_i + \beta_{14}(UNEMPLOYED)_i + \beta_{15}(NODIPLOMA)_i + \varepsilon_i$$

The Impact of Vegetables Grown for Fresh Markets on County-level Food Insecurity

$$COUNTYLOW_i = \beta_0 + \beta_1(COSTPERMEAL) + \beta_2(COSTOFLIVING) + \beta_3(POPULATION) + \beta_4(HHNUMBER) + \beta_5(CHILD) + \beta_6(NOTCITIZEN)_i - \beta_7(LOWINCOME)_i + \beta_8(BLACK)_i + \beta_9(HISPANIC)_i + \beta_{10}(RENT)_i + \beta_{11}(FEMALEHH)_i + \beta_{12}(SINGLEFEMALE)_i + \beta_{13}(SINGLEMALE)_i + \beta_{14}(UNEMPLOYED)_i + \beta_{15}(NODIPLOMA)_i - \beta_{16}(LETTUCEFRESH)_i - \beta_{17}(TOMATOESFRESH)_i - \beta_{18}(SQUASHFRESH)_i + \varepsilon_i$$

$$COUNTYVERYLOW_i = \beta_0 + \beta_1(COSTPERMEAL) + \beta_2(COSTOFLIVING) + \beta_3(POPULATION) + \beta_4(HHNUMBER) + \beta_5(CHILD) + \beta_6(NOTCITIZEN)_i + \beta_7(LOWINCOME)_i + \beta_8(BLACK)_i + \beta_9(HISPANIC)_i + \beta_{10}(RENT)_i + \beta_{11}(FEMALEHH)_i + \beta_{12}(SINGLEFEMALE)_i + \beta_{13}(SINGLEMALE)_i + \beta_{14}(UNEMPLOYED)_i + \beta_{15}(NODIPLOMA)_i - \beta_{16}(LETTUCEFRESH)_i - \beta_{17}(TOMATOESFRESH)_i - \beta_{18}(SQUASHFRESH)_i + \varepsilon_i$$

$$FOODINSECURITYRATE_i = \beta_0 + \beta_1(COSTPERMEAL) + \beta_2(COSTOFLIVING) + \beta_3(POPULATION) + \beta_4(HHNUMBER) + \beta_5(CHILD) + \beta_6(NOTCITIZEN)_i + \beta_7(LOWINCOME)_i + \beta_8(BLACK)_i + \beta_9(HISPANIC)_i + \beta_{10}(RENT)_i + \beta_{11}(FEMALEHH)_i + \beta_{12}(SINGLEFEMALE)_i + \beta_{13}(SINGLEMALE)_i + \beta_{14}(UNEMPLOYED)_i + \beta_{15}(NODIPLOMA)_i - \beta_{16}(LETTUCEFRESH)_i - \beta_{17}(TOMATOESFRESH)_i - \beta_{18}(SQUASHFRESH)_i + \varepsilon_i$$

The Impact of Corn Grown for Grain and Corn Grown for Animal Feed on County-level Food Insecurity

$$COUNTYLOW_i = \beta_0 + \beta_1(COSTPERMEAL) + \beta_2(COSTOFLIVING) + \beta_3(POPULATION) + \beta_4(HHNUMBER) + \beta_5(CHILD) + \beta_6(NOTCITIZEN)_i - \beta_7(LOWINCOME)_i + \beta_8(BLACK)_i + \beta_9(HISPANIC)_i + \beta_{10}(RENT)_i + \beta_{11}(FEMALEHH)_i + \beta_{12}(SINGLEFEMALE)_i + \beta_{13}(SINGLEMALE)_i + \beta_{14}(UNEMPLOYED)_i + \beta_{15}(NODIPLOMA)_i - \beta_{16}(GRAINCORN)_i + \beta_{17}(FEEDCORN)_i + \varepsilon_i$$

$$COUNTYVERYLOW_i = \beta_0 + \beta_1(COSTPERMEAL) + \beta_2(COSTOFLIVING) + \beta_3(POPULATION) + \beta_4(HHNUMBER) + \beta_5(CHILD) + \beta_6(NOTCITIZEN)_i + \beta_7(LOWINCOME)_i + \beta_8(BLACK)_i + \beta_9(HISPANIC)_i + \beta_{10}(RENT)_i + \beta_{11}(FEMALEHH)_i + \beta_{12}(SINGLEFEMALE)_i + \beta_{13}(SINGLEMALE)_i + \beta_{14}(UNEMPLOYED)_i + \beta_{15}(NODIPLOMA)_i - \beta_{16}(GRAINCORN)_i + \beta_{17}(FEEDCORN)_i + \varepsilon_i$$

$$FOODINSECURITYRATE_i = \beta_0 + \beta_1(COSTPERMEAL) + \beta_2(COSTOFLIVING) + \beta_3(POPULATION) + \beta_4(HHNUMBER) + \beta_5(CHILD) + \beta_6(NOTCITIZEN)_i + \beta_7(LOWINCOME)_i + \beta_8(BLACK)_i + \beta_9(HISPANIC)_i + \beta_{10}(RENT)_i + \beta_{11}(FEMALEHH)_i + \beta_{12}(SINGLEFEMALE)_i + \beta_{13}(SINGLEMALE)_i + \beta_{14}(UNEMPLOYED)_i + \beta_{15}(NODIPLOMA)_i - \beta_{16}(GRAINCORN)_i + \beta_{17}(FEEDCORN)_i + \varepsilon_i$$

As illustrated in Table 1 and all nine theoretical equations, the expected signs of COSTPERMEAL and COSTOFLIVING are positive because food security is more difficult to achieve for households in areas that have higher food costs and are more expensive to live in. POPULATION is expected to be positive because with large populations, the probability of food insecure people increases. The expected sign of NOTCITIZEN is positive because immigrants have less opportunity in the United States for high-paying jobs, leaving them in a situation that makes them more likely to have poor socio-economic status, increasing their chance for low or very low food security. The LOWINCOME variable is expected to be positive in the COUNTYVERYLOW model, but negative in the COUNTYLOW model, because of the findings from the 2015 ERS study on food security that low income was only correlated to food insecurity when it was very low and not marginal. The ERS also found that probability of food

insecurity was higher for households of people living alone and for single women who were head of household, and so SINGLEMALE, SINGLEFEMALE, AND FEMALEHH are all anticipated to be positively related to low and very low food security (Coleman-Jenson, Rabbitt, Gregory, & Singh, 2016). BLACK and HISPANIC are both expected to be positive. Both of these race variables lack clear literature supporting a sign. A positive sign was chosen following the example of Gunderson et al., even though they state that research has not yet demonstrated that characteristics, such as black and Hispanic races, are associated with food insecurity (2011). Results from the *Map the Meal Gap* initiative included that the proportion of population who are homeowners have a negative relationship to food insecurity, which is why the variable RENT is anticipated to be positive in the models. The results of *Map the Meal Gap* also determined that unemployment was a strong factor of food insecurity. These results lead the expected sign on UNEMPLOYED to be positive (Gundersen, Dewey, Crumbaugh, Kato, & Engelhard, 2014). HHNUMBER is expected to be positive following studies that show having children increases the chance of food insecurity. Thus, the larger number of people in a household should increase the chance of having low or very low food security (Gundersen, Kreider, & Pepper, 2011). NODIPLOMA is expected to be positive because people who have not completed high school are more likely to have low wage structures, which leads to lower socioeconomic statuses, and therefore are more susceptible to food insecurity. Finally, following Pimentel and Pimentel, the expected signs of LETTUCEFRESH, TOMATOESFRESH, and SQUASHFRESH are negative because more fresh vegetables available within a county will benefit food security levels. The sign on GRAINCORN is expected to be negative while the sign on FEEDCORN is expected to be positive because corn grown for human consumption will directly improve food security levels while corn grown for animals feeds humans indirectly and less efficiently (2003).

VII. Data

The data used in this study is from the 2011 Current Population Survey (CPS) Food Security Supplement provided by the United States Department of Commerce, Bureau of the Census; the United States Department of Labor, Bureau of Labor Statistics; and the United States Department of Agriculture, Economic Research Service (ERS). The data was accessed through the Inter-University Consortium for Political and Social Research (ICPSR 34434). It is a collection of data from two surveys, the CPS and the Food Security Survey supplement of the CPS administered in 2011. The first is a monthly survey that produces current estimates of the economic status and activities of the U.S. population. The latter gathered information on all levels of food security and the severity of food insecurity experienced by all households.

Answers to the survey questions were used to produce multiple scaled measures of food insecurity. One of these measures, HRFS12M1 (from now on referred to as 12SUM), the summary food security statistic of a 12 month reference period, is used to create the COUNTYLOW and COUNTYVERYLOW dependent variables in this study. The variable is categorical and classifies households in the categories food secure, low food security, and very low food security. The latter two categories may be combined as food insecure. This variable is the scale score that is calculated using a single parameter Rasch model.

Rasch Analysis

Analyzing data using a Rasch Model allows one score to characterize an individual. This score is calculated based on the responses of one subject to several questions for which the response choices are given values of 0, 1, 2, 3, etc. The sum of the values to all responses given provides the final score. Rasch analysis allows researchers to compare subjects, independent from their individual response components (Rasch Analysis, 1990).

The Rasch scale in the CPS data was created based off of the raw score (HRFS12M3) and presence or absence of children in a household. The raw score is a count of the number of questions in the food security questionnaire that the household respondent affirmed. The 12SUM score is a continuous score based on filling the data to the Rasch model using item calibrations calculated from the CPS data of 1998. The computed values of each score range from one to fourteen. Households that affirmed none of the questions are food secure and do not have a score based on the Rasch model. Food secure households are instead assigned a value of -6. 12SUM, a measure that combines the information from the food security questionnaire are generally considered to be more reliable measures of food insecurity than responses to individual items (CPS 2011 User Guide, 2013). A sample of the questionnaire is located in appendix A.

The data also provides demographic variables that include race, sex, age, education level, income, occupation, and more. The sample of this dataset comprised of all 53,446 U.S. households that were interviewed for the CPS (CPS 2011, 2013). This study reduced the sample by excluding households 185% or more above the poverty line, households with family incomes greater than or equal to $55,000 over the last twelve months, households where the primary member was in the armed forces, and households categorized as "group living quarters", leaving 5,058 observations.

This study's models requires a variable that accounts for cost of living within counties. Data for this variable was challenging to find, and so this study uses data from Feeding America's *Map the Meal Gap* project and The Center for Neighborhood Technology's Housing and Transportation (H+T) Affordability index to create the COSTOFLIVING and COSTPERMEAL variables to proxy for cost of living. The *Map the Meal Gap* project data from 2012 was received over email, upon request from the researchers at Feeding America. Feeding

America undertook *Map the Meal Guide* project to more accurately assess food insecurity at the congressional district and county-level. The data establishes food insecurity estimates for 3,142 counties, as well as the food budget shortfall, the cost-of-food index, and the average cost of a meal. The average cost of meals per county was derived by weighting the national average cost per meal by the cost-of-food-index. The national average meal cost was determined using data from the Current Population Survey and responses about weekly household expenditures on food. The cost-of-food-index index allows comparability between counties and is created by translating a total market basket from the USDA Thrifty Food Plan (TFP) into a multiplier that can be applied to any dollar amount. This multiplier differs by county, therefore revealing the differences of food costs at the county level (Gundersen, Dewey, Crumbaugh, Kato, & Engelhard, 2014).

The H+T Affordability index measures the true affordability of housing by including the cost of transportation based on a home's location at both the neighborhood and county levels. This dataset was accessed and downloaded through The Center for Neighborhood Technology's H+T website and contains information on 1,809 U.S. counties. The index estimates auto ownership, auto use, and transit use, as a function of median household income, average household size, average commuters per household, gross household density, Regional Household Intensity, fraction of single family detached housing, Employment Access Index, Employment Mix Index, block density, Transit Connectivity Index, Average Available Transit Trips per Week, Transit Access Shed, and Jobs within the Transit Access Shed. The relevant variables in the dataset for this study is the county information and the H+T measure of affordability, which is the percentage of the median household income that the combined housing and transportation costs makes up. Therefore, households in counties with higher percentages pay higher housing

and transportation costs relative to their incomes, and so higher percentages indicate lower affordability. The values for this measure of affordability in the H+T data ranges from 32% to 93% (H+T Index Methods, 2015).

To explore the influence that small-scale agriculture has on county-level food insecurity in the United States, data from the United States Agriculture Data 1840-2012 number 47, which is the data from the 2012 United States Agricultural Census, was used. This dataset was provided by the U.S. Department of Agriculture through the National Agricultural Statistics Service (NASS) and was accessed through the Inter-University Consortium for Political and Social Research (ICPSR 35206). The 2012 United States Agricultural Census is a collection of survey information from 3,130 agricultural operations that potentially meet the farm definition. The dataset contains information on the number, types, output, and prices of the agricultural products and livestock that the farms produce, as well as information on machinery, buildings, farmland, employees, location, etc. (Haines, Fishback, & Rhode, 2012).

The 2012 Agricultural Census data set, the H+T affordability index dataset, and the *Map the Meal Gap* dataset were all merged with the CPS Food Security Supplement dataset by county. All four datasets contained Federal Information Processing Standard (FIPS) state and county identification codes as variables. A variable to identify individual counties was created by dividing the FIPS county code of an observation by 1,000 and adding this to its FIPS state code. This method ensured that there was no overlap of county identification numbers. Table 2 outlines the descriptive statistics of the variables from all four dataset that were used in this study.

Table 2

Descriptive Statistics						
Variable	**N**	**Mean**	**Standard Deviation**	**Max**	**Min**	**Variance**
COUNTYLOW	9653	0.2059	0.1112	1.00	0	0.0124
COUNTYVERYLOW	9653	0.1287	0.0922	1.00	0	0.0085
FOODINSECURITYRATE	9653	0.1515	0.0277	0.23	0.05	0.0008
COSTPERMEAL	9653	2.85	0.3130	0.23	2.05	0.0980
COSTOFLIVING (%)	9653	54.54	7.97	77.00	32.00	63.57
POPULATION	9653	1725632.09	2635419.93	9888601.00	95901.00	6945438200000
HHNUMBER	9653	3.3312	0.6824	7.00	1.00	0.4656
CHILD	9653	0.3118	0.1139	1.00	0	0.0130
NOTCITIZEN	9653	0.1672	0.1365	1.00	0	0.0186
LOWINCOME	9653	0.6305	0.1490	1.00	0.11	0.0222
BLACK	9653	0.1697	0.1832	1.00	0	0.0336
HISPANIC	9653	0.2911	0.2515	1.00	0	0.0633
RENT	9653	1.0940	0.3805	1.00	0	0.1448
FEMALEHH	9653	0.2318	0.1163	1.00	0	0.0135
SINGLEFEMALE	9653	0.1335	0.0846	1.00	0	0.0071
SINGLEMALE	9653	0.1128	0.0816	0.57	0	0.0067
UNEMPLOYED	9653	0.0982	0.0553	0.50	0	0.0031
NODIPLOMA	9653	0.2980	0.1211	1.00	0	0.0147
LETTUCEFRESH	5337	1611.05	11172.18	134662.00	0	124817651.00
TOMATOESFRESH	6758	141.50	380.28	2105.00	0	144613.70
SQUASHFRESH	6494	383.58	1223.49	13408.00	0	1496937.16
GRAINCORN	5866	3043405.93	6905944.97	45464941.00	0	47692076000000
FEEDCORN	6792	95004.00	291604.28	2953108.00	0	85033057171

Several observations stand out in the descriptive statistics of the variables. The mean of NOTCITIZEN indicates that about 17% of survey respondents were not U.S. citizens. Another interesting result is that there are more Hispanic people than Black people in the sample, given that the mean for HISPANIC is 0.2911 while for BLACK it is 0.1697. In addition, the mean value for HHNUMBER is 3, indicating that 3 people live in an average household, but the mean value of CHILD indicates that just 31% of households included children. Another element that stands out is that 30% of the respondents in the sample have not completed high school, which is higher than anticipated because receiving a high school diploma is the norm in our society.

Some observations that stand out about the agricultural variables are that U.S. counties on average devote the most acreage to lettuce production, then squash production, then tomato production. One ton of corn is equal to 45.9296 bushels (Grain.org). Therefore, the mean amount of corn produced in counties for animal feed measured in bushels is 4,363,495.72. Thus, counties produce 1,320,089.79 more bushels of corn for feed than for grain on average.

VIII. Empirical Food Insecurity Models and Results

Using the theoretical models as guides, the following empirical results were found. Tables 3, 4, and 5 provide the regression results for the specifications with the dependent variable COUNTYLOW. Tables 6, 7, and 8 provide the regression results for the specifications with the dependent variable COUNTYVERYLOW. Tables 9, 10, and 11 provide the regression results for the specifications with the dependent variable FOODINSECURITYRATE. The first of the three tables for each dependent variable gives the results to this study's food insecurity model. The second and third tables give the results for the food insecurity models that also include agricultural variables to examine their effects on food insecurity at the county level. The second of the three tables for each dependent variable includes the variables LETTUCEFRESH, TOMATOESFRESH, and SQUASHFRESH, to look at the effects of produce grown specifically for the fresh market in counties on food insecurity. The third table provides the results for the models that include GRAINCORN and FEEDCORN, to investigate the influence of corn grown in counties to be consumed by people as grain as well as the corn grown for livestock feed as an indirect source of human food.

Table 3: County-Level Food Insecurity

Regression Procedure		Adjusted R-Square		
Dependent Variable: Low Food Security		0.1260		
Variable	Parameter Estimate	Standard Error	t-Value	Pr > |t|
INTERCEPT	0.0159	0.0209	0.7600	0.4455
COSTPERMEAL	0.0104	0.0043	2.4200	0.0154
COSTOFLIVING (%)	0.0009	0.0002	5.2700	<.0001
POPULATION	-7.1574E-10	5.114E-10	-1.4000	0.1617
HHNUMBER	0.0067	0.0023	2.8800	0.0040
CHILD	0.1669	0.0112	14.9000	<.0001
NOTCITIZEN	-0.0491	0.0138	-3.5600	0.0004
LOWINCOME	0.0198	0.0091	2.1800	0.0292
BLACK	0.0301	0.0076	3.9400	<.0001
HISPANIC	0.0811	0.0077	10.6000	<.0001
RENT	-0.0370	0.0075	-4.9200	<.0001
FEMALEHH	0.0404	0.0106	3.8200	0.0001
SINGLEFEMALE	0.0575	0.0156	3.6800	0.0002
SINGLEMALE	-0.1547	0.0159	-9.7400	<.0001
UNEMPLOYED	0.1215	0.0201	6.0300	<.0001
NODIPLOMA	0.0458	0.0121	3.8000	0.0001

Table 3 provides the results for the food insecurity model with the dependent variable low food security (COUNTYLOW). This food insecurity model determining low food security had an adjusted R-square of 0.1260. All explanatory variables in this specification were statistically significant at the 5% level, except for POPULATION. Counties with more children had the largest influence, increasing the probability of low food security by 16.7%. Counties with higher unemployment rates increased the chance of low food security by 12.2%.

Several variables in this regression output had unexpected signs, including counties with higher percentage of households with low income. The expected negative relationship for low food security with low income was based off of literature finding income levels to have a positive relationship with food insecurity only when it was to the extent of very low food security. The possibility exists that this literature and the data used for this study had different measurements of income. Another element of this specification with an unexpected signs was

counties with populations with higher percentages of noncitizens. One could argue that people coming in from other countries may lead lifestyles that are more modest or thrifty than the average American and this type of cultural difference is not captured in the data.

Table 4: County-Level Food Insecurity and Vegetables for Fresh Market

Regression Procedure		Adjusted R-Square		
Dependent Variable: Low Food Security		0.3213		
Variable	Parameter Estimate	Standard Error	t-Value	Pr > |t|
INTERCEPT	0.0036	0.0368	0.1000	0.9217
COSTPERMEAL	0.0223	0.0091	2.4500	0.0145
COSTOFLIVING (%)	0.0018	0.0004	5.0000	<.0001
POPULATION	3.6067E-09	6.2994E-10	5.7300	<.0001
HHNUMBER	-0.0088	0.0033	-2.6800	0.0074
CHILD	0.2656	0.0165	16.1200	<.0001
NOTCITIZEN	-0.1240	0.0265	-4.6900	<.0001
LOWINCOME	-0.0310	0.0134	-2.3200	0.0203
BLACK	-0.1407	0.0129	-10.9000	<.0001
HISPANIC	0.1191	0.0168	7.0800	<.0001
RENT	-0.1050	0.0112	-9.4000	<.0001
FEMALEHH	0.1101	0.0200	5.5100	<.0001
SINGLEFEMALE	0.1666	0.0238	7.0100	<.0001
SINGLEMALE	0.1695	0.0215	7.9000	<.0001
UNEMPLOYED	0.1442	0.0263	5.4900	<.0001
NODIPLOMA	-0.0345	0.0200	-1.7300	0.0844
LETTUCEFRESH	-1.8200E-06	1.5351E-07	-11.8700	<.0001
TOMATOESFRESH	-2.5756E-04	1.2050E-05	-21.3700	<.0001
SQUASHFRESH	7.7640E-05	3.1300E-06	24.8200	<.0001

Table 4 gives the results for the food insecurity model with the dependent variable low food security that also includes the agricultural variables for vegetables produced for the fresh market. Including the three agricultural variables (LETTUCEFRESH, TOMATOESFRESH, and SQUASHFRESH) resulted in a model with an adjusted R-square of 0.3213. In general, the variables had more explanatory power for low food security when the agricultural variables were included. All of the explanatory variables in this specification were statistically significant at the 5% level, except for NODIPLOMA. Counties with more children once again had the strongest

explanatory relationship to low food security, increasing the probability by 26.6%. Counties with more households that have one member, regardless of gender, increased the probability of low food security by about 17%. The probability of low food security increased by 14.4% when household heads were unemployed.

The results of this specification had several variables with unexpected signs, which included counties with a higher percentage of African American households. Reevaluating the meanings of this variable, racial minority households may be more likely to apply for and receive federal food assistance, making them more food secure at lower levels of income. Counties with a higher average number of people per household had an unexpected sign. It is possible that this variable's negative relationship with low food security is due to more people within households having jobs, and contributing money to buy food for the family, when average number of people per household increases. Counties with a higher percentage of noncitizens had an unexpected sign in this model as well.

Focusing on the role that agriculture plays in food insecurity, the three agricultural variables in Table 4 tell us how vegetables produced in U.S. counties for fresh sale to citizens are related to low food security levels. In counties with more acres devoted to the production of lettuce and tomatoes for fresh market, low food security was 0.0002% and 0.03% less likely, respectively. This produce can decrease the incidence of food insecurity as fresh and healthy foods at possible lower costs. Counties with more acres devoted to squash production for fresh market were 0.008% more likely to experience low food security levels. The positive coefficient for squash production is unexpected and why it differs from the lettuce and tomato variables merits further study.

Table 5: County-Level Food Insecurity and Corn for Grain vs. Corn for Feed

Regression Procedure		Adjusted R-Square		
Dependent Variable: Low Food Security		0.1071		
Variable	Parameter Estimate	Standard Error	t-Value	Pr > |t|
INTERCEPT	0.1320	0.0359	3.6800	0.0002
COSTPERMEAL	0.0082	0.0083	0.9900	0.3209
COSTOFLIVING (%)	0.0007	0.0003	2.2300	0.0259
POPULATION	-1.7350E-08	2.3003E-09	-7.5400	<.0001
HHNUMBER	0.1528	0.0168	9.1000	<.0001
CHILD	-0.0319	0.0045	-7.1000	<.0001
NOTCITIZEN	0.0088	0.0243	0.3600	0.7180
LOWINCOME	-0.0049	0.0133	-0.3700	0.7142
BLACK	0.0625	0.0130	4.8200	<.0001
HISPANIC	0.1154	0.0154	7.5000	<.0001
RENT	0.0221	0.0118	1.8700	0.0615
FEMALEHH	0.0507	0.0159	3.1900	0.0014
SINGLEFEMALE	-0.0101	0.0220	-0.4600	0.6477
SINGLEMALE	-0.0704	0.0232	-3.0300	0.0024
UNEMPLOYED	0.2456	0.0322	7.6300	<.0001
NODIPLOMA	0.0520	0.0187	2.7800	0.0055
GRAINCORN	-5.6079E-10	2.4793E-10	-2.2600	0.0238
FEEDCORN	2.0939E-09	5.8697E-09	0.3600	0.7213

Table 5 provides the results for the food insecurity model with the two agricultural variables, GRAINCORN and FEEDCORN, and the determination of low food security. This model had an adjusted R-Square of 0.1071. The statistically significant variables at the 5% level were COSTOFLIVING, POPULATION, HHNUMBER, CHILD, BLACK, HISPANIC, FEMALEHH, SINGLEMALE, UNEMPLOYED, NODIPLOMA, and GRAINCORN. The element with the most explanatory power was county rate of unemployment, which increased the probability of low food security by 24.6%. In addition, average number of people per household increased the chance of low food security by 15.3%. A notable result was that counties with more children, or higher numbers of average inhabitants per household, and higher unemployment rates had the most influence on low food security levels in all three of these

models. It is interesting that the percent of households that have children is not significant but the average number of people per household is, since these numbers would seem to correlate.

The agricultural variables in this model are included to investigate the impact of corn produced in counties for grain and corn produced for livestock feed on the probability of low food security. The results tell us that when corn produced for grain increases, the probability of low food security decreases by 6×10^{-8} percent. The variable for corn produced for livestock feed was not significant in this specification.

Table 6: County-Level Food Insecurity

Regression Procedure		Adjusted R-Square		
Dependent Variable: Very Low Food Security		0.0702		
Variable	Parameter Estimate	Standard Error	t-Value	Pr > |t|
INTERCEPT	-0.0281	0.0178	-1.5800	0.1151
COSTPERMEAL	-0.0001	0.0037	-0.0200	0.9826
COSTOFLIVING (%)	0.0008	0.0001	5.2400	<.0001
POPULATION	2.0050E-09	4.3735E-10	4.5800	<.0001
HHNUMBER	0.0134	0.0020	6.7700	<.0001
CHILD	-0.0192	0.0096	-2.0000	0.0455
NOTCITIZEN	-0.1685	0.0118	-14.2900	<.0001
LOWINCOME	0.0640	0.0078	8.2500	<.0001
BLACK	0.0001	0.0065	0.0200	0.9869
HISPANIC	0.0080	0.0066	1.2200	0.2224
RENT	0.0823	0.0064	12.8200	<.0001
FEMALEHH	0.0536	0.0090	5.9300	<.0001
SINGLEFEMALE	-0.0077	0.0134	-0.5800	0.5651
SINGLEMALE	-0.1468	0.0136	-10.8100	<.0001
UNEMPLOYED	0.1314	0.0172	7.6300	<.0001
NODIPLOMA	0.0190	0.0103	1.8400	0.0659

Table 6 provides the results for the food insecurity model with the determination of very low food security (COUNTYVERYLOW). This specification had an adjusted R square of 0.0702. The explanatory variables in the regression output for this model that were statistically significant at the 5% level were COSTOFLIVING, POPULATION, HHNUMBER, CHILD, NOTCITIZEN, LOWINCOME, RENT, FEMALEHH, SINGLEMALE, and UNEMPLOYED.

Counties with more noncitizens citizens and counties with more households composed of one male individual decreased the probability of very low food security by 16.9% and 14.7%, respectively. When counties had higher unemployment rates, the chance of low food security increased by 13.1%. Contrasting findings for low food security, for which counties with more children had high explanatory power in the expected direction, this model had an unexpected sign for counties with more children.

Table 7: County-Level Food Insecurity and Vegetables for Fresh Market

Regression Procedure		Adjusted R-Square		
Dependent Variable: Very Low Food Security		0.3491		
Variable	Parameter Estimate	Standard Error	t-Value	Pr > |t|
INTERCEPT	-0.1358	0.0325	-4.1800	<.0001
COSTPERMEAL	0.1198	0.0081	14.8700	<.0001
COSTOFLIVING (%)	-0.0015	0.0003	-4.7700	<.0001
POPULATION	1.0499E-09	5.5692E-10	1.8900	0.0595
HHNUMBER	0.0277	0.0029	9.5000	<.0001
CHILD	-0.1891	0.0146	-12.9800	<.0001
NOTCITIZEN	-0.5354	0.0234	-22.8900	<.0001
LOWINCOME	-0.0561	0.0118	-4.7500	<.0001
BLACK	0.0890	0.0114	7.8000	<.0001
HISPANIC	0.1433	0.0149	9.6300	<.0001
RENT	0.1823	0.0099	18.4600	<.0001
FEMALEHH	-0.1134	0.0177	-6.4100	<.0001
SINGLEFEMALE	-0.0603	0.0210	-2.8700	0.0041
SINGLEMALE	-0.3197	0.0190	-16.8500	<.0001
UNEMPLOYED	0.0752	0.0232	3.2400	0.0012
NODIPLOMA	0.0664	0.0176	3.7600	0.0002
LETTUCEFRESH	-1.9400E-06	1.3571E-07	-14.2800	<.0001
TOMATOESFRESH	-4.9630E-05	1.0650E-05	-4.6600	<.0001
SQUASHFRESH	3.0840E-05	2.7700E-06	11.1500	<.0001

Table 7 gives the results for the food insecurity model with very low food security as its dependent variable that also includes the agricultural variables for vegetables produced for the fresh market. Including the three agricultural variables (LETTUCEFRESH, TOMATOESFRESH, and SQUASHFRESH) resulted in a model with an adjusted R-square of 0.3491. All of the explanatory variables in this specification were statistically significant at the

5% level, except for POPULATION. Counties with more noncitizens household heads decreased the probability of very low food security by 53.5%. When counties had more children and had more households with one male member, the chance of very low food security decreased by 18.9% and 32%, respectively. The unexpected signs on these two variables, as well as the unexpected sign on noncitizen household heads, are consistent with the previous model.

The results in Table 7 show us how fresh vegetables produced in counties are related to very low food security levels. When acres devoted to the production of lettuce and tomatoes for fresh market increases, the probability of very low food security decreases by 0.0002% and 0.005%, respectively, which are consistent with our expectations. However, counties with more acres devoted to squash production for fresh market had an unexpectedly positive relationship to very low food security and increased its probability by 0.003%.

Table 8: County-Level Food Insecurity and Corn for Grain vs. Corn for Feed

Regression Procedure		Adjusted R-Square		
Dependent Variable: Very Low Food Security		0.123		
Variable	Parameter Estimate	Standard Error	t-Value	Pr > |t|
INTERCEPT	-0.0515	0.0307	-1.6800	0.0937
COSTPERMEAL	0.0443	0.0071	6.2500	<.0001
COSTOFLIVING (%)	0.0009	0.0003	3.4100	0.0006
POPULATION	-6.7507E-09	1.9721E-09	-3.4200	0.0006
HHNUMBER	-0.0168	0.0039	-4.3700	<.0001
CHILD	-0.0161	0.0144	-1.1200	0.2620
NOTCITIZEN	-0.1868	0.0208	-8.9800	<.0001
LOWINCOME	0.0848	0.0114	7.4200	<.0001
BLACK	0.0330	0.0111	2.9700	0.0030
HISPANIC	0.0279	0.0132	2.1200	0.0342
RENT	0.1225	0.0101	12.1300	<.0001
FEMALEHH	0.0025	0.0136	0.1800	0.8533
SINGLEFEMALE	-0.1201	0.0189	-6.3600	<.0001
SINGLEMALE	-0.2387	0.0199	-11.9900	<.0001
UNEMPLOYED	0.1071	0.0276	3.8800	<.0001
NODIPLOMA	0.0139	0.0161	0.8700	0.3865
GRAINCORN	-1.7719E-09	2.1255E-10	-8.3400	<.0001
FEEDCORN	1.0187E-08	5.0321E-09	2.0200	0.0430

Table 8 provides the results for the food insecurity model with the determination of very low food security that also includes the agricultural variables of corn produced for grain and corn produced for livestock feed. This model has an adjusted R-Square of 0.123. Only three explanatory variables in this specification were not statistically significant, which were CHILD, FEMALEHH, and NODIPLOMA. A notable result is that counties with higher percentages of households renting their homes increased the probability of very low food security by 12.3%. Counties with higher rates of unemployment also increased the incidence of very low food security by 10.7%. Consistent with the two previous models, the variables for percentage of households with children, with noncitizen household heads, and with one male member had unexpected signs.

These results show us the impact that corn produced in counties has on food insecurity rates. While corn produced for grain reduced the probability of very low food security by 2×10^{-7} percent, corn produced for livestock feed increased it by 1×10^{-6} percent. These relationships were anticipated because they confirm that corn for grain, a direct human food source, is positively correlated to very low food security and corn for livestock feed, and indirect human food source and an input to food that is less healthful for consumers, is negatively correlated to very low food security.

Table 9: County- Level Food Insecurity

Regression Procedure		Adjusted R-Square		
Dependent Variable: Food Insecurity Security Rate		0.3709		
Variable	Parameter Estimate	Standard Error	t-Value	Pr > |t|
INTERCEPT	0.2814	0.0044	63.9500	<.0001
COSTPERMEAL	-0.0425	0.0009	-46.8000	<.0001
COSTOFLIVING (%)	-0.0004	3.6290E-05	-11.9700	<.0001
POPULATION	1.2732E-09	1.0794E-10	11.8000	<.0001
HHNUMBER	-0.0020	0.0005	-4.0100	<.0001
CHILD	-0.0565	0.0024	-23.8900	<.0001
NOTCITIZEN	-0.0058	0.0029	-2.0000	0.0456
LOWINCOME	0.0171	0.0019	8.9500	<.0001
BLACK	0.0594	0.0016	36.8800	<.0001
HISPANIC	0.0291	0.0016	18.0300	<.0001
RENT	0.0157	0.0016	9.9300	<.0001
FEMALEHH	-0.0017	0.0022	-0.7600	0.4493
SINGLEFEMALE	-0.0401	0.0033	-12.1600	<.0001
SINGLEMALE	-0.0019	0.0034	-0.5500	0.5813
UNEMPLOYED	0.0300	0.0043	7.0600	<.0001
NODIPLOMA	0.0097	0.0025	3.8100	0.0001

Table 9 provides the results for the food insecurity model with the dependent variable of food insecurity rate. This model determining food insecurity rate had an adjusted R-Square of 0.3709. All explanatory variables were statistically significant, except for FEMALEHH and SINGLEMALE. Counties with a higher percentage of African American households and of households with children had the most explanatory power for this specification, increasing the food insecurity rate by 0.06 and decreasing it by 0.06, respectively. The negative relationship that counties with more children had to the dependent variable was unexpected. Additional elements with unexpected signs were cost of living and cost per meal within counties, average number of people per household, percentage of noncitizens, and percentage of households with one female member.

Table 10: County- Level Food Insecurity and Vegetables for Fresh Market

Regression Procedure		Adjusted R-Square		
Dependent Variable: Food Security Rate		0.5326		
Variable	Parameter Estimate	Standard Error	t-Value	Pr > |t|
INTERCEPT	0.2405	0.0079	30.4500	<.0001
COSTPERMEAL	-0.0514	0.0020	-26.2400	<.0001
COSTOFLIVING (%)	0.0005	0.0001	7.0100	<.0001
POPULATION	2.0677E-09	1.3533E-10	15.2800	<.0001
HHNUMBER	0.0035	0.0007	4.9600	<.0001
CHILD	-0.0558	0.0035	-15.7600	<.0001
NOTCITIZEN	-0.0463	0.0057	-8.1500	<.0001
LOWINCOME	0.0214	0.0029	7.4400	<.0001
BLACK	0.0664	0.0028	23.9300	<.0001
HISPANIC	0.0279	0.0036	7.7300	<.0001
RENT	0.0087	0.0024	3.6200	0.0003
FEMALEHH	0.0003	0.0043	0.0700	0.9460
SINGLEFEMALE	-0.0222	0.0051	-4.3600	<.0001
SINGLEMALE	0.0010	0.0046	0.2300	0.8214
UNEMPLOYED	0.0002	0.0057	0.0300	0.9746
NODIPLOMA	0.0032	0.0043	0.7400	0.4585
LETTUCEFRESH	-1.8297E-07	3.2979E-08	-5.5500	<.0001
TOMATOESFRESH	-1.4070E-05	2.5900E-06	-5.4300	<.0001
SQUASHFRESH	7.6200E-06	6.7195E-07	11.3300	<.0001

Table 10 gives the results for the food insecurity model with the dependent variable food insecurity rate that also includes the agricultural variables for vegetables produced for the fresh market. Including the three agricultural variables (LETTUCEFRESH, TOMATOESFRESH, and SQUASHFRESH) resulted in a model with an adjusted R-square of 0.5326. Four explanatory variables in this specification, FEMALEHH, SINGLEMALE, UNEMPLOYED, and NODIPLOMA are not statistically significant at the 5% level. Counties with higher percentages of African American households had the most explanatory power in this model, increasing the food insecurity rate by 0.07. Unexpected signs resulted again for percentage of households with children and percentage of noncitizen household heads, which were influential in the expected direction for models with previous dependent variables.

The results in Table 10 demonstrate that the production of lettuce and tomatoes for fresh market in a county decreases the food insecurity rate by 2 x 10^{-7} and 1 x 10^{-5}, while the production of squash for fresh market increases the food insecurity rate by 8 x 10^{-6}. This unexpected sign for acres of squash produced in the county for fresh market is consistent with the results for first two dependent variables.

Table 11: County-Level Food Insecurity and Corn for Grain vs. Corn for Animal Feed

Regression Procedure		Adjusted R-Square		
Dependent Variable: Food Insecurity Rate		0.4901		
Variable	Parameter Estimate	Standard Error	t-Value	Pr > |t|
INTERCEPT	0.3062	0.0070	43.6200	<.0001
COSTPERMEAL	-0.0636	0.0016	-39.2600	<.0001
COSTOFLIVING (%)	-3.5850E-05	6.3010E-05	-0.5700	0.5694
POPULATION	3.5991E-09	4.5028E-10	7.9900	<.0001
HHNUMBER	-0.0514	0.0033	-15.6600	<.0001
CHILD	0.0006	0.0009	0.6800	0.4964
NOTCITIZEN	0.0019	0.0048	0.4100	0.6829
LOWINCOME	0.0112	0.0026	4.3000	<.0001
BLACK	0.0609	0.0025	23.9700	<.0001
HISPANIC	0.0092	0.0030	3.0600	0.0022
RENT	0.0216	0.0023	9.3400	<.0001
FEMALEHH	-0.0010	0.0031	-0.3300	0.7401
SINGLEFEMALE	-0.0370	0.0043	-8.5900	<.0001
SINGLEMALE	0.0083	0.0045	1.8300	0.0680
UNEMPLOYED	-0.0075	0.0063	-1.1900	0.2329
NODIPLOMA	0.0256	0.0037	7.0000	<.0001
GRAINCORN	-9.5328E-10	4.8532E-11	-19.6400	<.0001
FEEDCORN	1.1897E-08	1.1490E-09	10.3500	<.0001

Table 11 provides the results for the food insecurity model with the dependent variable food insecurity rate that also includes the agricultural variables of corn produced for grain and corn produced for feed. This specification had an adjusted R square of 0.4901. Food insecurity rate increased by 0.06 when counties had higher percentages of African American households. The results for the agricultural variables in this model were consistent with the results in Table 8.

Corn produced for grain in counties decreased the food security rates by 10×10^{-10} while corn produced for feed increased the rate by 1×10^{-8}.

IX. Conclusion and Future Implications

Food insecurity is complex and has numerous fundamental drivers, one being agriculture. Using economic analysis, this research explores the relationship between various agricultural products and food insecurity in U.S. counties. In considering the existing research on the topic, this study hypothesizes that more vegetables grown for fresh market as well as corn grown for grain in counties will have a negative relationship with food insecurity while corn grown for livestock feed will further food insecurity. This research will help to inform policy choices attempting to improve and prevent food insecurity.

Table 12: Important Results

Explanatory Variable:	Model:	Low Food Security	Very Low Food Security	Food Insecurity Rate
Unemployed	Food Insecurity	12%	13%	0.03
	Vegetables for Fresh Market	14%	14%	8.00
	Grain Corn vs. Feed Corn	25%	11%	-
Black	Food Insecurity	3%	-	0.06
	Vegetables for Fresh Market	-14%	9%	0.06
	Grain Corn vs. Feed Corn	6%	3%	0.06
Hispanic	Food Insecurity	8%	-	0.03
	Vegetables for Fresh Market	12%	14%	0.03
	Grain Corn vs. Feed Corn	12%	3%	0.01
Lettuce Fresh	Vegetables for Fresh Market	-0.0001820%	-0.0001940%	-1.83E-07
Tomatoes Fresh	Vegetables for Fresh Market	-0.0257560%	-0.0049630%	-1.41E-05
Squash Fresh	Vegetables for Fresh Market	0.0077640%	0.0030840%	7.62E-06
Corn for Grain	Grain Corn vs. Feed Corn	-0.0000001%	-0.0000002%	-9.53E-10
Corn for Feed	Grain Corn vs. Feed Corn	-	0.0000010%	1.19E-08

The most important results from the nine regression outputs were compiled in Table 12. The first noteworthy result was the trend of unemployment's consistently significant and positive

relationship to food insecurity. The first row of results indicate that in the food insecurity model, counties with higher unemployment rates increase the probability of low food security by 12%, the probability of very low food security by 13%, and the food insecurity rate by 0.03. When the vegetables for fresh market are added to the equation, the correlation between the dependent variables and unemployment are even stronger. This relationship is strongest when the corn variables are added to the model, excluding food insecurity rate, which did not have a significant coefficient. Another important result is that African American and Hispanic racial minorities had consistent positive correlations with food insecurity across the nine models.

The relationships that are most important to consider in the results are the agricultural variables. The rows of the fourth, fifth, and sixth explanatory variables in Table 12 provide the relationships found between vegetables for fresh market and each of the dependent variables. When more lettuce and tomatoes are grown within counties for fresh market, low food security and very low food security are less likely and the food insecurity rate is lower. However squash consistently had the opposite relationship to food insecurity, which was the opposite of what we expected. The results for the last two explanatory variables in Table 12, corn for grain and corn for feed, indicate that when counties grow more corn for grain, a direct source of food for people, the probability of food insecurity is lower, whereas when counties grow more corn for livestock feed, an indirect source of food for people, the probability of food insecurity is higher.

For some of the explanatory variables in this study's models, the justifications behind their impact was difficult to decide. Expected signs were guided by past literature, however we can come up with equally economically sustainable arguments for the alternative directions. For example, counties with more households with one member, regardless of sex, were expected to negatively impact food insecurity levels. We can make the argument that these people live with

circumstances making them worse off, but we can also make the argument that less money is needed to support just one person. Another example is counties with more households that rent their homes. These families may not be able to afford homes, which reflects their lower ability to provide food, but perhaps renting their homes demonstrates that they are living lifestyles that are wise given their economic status, in which they can comfortably afford to provide food. The latter of these two scenarios would suggest a sign opposite of what was expected in this study for the variable RENT. Analyzing the variables in this way reveals that the data is missing the aspect of human behavior. We cannot be sure who these people are and how they are living. This element would help us to determine expectations as well as better understand our results. We must also consider that this is self-reported data and even though there are some interesting findings, we have to understand and acknowledge the bias that comes from this kind of information.

While reviewing the results of this study, it is important to keep in mind that food security is a relatively new social and political concept. Not a lot of economic research has been done on the subject, and so this study is an important first step. Though the impacts of the explanatory variables on low and very low food security and food insecurity rate are not incredibly substantial, it is noteworthy that they had significant outcomes because it opens the door for policy addressing food insecurity in the future. This is especially because food insecurity is a social matter that is difficult for many people to address, as it impacts dignity and status. Therefore, these results provide avenues through which food insecurity could be addressed and help to identify the Americans who may need assistance but are too proud to pursue it.

Exploring agriculture as a factor of food insecurity is also a new concept without much existing economic literature, and so this study is just the beginning of researching this relationship. Taking this research to the next level might be include controlling for county size and farm size. The models in this study were not ideal and the impacts were small, however the importance of the agricultural variable's statistically significant effects on food insecurity must be revealed before this research can be improved. The controversy of the subject is high because uncovering the relationships between certain agricultural products, such as corn, and food insecurity could potentially take away from large, powerful, and subsidized industries, such the processed food, meat, and dairy industries. With priority placed on profit instead of citizen well-being and the environment within these industries, the initiative to pursue research like this is very small. However research can't take a back seat to profit-orientation any longer. Humanitarians, environmentalists, and economists need to converge their ideas and research efforts to achieve a new type of profit-maximization: one that is not measured in dollars but one that betters the lives of citizens and the conditions of our environment.

Works Cited

Altieri, M. A. (2009, July-August). Agroecology, Small Farms, and Food Sovereignty. *Monthly Review, 61*(03). Retrieved 2017, from https://monthlyreview.org/2009/07/01/agroecology-small-farms-and-food-sovereignty/

Appendix A.: Census of Agriculture Methodology. (2012). Retrieved 2016, from 2012 Census of Agriculture: https://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_1_US/usappxa.pdf

Barrett, C. B. (1993). *On Price Risk and the Inverse Farm Size-Productivity Relationship.* University of Wisconsin-Madison, Agricultural Economics. Retrieved 2017, from https://pdfs.semanticscholar.org/2b3c/36a7398c6bc0ed7ed351db6b67a28003d265.pdf

Browder, J. O. (Ed.). (1989). *Fragile Lands of Latin America: Strategies for Sustainable Development.* Boulder, Colorado, USA: Westview Press. Retrieved 2017

Coleman-Jenson, A., Rabbitt, M. P., Gregory, C. A., & Singh, A. (2016). *Household Food Security in the United States in 2015.* Economic Research Service. Retrieved October 20, 2016, from http://www.ers.usda.gov/publications/pub-details/?pubid=79760

Current Population Survey, December 2011: Food Security Supplement (ICPSR 34434). (2013, April 12). Retrieved from ICPSR: http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/34434?q =34434

Current Population Survey, December 2011: Food Security Supplement (ICPSR 34434): User Guide. (2013, April 12). Retrieved 2016, from ICPSR: http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/3 4434?q =34434

Data Download. (2015). Retrieved 2017, from H+T Index: http://htaindex.cnt.org/download/data.php

Definitions of Food Security. (2016, October 4). Retrieved October 20, 2016, from Economics Research Service, USDA: http://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/definitions-of-food-security.aspx

Fields, S. (2004, October). The Fat of the Land: Do Agricultural Subsidies Foster Poor Health? *Environmental Health Perspectives, 112*(14), A820–A823. Retrieved 2017, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1247588/

Food Security and Food Access: What Does "Food Security" Mean? (2016). (GRACE Communications Foundation) Retrieved November 2, 2016, from Sustainable Table: http://www.sustainabletable.org/280/food-security-food-access

Food Security in the U.S.: Key Statistics and Graphs. (2015). Retrieved November 2, 2016, from USDA Economic Research Service: http://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/key-statistics-graphics.aspx#insecure

Food Security in the United States: Food Security Data Access and Documentation Downloads. (2016, October 20). (U. S. Agriculture, Producer) Retrieved November 2016, from Economic Research Service: https://www.ers.usda.gov/data-products/food-security-in-the-united-states.aspx

Gundersen, C., Dewey, A., Crumbaugh, A. S., Kato, M., & Engelhard, E. (2014). *Map the Meal Gap 2014: Technical Brief.* Feeding America. Retrieved October 2016, from http://www.feedingamerica.org/hunger-in-america/our-research/map-the-meal-gap/2012/2012-map-the-meal-gap-tech-brief.pdf

Gundersen, C., Kreider, B., & Pepper, J. (2011). The Economics of Food Insecurity in the United

States. Retrieved October 10, 2016, from http://people.virginia.edu/~jvp3m/abstracts/FI.pdf

Gunderson, C., Engelhard, E., Satoh, A., & Waxman, E. (2014). *Map the Meal Gap 2014: Food Insecurity and Child Food Insecurity Estimates at the County Level.* Feeding America. Retrieved 2017

(2015). *H+T Index Methods.* Center for Neighborhood Technology. Retrieved 2017, from http://htaindex.cnt.org/about/

Haines, M., Fishback, P., & Rhode, P. (2012). *United States Agriculture Data, 1840 - 2012 (ICPSR 35206).* Retrieved 2016, from ICPSR: http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/35206#method

Haines, M., Fishback, P., & Rhode, P. (2012). *United States Agriculture Data, 1840 - 2012 (ICPSR 35206): Codebook for 2012 County and State.* Ann Arbor: ICPSR. Retrieved 2016, from ICPSR: http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/35206#method

Halweil, B. (2002, November). Home Grown: The Case for Local Food in a Global Market. (T. Prugh, Ed.) *Worldwatch Institute*. Retrieved 2017, from http://www.worldwatch.org/node/827

Industrial Livestock Production. (2016). (GRACE Communications Foundation) Retrieved November 2016, from Sustainable Table: http://www.sustainabletable.org/859/industrial-livestock-production

Kaufman, P. R. (1999, April). Rural Poor Have Less Access to Supermarkets, Large Grocery Stores. *Rural Development Perspectives*, 19-26. Retrieved 2017

Lin, B. B. (2006, December 9). Agroforestry Management as an Adaptive Strategy Against Potential Microclimate Extremes in Coffee Agriculture. *Agricultural and Forest Meteorology, 144*, 85-94. Retrieved 2017, from http://libcatalog.cimmyt.org/download/reprints/96730.pdf

Lucas, D. C. (2001). *Stopping the Great Food Swap: Relocalising Europe's Food Supply.* Brussels: The Greens / European Free Alliance, European Parliament. Retrieved 2017

National Income and Product Accounts; Gross Domestic Product: Fourth Quarter and Annual 2015 (Third Estimate); Corporate Profits: Fourth Quarter and Annual 2015 . (2016, March 25). (U.S. Department of Commerce) Retrieved 2017, from Bureau of Economic Analysis: https://www.bea.gov/newsreleases/national/gdp/2016/gdp4q15_3rd.htm

Peters, C., Bills, N., Wilkins, J., & Smith, R. (2003). *Vegetable Consumption, Dietary Guidelines and Agricultural Production in New York State – Implications For Local Food Economies.* Cornell University. Retrieved 2017

Pimentel, D., & Pimentel, M. (2003, September). Sustainability of meat-based and plant-based diets and the environment. *The American Journal of Clinical Nutrition, 78*(3), 6605-6635. Retrieved October 2016, from http://ajcn.nutrition.org/content/78/3/660S.full

Ploeg, M. V., & Rahkovsky, I. (2016, May 2). Recent Evidence on the Effects of Food Store Access on Food Choice and Diet Quality. *Amber Waves*. Retrieved November 2, 2016, from http://www.ers.usda.gov/amber-waves/2016/may/recent-evidence-on-the-effects-of-food-store-access-on-food-choice-and-diet-quality/

Pretty, J. N., Noble, A., Bossio, D., Dixon, J., Hine, R., Penning de Vries, F., & Morison, J. (2006, November 4). Resource-Conserving Agriculture Increases Yields in Developing Countries. *Environmental Science & Technology, 40*, 1114-1119. Retrieved 2017

Producer and Consumer Support Estimates database. (2015). Retrieved 2017, from OECD: http://www.oecd.org/tad/agricultural-policies/producerandconsumersupportestimatesdatabase.htm

Altieri, M. A. (2009, July-August). Agroecology, Small Farms, and Food Sovereignty. *Monthly Review, 61*(03). Retrieved 2017, from https://monthlyreview.org/2009/07/01/agroecology-small-farms-and-food-sovereignty/

Appendix A.: Census of Agriculture Methodology. (2012). Retrieved 2016, from 2012 Census of Agriculture: https://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_1_US/usappxa.pdf

Barrett, C. B. (1993). *On Price Risk and the Inverse Farm Size-Productivity Relationship.* University of Wisconsin-Madison, Agricultural Economics. Retrieved 2017, from https://pdfs.semanticscholar.org/2b3c/36a7398c6bc0ed7ed351db6b67a28003d265.pdf

Browder, J. O. (Ed.). (1989). *Fragile Lands of Latin America: Strategies for Sustainable Development.* Boulder, Colorado, USA: Westview Press. Retrieved 2017

Current Population Survey, December 2011: Food Security Supplement (ICPSR 34434). (2013, April 12). Retrieved from ICPSR: http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/34434?q=34434

Current Population Survey, December 2011: Food Security Supplement (ICPSR 34434): User Guide. (2013, April 12). Retrieved 2016, from ICPSR: http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/3 4434?q =34434

Data Download. (2015). Retrieved 2017, from H+T Index: http://htaindex.cnt.org/download/data.php

Fields, S. (2004, October). The Fat of the Land: Do Agricultural Subsidies Foster Poor Health? *Environmental Health Perspectives, 112*(14), A820–A823. Retrieved 2017, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1247588/

Gunderson, C., Engelhard, E., Satoh, A., & Waxman, E. (2014). *Map the Meal Gap 2014: Food Insecurity and Child Food Insecurity Estimates at the County Level.* Feeding America. Retrieved 2017

(2015). *H+T Index Methods.* Center for Neighborhood Technology. Retrieved 2017, from http://htaindex.cnt.org/about/

Haines, M., Fishback, P., & Rhode, P. (2012). *United States Agriculture Data, 1840 - 2012 (ICPSR 35206).* Retrieved 2016, from ICPSR: http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/35206#method

Haines, M., Fishback, P., & Rhode, P. (2012). *United States Agriculture Data, 1840 - 2012 (ICPSR 35206): Codebook for 2012 County and State.* Ann Arbor: ICPSR. Retrieved 2016, from ICPSR: http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/35206#method

Halweil, B. (2002, November). Home Grown: The Case for Local Food in a Global Market. (T. Prugh, Ed.) *Worldwatch Institute*. Retrieved 2017, from http://www.worldwatch.org/node/827

Kaufman, P. R. (1999, April). Rural Poor Have Less Access to Supermarkets, Large Grocery Stores. *Rural Development Perspectives*, 19-26. Retrieved 2017

Lin, B. B. (2006, December 9). Agroforestry Management as an Adaptive Strategy Against Potential Microclimate Extremes in Coffee Agriculture. *Agricultural and Forest Meteorology, 144*, 85-94. Retrieved 2017, from http://libcatalog.cimmyt.org/download/reprints/96730.pdf

Lucas, D. C. (2001). *Stopping the Great Food Swap: Relocalising Europe's Food Supply.* Brussels: The Greens / European Free Alliance, European Parliament. Retrieved 2017

National Income and Product Accounts; Gross Domestic Product: Fourth Quarter and Annual 2015 (Third Estimate); Corporate Profits: Fourth Quarter and Annual 2015 . (2016, March 25). (U.S. Department of Commerce) Retrieved 2017, from Bureau of Economic Analysis: https://www.bea.gov/newsreleases/national/gdp/2016/gdp4q15_3rd.htm

Peters, C., Bills, N., Wilkins, J., & Smith, R. (2003). *Vegetable Consumption, Dietary Guidelines and Agricultural Production in New York State – Implications For Local Food Economies.* Cornell University. Retrieved 2017

Pretty, J. N., Noble, A., Bossio, D., Dixon, J., Hine, R., Penning de Vries, F., & Morison, J. (2006, November 4). Resource-Conserving Agriculture Increases Yields in Developing Countries. *Environmental Science & Technology, 40*, 1114-1119. Retrieved 2017

Producer and Consumer Support Estimates database. (2015). Retrieved 2017, from OECD: http://www.oecd.org/tad/agricultural-policies/producerandconsumersupportestimatesdatabase.htm

Questionnaire - December 2011 Food Security Supplement. (2012, 9 5). Retrieved from USDA Economics Research Service: https://www.ers.usda.gov/webdocs/DataFiles/Food_Security_in_the_United_States__17983/30950_qn2011.pdf?v=41157

Rafael Harun, S. M., & Ogneva-Himmelberger, Y. (2013). Distribution of Industrial Farms in the United States and Socioeconomic, Health, and Environmental Characteristics of Counties. *Geography Journal, 2013*, 12. doi:10.1155/2013/385893

Rasch Analysis. (1990). Retrieved from Rasch-Analysis: http://www.rasch-analysis.com/rasch-analysis.htm

Rosset, P. (1999, December). Small Is Bountiful. *The Ecologist*, *29*(8). Retrieved 2017, from http://naturefirstusa.org/Special%20Reports/family%20farms/Small%20Is%20Bountiful.htm

Shattuck, A., & Holt-Gimenez, E. (2009, April). Policy Brief No. 18: Why the Lugar-Casey Global Food Security Act will Fail to Curb Hunger. *Food First: Institute for Food and Development Policy*, pp. 4-5.

(2009). *The Environmental Food Crisis.* United Nations Environment Programme. Retrieved 2017, from http://old.unep-wcmc.org/medialibrary/2010/09/07/51d38855/FoodCrisis.pdf

Questionnaire - December 2011 Food Security Supplement. (2012, September 5). Retrieved from

USDA Economics Research Service: https://www.ers.usda.gov/webdocs/DataFiles/Food_ Securit y_in_the_United_States__17983/30950_qn2011.pdf?v=41157

Rafael Harun, S. M., & Ogneva-Himmelberger, Y. (2013). Distribution of Industrial Farms in the United States and Socioeconomic, Health, and Environmental Characteristics of Counties. *Geography Journal, 2013*, 12. doi:10.1155/2013/385893

Rasch Analysis. (1990). Retrieved from Rasch-Analysis: http://www.rasch-analysis.com/rasch-an Alysis.htm

Rosset, P. (1999, December). Small Is Bountiful. *The Ecologist, 29*(8). Retrieved 2017, from http://naturefirstusa.org/Special%20Reports/family%20farms/Small%20Is%20Bountiful. htm

Shattuck, A., & Holt-Gimenez, E. (2009, April). Policy Brief No. 18: Why the Lugar-Casey Global Food Security Act will Fail to Curb Hunger. *Food First: Institute for Food and Development Policy*, pp. 4-5.

(2009). *The Environmental Food Crisis.* United Nations Environment Programme. Retrieved 2017, from http://old.unep-wcmc.org/medialibrary/2010/09/07/51d38855/FoodCrisis.pdf

Statistics & Information. (2016, October 6). (U. S. Agriculture, Producer) Retrieved November 2016, from Economic Research Service: https://www.ers.usda.gov/topics/animal-products/cattle-beef/statistics-information.aspx

(1999). *The State of Food Insecurity in the World.* Rome: Food and Agricultural Organization of the United Nations. Retrieved November 2016, from ftp://ftp.fao.org/docrep/fao/007/x 3114e/x3114e00.pdf

U.S. could feed 800 million people with the grain that livestock eat, Cornell ecologist advises animal scientists. (1997, August 7). *Cornell Chronicle*. Retrieved October 2016, from http://www.news.cornell.edu/stories/1997/08/us-could-feed-800-million-people-grain-livestock-eat

Appendix A

Current Population Survey Food Security Supplement questionnaire sample questions (questions are verbally given to the respondent).

1. LAST WEEK, did (you/anyone in your household) buy food at a restaurant, fast food place, cafeteria, or vending machine? (Include any children who may have bought food at the school cafeteria). <1> Yes <2> No
2. How much did (you/anyone in your household) ACTUALLY spend at supermarkets and grocery stores LAST WEEK (including any purchases made with or food stamp benefits)? ENTER <0> IF RESPONDENT CAN ONLY GIVE RANGE $_ _ _.00
3. How much did (you/your household) spend for food at restaurants, fast food places, cafeterias, and vending machines LAST WEEK, not including alcohol purchases?
4. (Let's see, it seems that (you/your household) did not buy any food LAST WEEK. /Let's see, (you/your household) spent about (fill with S8O) on food LAST WEEK.) Now think about how much (you/anyone in your household) USUALLY (spend/spends). How much (do you/does your household) USUALLY spend on food at all the different places we've been talking about IN A WEEK? (Please include any purchases made with or food stamp benefits). Do not include non-food items such as pet food, paper products, detergent or

cleaning supplies. Enter <1> for whole dollar amount Enter <2> if respondent can only give range

5. In order to buy just enough food to meet (your needs/the needs of your household), would you need to spend more than you do now, or could you spend less? <1> More (GO TO S8C) <2> Less (GO TO S8D) <3> Same (GO TO S9)
6. About how much MORE would you need to spend each week to buy just enough food to meet the needs of your household? Enter whole dollar amount Enter <0> if respondent can only give range $_ _ _.00
7. In the past 12 months, since December of last year, did (you/anyone in this household) get or food stamp benefits? <1> Yes (GO TO SP2) <2> No (GO TO SP6CK)
8. During the past 30 days, did any children in the household (between 5 and 18 years old) receive free or reduced-cost lunches at school? <1> Yes <2> No (GO TO SP7ACK)
9. How many (women/women or children/children) in the household got WIC foods? Number _____
10. Which of these statements best describes the food eaten in your household-- enough of the kinds of food (I/ we) want to eat, enough but not always the kinds of food (I/ we) want to eat, sometimes not enough to eat, or often not enough to eat? <1> Enough of the kinds of food we want to eat <2> Enough but not always the kinds of food we want to eat <3> Sometimes not enough to eat <4> Often not enough to eat
11. "(I/we) couldn't afford to eat balanced meals." Was that OFTEN, SOMETIMES or NEVER true for (you/ your household) in the last 12 months? <1> Often true (GO TO SSM4) <2> Sometimes true (GO TO SSM4) <3> Never true (GO TO SX2CK)

12. In the last 12 months, did (you/ you or other adults in your household) ever cut the size of your meals or skip meals because there wasn't enough money for food? <1> Yes <2> No (GO TO SH3)
13. In the last 12 months, were you ever hungry but didn't eat because there wasn't enough money for food? <1> Yes <2> No (GO TO SH5)

(Questionnaire - December 2011 Food Security Supplement, 2012).

Appendix B: SAS Code

```
PROC IMPORT OUT= WORK.Food
            DATAFILE= "D:\Desktop\34434-0001-Data.sav"
            DBMS=SPSS REPLACE;
RUN;
data name;
set food;
if 2 =< hrfs12m1 =< 3 then insecure=1; else insecure=0;
if hrfs12m1 = 3 then verylow=1; else verylow=0;
if hrfs12m1 = 2 then low=1; else low=0;

if ptdtrace ='2' then black=1; else black=0;
if prdthsp ='-1' then hispanic=0; else hispanic=1;

if hrpoor = -1 then delete;
if hrpoor = 2 then delete;

if prempnot = 1 then employed =1; else employed=0;
if prempnot = 2 then unemployed =1; else unemployed=0;
if prempnot > 2 then outoflf=1; else outoflf=0;

if hefaminc = -1 then delete;
if hefaminc = 1 then hefaminc = 2500;
if hefaminc = 2 then hefaminc = 6250;
if hefaminc = 3 then hefaminc = 8750;
if hefaminc = 4 then hefaminc = 11250;
if hefaminc = 5 then hefaminc = 13750;
if hefaminc = 6 then hefaminc = 17500;
if hefaminc = 7 then hefaminc = 22500;
if hefaminc = 8 then hefaminc = 27500;
if hefaminc = 9 then hefaminc = 32500;
if hefaminc = 10 then hefaminc = 37500;
if hefaminc = 11 then hefaminc = 45000;
if hefaminc = 12 then hefaminc = 55000;
if hefaminc = 13 then hefaminc = 67500;
```

```
if hefaminc = 14 then hefaminc = 87500;
if hefaminc = 15 then hefaminc = 125000;
if hefaminc = 16 then hefaminc = 150000;
if hefaminc => 55000 then delete;
if hefaminc =< 22500 then lowincome=1; else lowincome=0;

if hetenure = 1 then own=1; else own=0;
if hetenure=2 then rent=1; else rent=0;

if hrhtype = 0 then delete;
if hrhtype = 5 then delete;
if hrhtype => 8 then delete;
if 1=<hrhtype=<2 then married=1; else married=0;
if hrhtype =3 then malehh=1; else malehh=0;
if hrhtype =4 then femalehh=1; else femalehh=0;
if hrhtype = 6 then singlemale=1; else singlemale=0;
if hrhtype = 7 then singlefemale=1; else singlefemale=0;

if peeduca = -1 then delete;
if peeduca <= 38 then nodiploma=1; else nodiploma=0;
if peeduca = 39 then diploma=1; else diploma=0;
if peeduca = 40 then collegenodeg=1; else collegenodeg=0;
if 41<=peeduca<=42 then collegedeg=1; else collegedeg=0;
if peeduca=>43 then higherdeg=1; else higherdeg=0;

if prcitshp<1 then delete;
if 1<=prcitshp<=4 then citizen=1; else citizen=0;
if prcitshp=5 then notcitizen=1; else notcitizen=0;

if prchld=>1 then child=1; else child=0;
PROC IMPORT OUT= WORK.Agcensus
            DATAFILE= "D:\Desktop\35206-0047-Data.sav"
            DBMS=SPSS REPLACE;

RUN;
data ag;
set agcensus;
if cofips = 0 then delete;
proc sort data=work.ag;
by statefip cofips;
run;
proc sort data=work.name;
by GESTFIPS GTCO;
run;
data county;
set name;
if gtco = 0 then delete;
run;
data rename;
set county;
rename GTCO=COFIPS;
rename GESTFIPS=STATEFIP;
run;
data fips;
set rename;
county = statefip + (cofips/1000);
run;
```

```
proc means data=work.fips;
var county;
run;
proc sort data=work.fips;
by county;
run;
data agfips;
set ag;
county = statefip + (cofips/1000);
run;
proc sort data=work.agfips;
by county;
run;
data counties;
merge fips agfips;
by county;
run;
data tab(keep = prchld prnmchld child data29_617 data29_641 data29_642
data29_650 data39_212 data29_612 data25_36 data29_627 data29_647 data29_652
data8_80 data24_29 data26_326 data1_3 data1_4 data1_5 data1_6 data1_9
data1_10 data1_11 data1_12 data1_13 data1_14 data1_32 data1_33 data5_1
data5_3 data5_5 data1_34 data1_35 data1_36 data1_37 data1_40 data1_45
data2_55 data2_57 data2_139 data2_141 data2_177
county data6_3 data2_175 hrfs12m1 insecure low verylow hrpoor hefaminc
hrhtype peeduca prcitshp NOTCITIZEN LOWINCOME BLACK HISPANIC RENT MALEHH
FEMALEHH SINGLEMALE SINGLEFEMALE HRNUMHOU UNEMPLOYED NODIPLOMA);
set counties;
run;
data tab2;
set tab;
if data6_3 =< 250 then small=1; else small=0;
if data6_3=<2633 then sm=1; else sm=0;
if 250<data6_3 =< 5266.52 then med=1; else med=0;
if 5266.52<data6_3 =< 109460 then large=1; else large=0;

if data2_175 =< 17 then lowdirect=1; else lowdirect=0;
if 17< data2_175 =< 78 then meddirect=1; else meddirect=0;
if 78< data2_175 =< 839 then largedirect=1; else largedirect=0;
proc import out=work.Mealcost
datafile = 'D:\Senior Year 2016-17\Honors\MTMG Data\MMG2012.txt'
DBMS=TAB REPLACE;
getnames=yes;
run;
data Cost;
merge tab2 Mealcost;
by county;
run;
proc import out=work.HT
datafile = 'D:\Senior Year 2016-17\Honors\H+T Data\H+T.txt'
DBMS=TAB REPLACE;
getnames=yes;
run;
data final;
merge Cost HT;
by county;
run;
```

```
data final2;
set final;
if verylow = "." then delete;
proc sort data=work.final2;
by county;
run;
proc means data=work.final2;
by county;
var insecure low verylow;
output out=final3 mean=avginsecure avglow avgverylow;
run;
proc sort data=work.final2;
by county;
run;
proc sort data=work.final3;
by county;
run;
data final4;
merge final2 final3;
by county;
run;

PROC SORT DATA=WORK.FINAL4;
BY COUNTY;
RUN;
proc means data=work.final4;
by county;
var child population NOTCITIZEN LOWINCOME BLACK HISPANIC RENT FEMALEHH
SINGLEFEMALE SINGLEMALE HRNUMHOU UNEMPLOYED NODIPLOMA;
output out=final5 mean=child2 population2 NOTCITIZEN2 LOWINCOME2 BLACK2
HISPANIC2 RENT2 FEMALEHH2 SINGLEFEMALE2 SINGLEMALE2 HRNUMHOU2 UNEMPLOYED2
NODIPLOMA2;
run;

data final6;
merge final4 final5;
by county;
run;

PROC MEANS DATA=WORK.FINAL6
mean std max min var;
var avglow avgverylow avginsecure _012_Food_Insecurity_Rate
_012_Cost_Per_Meal ht_ami population child2 NOTCITIZEN2 LOWINCOME2 BLACK2
HISPANIC2 RENT2 FEMALEHH2 SINGLEFEMALE2 SINGLEMALE2 HRNUMHOU2 UNEMPLOYED2
NODIPLOMA2 data29_627 data29_647 data29_652 data25_36 data24_29;
run;

option nolabel;
proc reg data=work.final6;
model avglow = _012_Cost_Per_Meal ht_ami population HRNUMHOU2 child2
NOTCITIZEN2 LOWINCOME2 BLACK2 HISPANIC2 RENT2 FEMALEHH2 SINGLEFEMALE2
SINGLEMALE2 UNEMPLOYED2 NODIPLOMA2;
run;proc reg data=work.final6;
model avgverylow = _012_Cost_Per_Meal ht_ami population HRNUMHOU2 child2
NOTCITIZEN2 LOWINCOME2 BLACK2 HISPANIC2 RENT2 FEMALEHH2 SINGLEFEMALE2
SINGLEMALE2 UNEMPLOYED2 NODIPLOMA2;
```

```
run;
proc reg data=work.final6;
model _012_Food_Insecurity_Rate = _012_Cost_Per_Meal ht_ami population
HRNUMHOU2 child2 NOTCITIZEN2 LOWINCOME2 BLACK2 HISPANIC2 RENT2 FEMALEHH2
SINGLEFEMALE2 SINGLEMALE2 UNEMPLOYED2 NODIPLOMA2;
run;

proc reg data=work.final6;
model avglow = data29_627 data29_647 data29_652 _012_Cost_Per_Meal ht_ami
population HRNUMHOU2 child2 NOTCITIZEN2 LOWINCOME2 BLACK2 HISPANIC2 RENT2
FEMALEHH2 SINGLEFEMALE2 SINGLEMALE2 UNEMPLOYED2 NODIPLOMA2;
run;
proc reg data=work.final6;
model avgverylow = data29_627 data29_647 data29_652 _012_Cost_Per_Meal ht_ami
population HRNUMHOU2 child2 NOTCITIZEN2 LOWINCOME2 BLACK2 HISPANIC2 RENT2
FEMALEHH2 SINGLEFEMALE2 SINGLEMALE2 UNEMPLOYED2 NODIPLOMA2;
run;
proc reg data=work.final6;
model _012_Food_Insecurity_Rate = data29_627 data29_647 data29_652
_012_Cost_Per_Meal ht_ami population HRNUMHOU2 child2 NOTCITIZEN2 LOWINCOME2
BLACK2 HISPANIC2 RENT2 FEMALEHH2 SINGLEFEMALE2 SINGLEMALE2 UNEMPLOYED2
NODIPLOMA2;
run;

proc reg data=work.final6;
model avglow = data25_36 data24_29 _012_Cost_Per_Meal ht_ami population
child2 HRNUMHOU2 NOTCITIZEN2 LOWINCOME2 BLACK2 HISPANIC2 RENT2 FEMALEHH2
SINGLEFEMALE2 SINGLEMALE2 UNEMPLOYED2 NODIPLOMA2;
run;
proc reg data=work.final6;
model avgverylow = data25_36 data24_29 _012_Cost_Per_Meal ht_ami population
HRNUMHOU2 child2 NOTCITIZEN2 LOWINCOME2 BLACK2 HISPANIC2 RENT2 FEMALEHH2
SINGLEFEMALE2 SINGLEMALE2 UNEMPLOYED2 NODIPLOMA2;
run;
proc reg data=work.final6;
model _012_Food_Insecurity_Rate = data25_36 data24_29 _012_Cost_Per_Meal
ht_ami population child2 HRNUMHOU2 NOTCITIZEN2 LOWINCOME2 BLACK2 HISPANIC2
RENT2 FEMALEHH2 SINGLEFEMALE2 SINGLEMALE2 UNEMPLOYED2 NODIPLOMA2;
run;
```