

“From Farm-to-Fork”:

Proposed “Food Production Node” Placements in the Upstate,
South Carolina to Increase Efficiency of Local Food System
Networks

Caitlin Kelliher

Master Thesis Series in Environmental Studies and Sustainability Science,
No 2014:011

A thesis submitted in partial fulfillment of the requirements of Lund University
International Master’s Programme in Environmental Studies and Sustainability Science
(30hp/credits)



LUCSUS

Lund University Centre for
Sustainability Studies



LUND
UNIVERSITY

“From Farm-to-Fork”:

Proposed “Food Production Node” Placements in the Upstate, South Carolina to
Increase Efficiency of Local Food System Networks

Caitlin Kelliher

A thesis submitted in partial fulfillment of the requirements of Lund University International
Master’s Programme in Environmental Studies and Sustainability Science

Submitted May 15, 2014

Supervisor: Molly MacGregor, LUCSUS, Lund University

Abstract

Food insecurity is a reality faced by millions of people worldwide. Poor access and availability to food markets, poverty, and uncertain global system futures all exacerbate this issue. In seeking to combat food insecurity for South Carolina residents and improve the viability and resilience of local food markets around Greenville County, South Carolina, this assessment determines optimal potential placements for a “food production node” in the Upstate, South Carolina. A mixed methods approach was engaged, with action research comprising the qualitative segment, and geographic information systems (GIS) mapping constituting the quantitative section.

Action research was conducted in conjunction with a representative from Greenville County Community Development and Planning’s Department of Planning and Code Compliance to determine the best criteria to consider when identifying potential “food production node” placement. Raw data collected for quantitative analysis included 1,759 farm locations consisting of Certified South Carolina Grown farms, Carolina Farm Stewardship Association members, ASAP Appalachian Grown members, Local Harvest members, and South Carolina and Georgia Market Maker farms within a 161 kilometer (100 mile) radius of Greenville County, South Carolina. This location data was coupled with data regarding what types of products each farm offers. This raw data was analyzed using GIS which identified clusters of like farms, and in conjunction with proximity to processor data, roads and highway data, slope data, and soil data, all distinguished as necessary criteria, weighted overlays were performed to determine best potential node implementation locations.

Resulting from weighted overlays, suggested node placements are locations in the following five areas; northern Laurens County, western Spartanburg County, northwest Anderson County, southern Greenville County, and central Cherokee County. Food node implementation and other similar improvements to local food systems will result in the creation of new economic and social opportunities for consumers and farmers and will facilitate more sustainable consumption choices.

Keywords: farm clusters, GIS, food web, food security, resilience, food hubs

Word Count: 10,562

Acknowledgements

I’d like to acknowledge and express my gratitude to: Dr. Weston Dripps, who assisted in the brainstorm process as well as put me in touch with Mr. Scott Park of Greenville County Community Development and Planning’s Department of Planning and Code Compliance; Mr. Scott Park, who graciously agreed to work with me and assisted patiently in many steps of this process; Dr. Suresh Muthukrishnan, Dr. Yengoh Genesis, and Mr. Mike Winiski who generously offered vital GIS support; Molly MacGregor, who remained a supportive supervisor and provided many insightful critiques; Wim Carton and peer reviewers, who suggested additional advice; Phil Donsbach, who made document recovery possible twice; Andreina Malki, who aided me throughout this process in countless ways; and my family, whose support has always been strongest and whose encouragement to develop intellectual curiosities has brought me to where I am today.

Table of Contents

1 Introduction and Background	1
1.1 Framing from a Global Perspective	1
1.2 The South Carolina Story	1
1.3 The Research Gap	3
1.4 The Role of Food Production Nodes	3
1.5 Linking to Sustainability Science	4
1.6 Supporting Theoretical Frameworks	4
1.7 Research Design	5
1.7.1 <i>Study Area</i>	6
1.7.2 <i>Research Questions</i>	7
2 Methodology	8
2.1 Philosophical Approach	8
2.2 Action Research.....	8
2.3 Quantitative Data Collection.....	9
2.4 Creation of Map Document	10
2.4.1 <i>Preliminary Setup</i>	10
2.4.2 <i>Farm Clusters</i>	11
2.4.3 <i>Optimized Hot Spot Analysis</i>	13
2.4.4 <i>Meat Processors</i>	13
2.4.5 <i>Road Networks/Traffic Lines</i>	13
2.4.6 <i>Highway System</i>	14
2.4.7 <i>Soils</i>	14
2.4.8 <i>Slope</i>	14
2.4.9 <i>Weighted Overlay</i>	15
2.4.10 <i>Auxiliary Elements</i>	15
2.5 Limitations	15
3 Results	16

3.1 Weighted Overlay with Five Hot Spot Outputs	17
3.2 Weighted Overlay with Only Red Meat Categories	18
3.3 Weighted Overlay with Only Poultry Categories.....	19
3.4 Weighted Overlay with Only Dairy Categories.....	20
3.5 Weighted Overlay with Only Vegetable/Fruit Categories.....	21
3.6 Weighted Overlay with Only Specialty Item Categories	22
3.7 Suitability for Food Production Node Implementation	23
4 Discussion	24
4.1 The Macro View	24
4.2 Chosen Criteria	25
4.3 Proposed Node Placements	25
<i>4.3.1 Suggested Node Placement One: Northern Laurens County.....</i>	<i>26</i>
<i>4.3.2 Suggested Node Placement Two: Western Spartanburg County</i>	<i>26</i>
<i>4.3.3 Suggested Node Placement Three: Northwest Anderson County</i>	<i>26</i>
<i>4.3.4 Suggested Node Placement Four: Southern Greenville County</i>	<i>26</i>
<i>4.3.5 Suggested Node Placement Five: Central Cherokee County</i>	<i>27</i>
4.4 On Assumptions	27
4.5 Potential Drawbacks Surrounding the Food Production Node Concept	29
4.6 Nodes and Links to Economic Benefits: A Local Lens.....	30
4.7 Nodes and Links to Social Benefits: A Local Lens.....	31
4.8 Role of the State.....	31
4.9 Nodes and Support of Development Themes: A Global Lens.....	32
<i>4.9.1 Resilience</i>	<i>32</i>
<i>4.9.2 Food Security and the Right-to-Food.....</i>	<i>33</i>
4.10 Going Beyond Food Production Nodes	34
5 Conclusion	35
References.....	36

1 Introduction and Background

1.1 Framing from a Global Perspective

To understand the fundamental importance of “food production node” implementation, one must first consider improvements to local food systems from a broader context. With its Millennium Development Goals, the Food and Agriculture Organization of the United Nations (FAO) seeks to promote “a world free of hunger and malnutrition for present and future generations, where agriculture contributes to improving the living standards of all in an environmentally sustainable way” (FAO, 2014). Currently, a wide range of nutrition-related afflictions plague the globe, from chronic hunger to malnutrition in the form of obesity. With one in eight people starving from hunger, and 7% of children worldwide under the age of five overweight (UN, 2013), there exists substantial needs for improved food systems that can effectively combat these conditions. Further, as part of its Post-2015 Development Agenda the FAO has identified fourteen overarching themes, of which, two are especially relevant to the South Carolina food system and are foundations to node implementation: resilience, and food security and the right-to-food (FAO, 2014).

1.2 The South Carolina Story

Noted to be one of the ten fastest growing US cities, with a growth rate of 32.5% from 2000-2010 alone (CNN, 2012), the Greenville area has witnessed rapid change in the last decade. This growth has been accompanied by an increase in consumer health awareness surrounding local purchase and consumption, with the Upstate area of South Carolina now supporting 28 different farmers’ markets and eight Community-Supported Agriculture (CSA) programs (Soike & Dripps, 2014). Earl Gohl, federal co-chair of the Appalachian Regional Commission noted in one publication that, “The local food marketplace at this point seems to be growing throughout the region and seems to be an opportunity to latch on to something that is on an upward trend and that can really permeate through a variety of levels of local economies, from the growers to the schools to grocery stores to restaurants” (Callum-Penso & Burns, 2013).

Posited in the past year to be one of the 15 best cities for young adults (Forbes, 2014), the city of Greenville has undergone positive changes and local food movement growth as a result of a high influx of new citizens. Not all of South Carolina towns and cities, however, can say the same. Inaccessibility to

many of the more nutritional food sources is a real issue for hundreds of thousands of South Carolinians. The United States Department of Agriculture (USDA) determined from its Food Desert Locator that there are approximately 250,000 residents living in 21 food deserts that are located in 14 different South Carolina counties (South Carolina Food Policy Council, 2013). This “lack of access to fresh, healthy produce contributes to South Carolina’s ranking as 46th (out of 50) for overall public health” (South Carolina Food Policy Council, 2013, p. 8). Further highlighting this point was commentary in the publication, *Making Small Farms into Big Business*; “In a state that is a proud exporter of fruit and vegetables, only 17% reported in 2009 that they eat enough produce to meet minimum health guidelines” (Meter & Goldenberg, 2013, p. 33). South Carolina’s health challenges do not stop here; malnutrition in the form of obesity also plagues The Palmetto State. Fifteen percent of children between the ages of two and five were recorded to be overweight, and 13% of these to be obese; 15% of adolescents were found to be overweight and 17% obese; and an overwhelming 67% of adults were determined overweight with 32% obese (Centers for Disease Control and Prevention, 2012). It is quite clear that many improvements to the South Carolina food system and superior food options are urgently needed to address these harmful health risks.

Currently, South Carolina is an active player in both national and international food trade. Not only does it export agricultural products to other East Coast states, but it also purchases produce from long-distance locations such as California, Florida, Georgia, North Carolina, Canada, and Mexico (Meter & Goldenberg, 2013). It is of particular note that well over 90% of food is sourced from outside of the state, and merely substituting South Carolina-grown food for a considerable portion of this imported food could add billions of dollars-worth of food sales to the state's domestic product (Meter & Goldenberg, 2013). Not only would reforming the state’s food system trade imbalance result in a marked increase of food security for its citizenry, but such a transformation would dramatically improve intra-state economic and social standards. Consumers are increasingly looking to improve quality of living and health, and this can be accomplished by cultivating relationships with farmers. Primary motives for “buying local” include perceived quality and freshness of local food and support for the local economy...“consumers who are willing to pay higher prices for locally produced foods place importance on product quality, nutritional value, methods of raising a product and those methods’ effects on the environment, and support for local farmers” (Martinez et al., 2010, p. iv). This cultural trend is widely recognized and is chronicled as such: “The local food movement is no passing fad; it may be the prime

vehicle for transforming the economy so that health, wealth, connection, and capacity are built in South Carolina communities” (Meter & Goldenberg, 2013, p. 50).

1.3 The Research Gap

While it is acknowledged that there are crucial steps to be taken to improve the viability of local food sources, options, and networks in South Carolina, there exists a lack of uniform understanding of how to effectively accomplish this. One primary objective of this research is to contribute to the local food movement discussion by proposing areas of interest in which to establish a “food production node” and highlighting what benefits will likely be realized as a result.

1.4 The Role of Food Production Nodes

A food production node is defined as “a cluster of farms in close proximity to each other, working in collaboration and using common food production infrastructure”, and these farm clusters can utilize common equipment to wash, sort, package, and store products for later sale (Meter & Goldenberg, 2013, p. 166). The primary purpose of such food nodes is five-fold; “to increase community capacity to produce food for itself, to create local efficiencies by clustering local activity in close proximity to each other, to create permanent physical facilities that ensure access to food for local residents, to foster local collaboration, and to scale up production as appropriate for regional food hubs” (Meter & Goldenberg, 2013, p. 62). By increasing the efficiency of production and collaboration among farmers, long-term infrastructures are built and secured, which perpetuates a sustainable local food system and ensures local food security. Specifically, it was argued by Meter and Goldenberg (2013) that, “...nodes are essential to building a network of supportive relationships and physical infrastructure that will allow larger-scale initiatives (such as food hubs, processors, and other facilities) to thrive. This network might be called a ‘food web’. Building such a web of interconnection is the essential precondition for building an economy in which small farms may become big business” (p. 12). It is increasingly vital that the South Carolina local food system be enhanced, as not only does demand for local food exceed supply and South Carolinians are concerned about protecting the integrity of “local” food trade, but also direct sales reward farmers more adequately (Meter & Goldenberg, 2013).

1.5 Linking to Sustainability Science

Kates et al. (2001) argue in *Science* that the pursuit of sustainability science must “span the range of spatial scales between such diverse phenomena as economic globalization and local farming practices” (p. 641). With this exploration of how to fruitfully advance local food development around the Upstate region, sustainability science is effectively advocated. Strides must be taken on both macro and micro scales to ensure a more sustainable future worldwide, and thus, food production node establishment is vital for success on such a micro scale.

1.6 Supporting Theoretical Frameworks

This research will be supported by two primary theoretical frameworks: resilience and food security. Resilience theory can be applied here, in the form of socio-ecological resilience. Because “the resilience of social systems is related in some way to the resilience of the ecological systems on which social systems depend” (Adger, 2000, p. 350), it is prudent for communities to rely less on uncertain global food and energy markets, and more on local systems they have close access to; that is, likelihood of successful transport and delivery is heightened as distance from source decreases. The discussion surrounding “community resilience” specifically, “a community’s ability to maintain, renew, or reorganize social system functions”, is becoming more prevalent, and such a system will require that an integrated and responsive process is carried out, involving planning, appropriate design and learning such that the capacity to deal with any future shocks is enhanced (Franklin, Newton, & McEntee, 2011, p. 775). This process must be coupled with “...synergies among technical good practices for disaster risk reduction and climate change adaptation, food chain crises prevention, social protection, financial risk transfer and tenure of natural resources for the most vulnerable” (FAO, 2014) in order to ensure maximum strength of local systems. This in part means that through state promotion of local food sales, any uncertainty in long-distance food transfer is reduced, and in addition, local social and economic benefits are realized. Meter and Goldenberg (2013) comment, “Direct food sales are important to farmers since they earn maximum value for the products they sell, and also build connections with consumers that lead to a broader awareness of the food system, and stronger resilience for South Carolina’s population” (p. 49). By improving the viability of local food networks and opportunities, South Carolina communities can be strengthened in multiple arenas.

To be coupled with this is the framework of food security. With food security becoming an ever-increasing blip on the globe's radar, communities worldwide have begun to place more emphasis on the creation of local food opportunities. Food security for these purposes refers to community food security where "all community residents obtain a safe, culturally acceptable, nutritionally adequate diet through a sustainable food system that also maximizes community self-reliance and social justice" (Pothukuchi, 2004, p. 356). Aspects of ensuring food security and the right to food include, "improving the governance of food systems; inclusive and responsible investments in agriculture and rural areas, in health and education; empowering small producers; and strengthening social protection mechanisms for risk reduction" (FAO, 2014). Empowering small producers like relevant farmers and strengthening social protection mechanisms for risk reduction to their livelihoods are essential when considered from a broader context. Because threats to food security are vast, and could be greatly exacerbated by the global challenges of climate change, geopolitical insecurity, energy supply disruptions, transport failures, and myriad other unpredicted supply shocks (Clark & Nicholas, 2012), the resilience of local food systems and ability to sustain surrounding communities is paramount. This means that local food network infrastructures must be resilient enough to withstand unforeseen supply shocks, and food production node implementation will support this. One needs only to consider the fact that typical food items on average travel approximately 2,400 kilometers from farm-to-fork (Hill, 2008) and the average tomato alone currently travels over 2,092 kilometers from source to destination in the U.S. (McIlvaine-Newsad, Merrett, & McLaughlin, 2004), to realize people are considerably far-removed from the origins of what they eat. Due to these long-distance imports, "Farmers notice that food shoppers are becoming more constrained by high oil prices, and are spending less for food in some cases, or are more reluctant to travel to get to the places where they buy food" (Meter & Goldenberg, 2013, p. 49). As a result, the quality and/or quantity of food South Carolinians are consuming may be limited by unfavorable prices, and this would mean that the health and nutrition challenges the state's population faces are intensified.

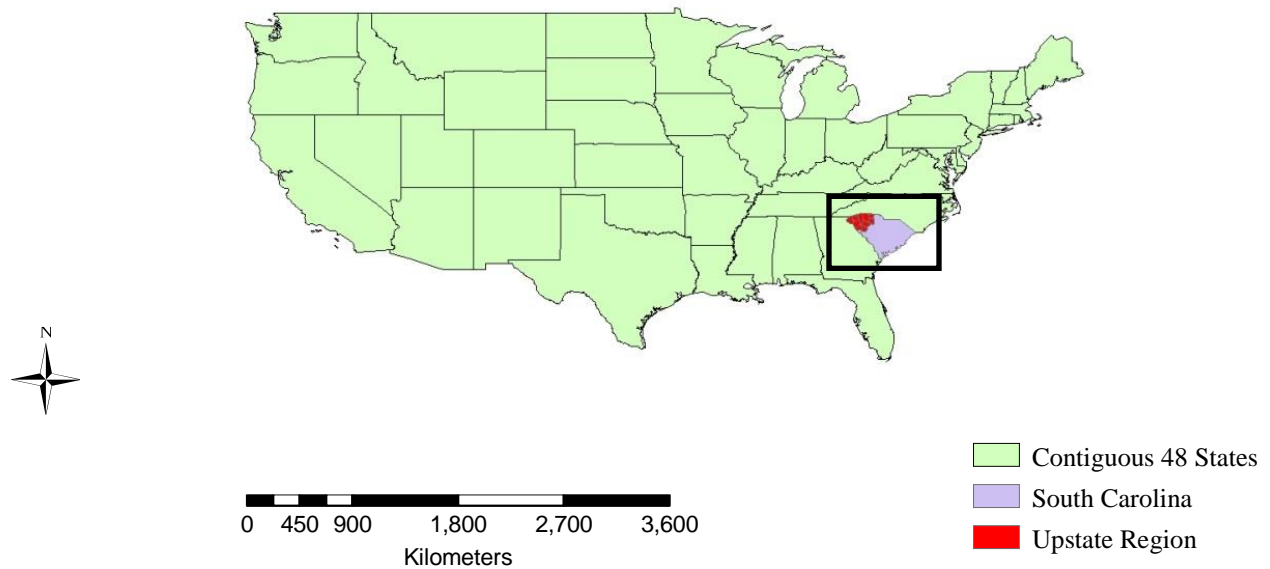
1.7 Research Design

Because it is crucial that the local food system expands and matures to accommodate these emerging health, economic, and social needs sufficiently, the design of this research employs quantitative GIS analysis that is based on qualitative criteria developed within action research. Results and conclusions are heavily supported by comprehensive mapping which pinpoints best potential node placements in the Upstate region based on current producers. Not only are farm locations themselves plotted, but also

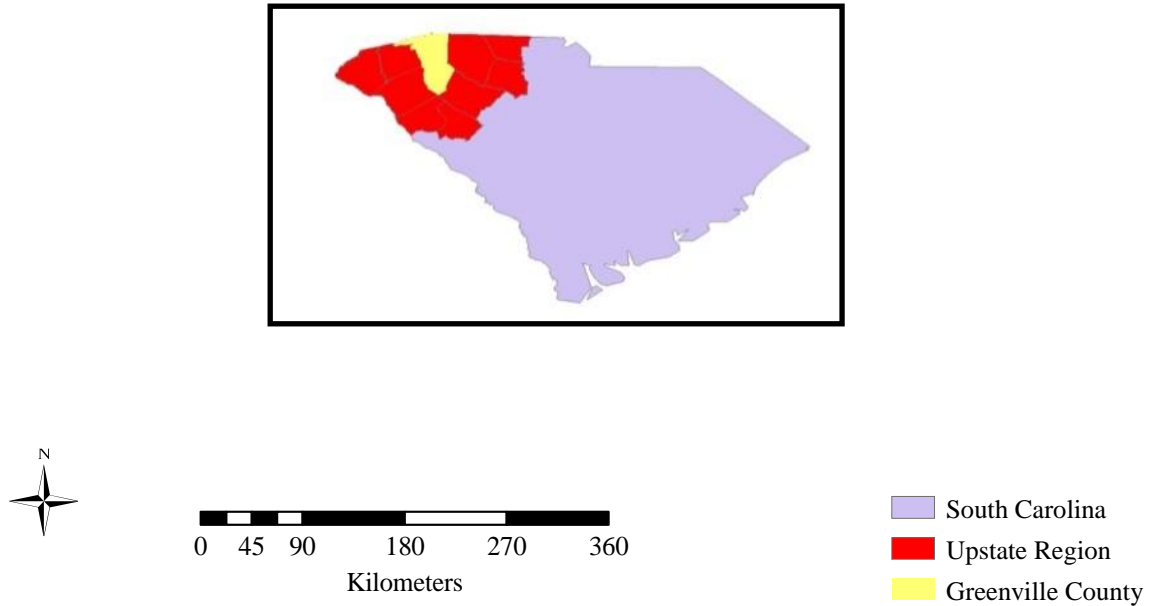
the primary products each farm offers highlighted. A “hot spot analysis” will be performed for each farm category to identify where “clusters” are located, which is an important criteria for node placement consideration. Optimal node placements also encompass close proximity to meat processors (where necessary) for easier management, close proximity to road networks and highway systems such that distribution of products can be expedient, and areas with favorable slope and fertile soil such that “incubator farms” adjacent to the node can also be successfully implemented. Incubator farms will act as catalysts for providing basic education to emergent farmers with respect to new crop management techniques, thus allowing beginners to understand all facets of the farming and distribution process.

1.7.1 Study Area

This research aims to determine optimal placements for a “food production node” in the Upstate region of South Carolina. The Upstate consists of the ten counties, Abbeville, Anderson, Cherokee, Greenville, Greenwood, Laurens, Oconee, Pickens, Spartanburg, and Union located in the northwest part of South Carolina (Figure 1).



(a)



(b)

Figure 1. “Study Area”. Three specific areas are highlighted here: (a) the state of South Carolina in the southeastern region of the United States (highlighted in purple); (b) the Upstate, South Carolina, which consists of the ten counties of Abbeville, Anderson, Cherokee, Greenville, Greenwood, Laurens, Oconee, Pickens, Spartanburg, and Union (highlighted in red); and (b) Greenville County, where this research was based (highlighted in yellow). Source: author.

This assessment will include the mapping of relevant Certified South Carolina Grown farms, Carolina Farm Stewardship Association members, ASAP Appalachian Grown members, Local Harvest members, and South Carolina and Georgia Market Maker farms within a 161 kilometer (100 mile) radius of Greenville County, South Carolina as a means to determine best placements for a “food production node” in the Upstate.

1.7.2 Research Questions

1. What are the best criteria to consider when identifying potential “food production node” placement?
2. Where are the best potential placements for a “food production node” in the Upstate of South Carolina?

3. How would node implementation support the FAO-cited development themes of resilience, and food security and the right-to-food?

2 Methodology

2.1 Philosophical Approach

Ontological and epistemological assumptions based in critical realism comprise the foundations of this project development. That is to say, it is adopted that there is in fact a real world outside of human influence, but also that human perceptions and interactions play a part in constructing interpretations of “reality”; thus, the state of the world is a function of both natural and human-induced processes (Moses & Knutsen, 2007). From this critical realist meta-theoretical starting point, the methodology evolved into a mixed methods approach. This approach consists of the utilization of both qualitative and quantitative means, as delineated in *Constructing Social Research* (Ragin & Amoroso, 2011); qualitative means speak to the criteria identified to be crucial to node implementation during the “field-work”, action research portion of the project, and quantitative means consist of the raw source data collected and the creation of GIS maps.

2.2 Action Research

Action research is a participatory process in which practical knowledge is developed to advance worthwhile societal endeavors (Brydon-Miller, Greenwood, & Maguire, 2003). This knowledge is considered essential to the welfare of communities as well as to advocating for larger-scale social change (Brydon-Miller et al., 2003). Being founded upon a basis of participation and democratic inclusion, action research finds its roots in a broad range of fields and is not influenced by any one academic discipline (Brydon-Miller et al., 2003). Kates et al. (2001) underscores that sustainability science will only be realized through the “systematic use of networks for the utilization of expertise and the promotion of social learning” (p. 641), and as such, it is recognized that change must be enacted through the cooperation of various stakeholders.

Action research was chosen in part because of the author’s background in working with local food systems and production. Having grown, harvested, and delivered fresh produce to local restaurants from a young age, the author acknowledges value in the strength that interactions between actors (such

as those between a farmer and chef) can have on local food development and promotion. The principles of action research posit that knowledge does have social constructions and all research encompasses a system of values (Brydon-Miller et al., 2003), and indeed, as a researcher, social constructions are realized as playing an equal role in reality as natural processes do.

The objectives of this research project were refined during the month-long field work segment of the thesis development process, which spanned the four weeks from beginning to end of February 2014. Criteria for suggested node placement were discussed and finalized during meetings with Scott Park of the Greenville County Community Development and Planning's Department of Planning and Code Compliance, whose close interactions with local farmers themselves can be incorporated into the ultimate decision-making process. Mike McGirr, a chef and local food advocate who works closely with the Clemson University community in South Carolina also participated in these proceedings, and these collaborations ultimately helped shape the direction of the project goals. The assessment commissioned specifically by the State of South Carolina from the Crossroads Resource Center, *Making Small Farms into Big Business*, also guided the background of the project, as it incorporates feedback from 150 local food system leaders. It is key to note here that the work product generated by this research not only satisfies the academic requirements for thesis delivery, but also serves as a viable, actionable reference addressing a very real agricultural challenge that exists today. Specifically, this work product is intended to be used by the Department of Planning and Code Compliance as material to propose potential node locations to concerned state agencies.

2.3 Quantitative Data Collection

Raw source data, the analysis of this data, and the processing of this data into resulting outputs lends to a quantitative research product. The initial step in this process was to compile the relevant farms of the Certified South Carolina Grown, Carolina Farm Stewardship Association, ASAP Appalachian Grown, Local Harvest, and South Carolina and Georgia Market Maker associations that are located in South Carolina, North Carolina, Tennessee, and Georgia within a 161 kilometer (100 mile) radius of Greenville County, South Carolina. Individual farms registered by these organizations were then disseminated into twelve separate Excel worksheets based on their listed categorical products offered (Table 1).

Table 1. Farm Production Categories

Farm Production Categories	Descriptions	Farms Plotted
Red Meat Production	Farm production centers on production of red meats. These include beef, pork, lamb, rabbit, goat, and bison.	78
Poultry Production	Farm production is focused on poultry. This includes chicken, turkey, and duck.	13
Mixed Meat Production	Farm produces any combination of red meats and poultry.	58
Dairy Production	Farm offers dairy products specifically. These include eggs, milks, cheeses, butters, and creams.	55
Vegetable/Fruit Production	Farm products consist of primarily vegetables and/or fruits, and some with additional herbs, nuts, grains and/or flowers available.	765
Specialty/Other Item Production	Farm produces specialty items or products. These include, but are not limited to, honey, jams, baked goods, teas, salves, sauces, and crafts.	288
Mixed Vegetable/Fruit and Specialty Production	Farm produces any combination of vegetables, fruits, and specialty items.	174
Mixed with Red Meat Production	Farm offers vegetables/fruits and/or specialty items in conjunction with any combination of red meat.	66
Mixed with Poultry Production	Farm products consist of vegetables/fruits and/or specialty items in conjunction with any combination of poultry.	24
Mixed with Mixed Meats Production	Farm production includes vegetables/fruits and/or specialty items in addition to any combination of red meats and poultry.	102
Mixed with Dairy Production	Farm offers vegetables/fruits and/or specialty items in addition to any combination of dairy products	124
No Information Found	No detailed information found about farm production.	12

Table 1. “Farm Production Categories”. This table provides a breakdown of the twelve categories the 1,759 farms collected were separated into. This breakdown consists of the category type, a description of that category, and how many farms fell into each category. Source: author.

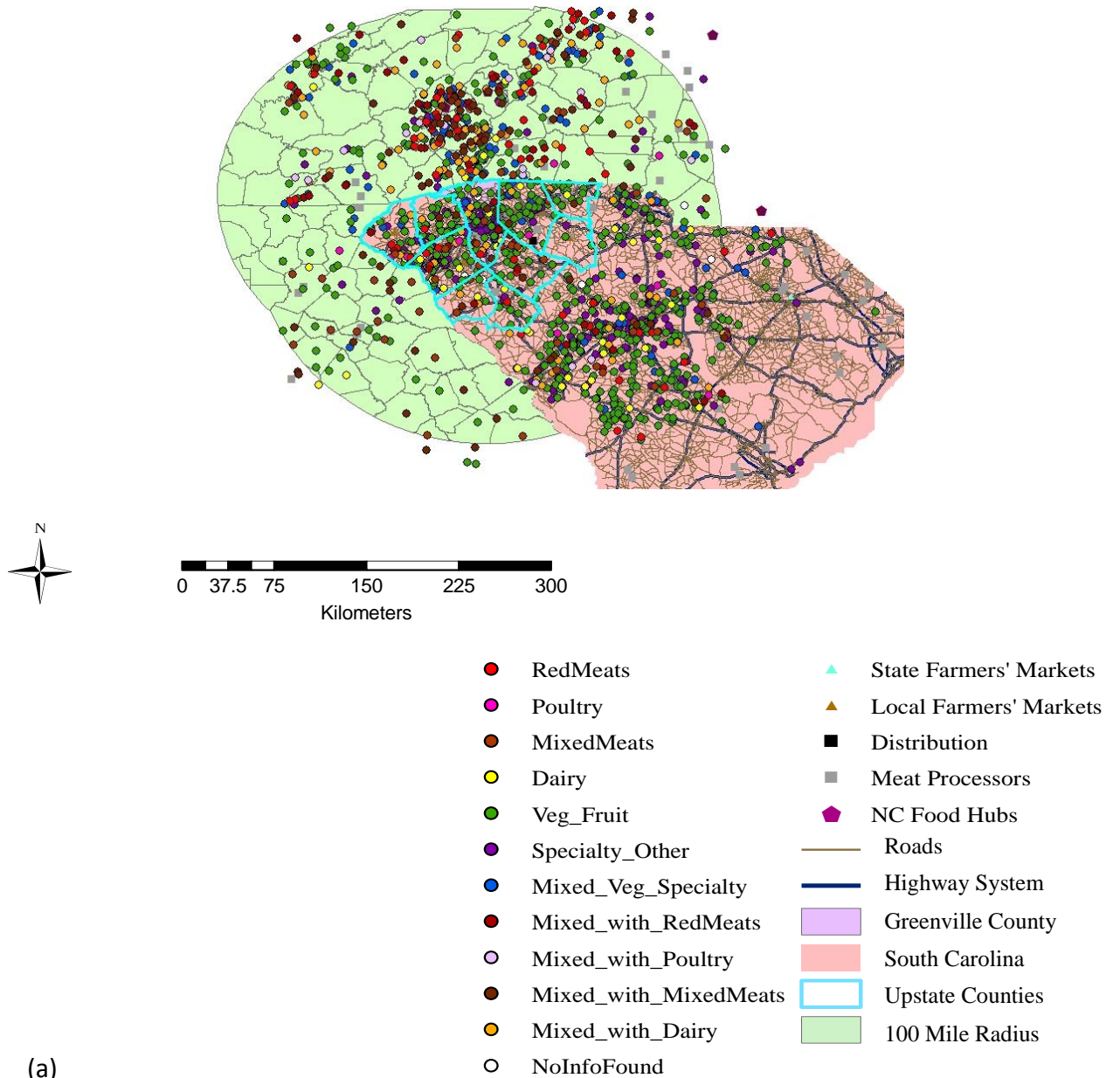
2.4 Creation of Map Document

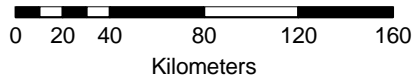
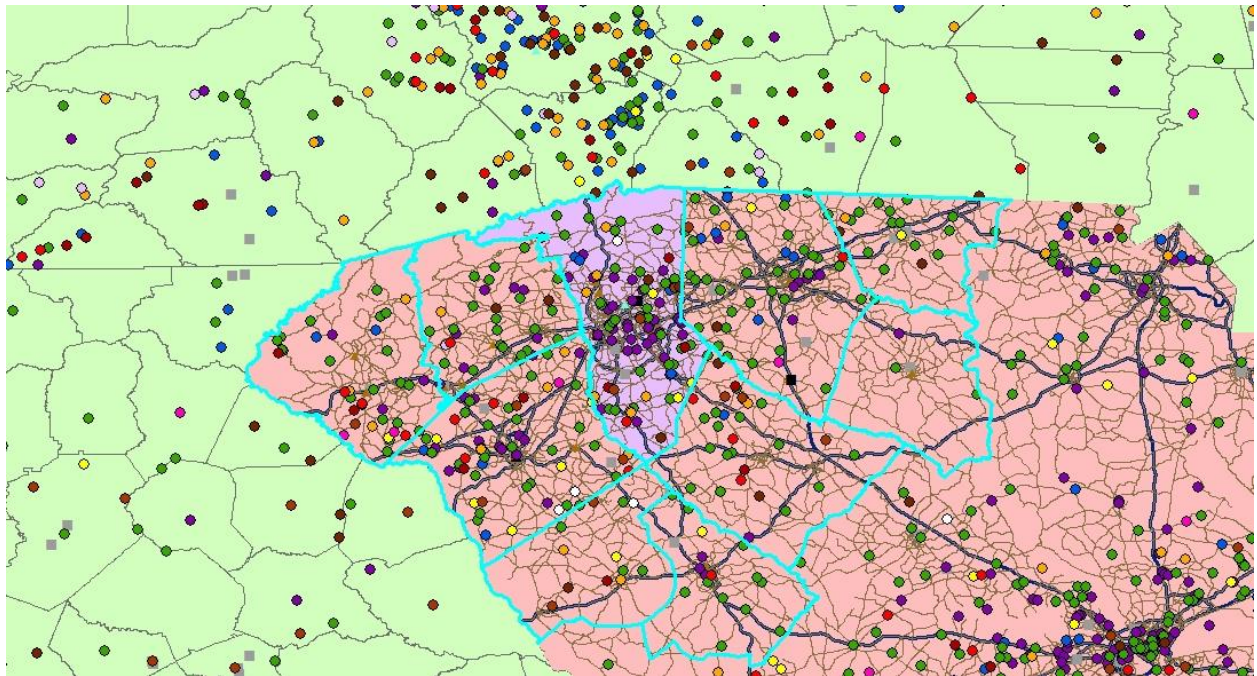
2.4.1 Preliminary Setup

A GIS map document was created in ArcMap 10.2.1 using ArcGIS software. County boundary shapefiles for each of the four states (South Carolina, North Carolina, Georgia, and Tennessee) were downloaded from state GIS archives, respectively, and were added into the ArcMap document. A 161 kilometer (100 mile) buffer from Greenville County, South Carolina was created to eliminate irrelevant regions from the map projection.

2.4.2 Farm Clusters

Following farm separation into the twelve categories depicted above (Table 1), the farms' respective latitude and longitude coordinates were determined from individual addresses using an online converter. These coordinates were then converted to Universal Transverse Mercator (UTM) coordinates, for successful plotting in the ArcMap document. Farm production types were displayed with different color-coded points (Figure 2).





(b)

- | | |
|-------------------------|--------------------------|
| ● RedMeats | ▲ State Farmers' Markets |
| ● Poultry | ▲ Local Farmers' Markets |
| ● MixedMeats | ■ Distribution |
| ● Dairy | ■ Meat Processors |
| ● Veg_Fruit | ◆ NC Food Hubs |
| ● Specialty_Other | — Roads |
| ● Mixed_Veg_Specialty | — Highway System |
| ● Mixed_with_RedMeats | ■ Greenville County |
| ○ Mixed_with_Poultry | ■ South Carolina |
| ● Mixed_with_MixedMeats | □ Upstate Counties |
| ● Mixed_with_Dairy | ■ 100 Mile Radius |
| ○ NoInfoFound | |

Figure 2. “Plotted Farms”. Depicted here are the 1,759 farms distinguished by category with different color-coded points. Also illustrated are farmers’ markets, distributors and processors, food hubs in North Carolina, and roads and highways. Part (a) is a zoomed out version of the map, and part (b) is zoomed in. Source: author.

2.4.3 Optimized Hot Spot Analysis

Optimized hot spot analysis was performed for five layers to identify farm clusters offering similar products. Optimized hot spot analysis is defined as, “[given incident points]...this tool identifies statistically significant spatial clusters of high values (hot spots) and low values (cold spots)” (Esri, 2014). Categories containing red meat production (red meat production, mixed meat production, mixed with red meat production, and mixed with mixed meat production) were combined into the first layer. Categories containing poultry production (poultry production, mixed meat production, mixed with poultry production, and mixed with mixed meat production) comprised the second. Categories containing dairy production (dairy production, and mixed with dairy production) constituted the third. Categories containing vegetable/fruit production (vegetable/fruit production, and mixed vegetable/fruit and specialty production) were combined into the fourth, and categories containing specialty item production (specialty/other item production, and mixed vegetable/fruit and specialty production) comprised the fifth layer. These categorical classifications allow for all farms producing separate product types to be included in different groupings for hot spot analysis. The five hot spot output layers were converted to raster format and reclassified.

2.4.4 Meat Processors

Meat processing centers in South Carolina, North Carolina, and Georgia are plotted in the map document to illustrate in which geographic areas such infrastructures are already implemented and around which a node would likely prosper most. A buffer of 8,000 meters (5 miles) was created for this layer to identify areas within this range for prioritization. This buffer was then converted to a raster for reclassification.

2.4.5 Road Networks/Traffic Lines

A road network shapefile for the state of South Carolina was provided by the Greenville County Community Development and Planning’s Department of Planning and Code Compliance and was added into the ArcMap document to act as one of two determinants of proximity of farms to efficient distribution networks. A buffer of 800 meters (1/2 mile) was created for this layer to separate areas within this distance for prioritization. This proximity was selected loosely based on an example of spatial models provided by Bolstad (2008, p. 488). This buffer was then converted to a raster for reclassification,

and finally, buffered traffic lines within the Upstate were extracted using an Upstate region clip as a mask.

2.4.6 Highway System

A highway system shapefile for the state of South Carolina was also provided by the Greenville County Community Development and Planning's Department of Planning and Code Compliance and was added into the ArcMap document to act as the second determinant for proximity of farms to well-connected distribution networks. A buffer of 5,000 meters (3 miles) was created for this layer to separate areas within this distance also for prioritization. This proximity was selected loosely based on an example of spatial models provided by Bolstad (2008, p. 488). This buffer was then converted to a raster for reclassification, and lastly, the buffered highway system within the Upstate was extracted using a clip of the Upstate region as a mask.

2.4.7 Soils

Subbasin shapefile layers were retrieved from archived South Carolina GIS files on the basis of subbasins located partially or completely within the Upstate and were added into the ArcMap document. In conjunction with slope data, the optimal growing areas for an incubator farm, ideally located adjacent to the food node, will be determined by soil fertility. Thus, areas linked to the attribute of "all areas are prime farmland" were selected from each subbasin and merged into one layer. This merge was converted to a raster and was reclassified.

2.4.8 Slope

A layer depicting topography and slope in the form of a digital elevation model (DEM) was retrieved from the South Carolina GIS site and added into the ArcMap document. The slope component of the DEM was derived using the slope function and was reclassified such that areas with slopes between 0-30 degrees were favored. These degrees were selected based on an example of spatial models provided by Bolstad (2008, p. 488). Slope data for the Upstate region only was then extracted using an Upstate region clip as a mask.

2.4.9 Weighted Overlay

“To solve [the] multicriteria problem [of] site selection” (Esri, 2011), a weighted overlay to identify best potential node placements was first performed including all five hot spot output layers with the following constituents; the reclassified hot spot raster of red meat categories with a 12% influence, the reclassified hot spot raster of poultry categories with a 12% influence, the reclassified hot spot raster of dairy categories with a 12% influence, the reclassified hot spot raster of vegetable/fruit categories with a 12% influence, the reclassified hot spot raster of specialty item categories with a 12% influence, the reclassified meat processors raster with 4% influence, the extracted traffic lines raster with 9% influence, the extracted highway system raster with 9% influence, the reclassified subbasin raster with 9% influence, and the extracted slope raster with 9% influence. Five subsequent weighted overlays were then performed to evaluate each individual category for supplementary node placement suggestions. The two weighted overlays of meat categories were comprised of the following constituents; reclassified hot spot rasters of red meat categories and poultry categories with 40% influence, respectively, the reclassified meat processor raster with 20% influence, the extracted traffic lines raster with 10% influence, the extracted highway system raster with 10% influence, the reclassified subbasin raster with 10% influence, and the extracted slope raster with 10% influence. The three final individual overlays had the following constituents; reclassified hot spot rasters of dairy categories, vegetable/fruit categories, and specialty item categories with 48% influence, respectively, the extracted traffic lines raster with 13% influence, the extracted highway system raster with 13% influence, the reclassified subbasin raster with 13% influence, and the extracted slope raster with 13% influence.

2.4.10 Auxiliary Elements

Locations also included within the map are state farmers’ markets as well as local farmers’ markets where many farmers could benefit from in future following node implementation. Food hubs of North Carolina are inserted in the map as an example for how similar infrastructures in South Carolina could develop. Primary distribution facilities for South Carolina are also included as a map layer.

2.5 Limitations

These aforementioned methods are constrained by some limitations, three in particular. First, only registered farms found from Certified South Carolina Grown, Carolina Farm Stewardship Association,

ASAP Appalachian Grown, Local Harvest, and South Carolina and Georgia Market Maker at the time of search were included here, so any unregistered farms or other added farms are not considered. Second, the size of farms was not factored into this research, and as such, the method used for analysis was dictated by what information was available as well as the results do not take into account magnitude of production. Additionally, the percent influences assigned to factors in the weighted overlay function, buffer distances assigned to processors, roads, highways, and degrees assigned for low-slope areas by the author influence results and conclusions. If different values were assigned in these areas, the identified preference locations from the weighted overlays may have varied. Also, only the factors of farm clusters, proximity to processors, roads, and highways, and areas of fertile soil and no/low-slope were incorporated into the weighted overlay equations; perhaps the inclusion of other indicators (e.g. proximity to farmers' markets, distributors) would influence results further.

3 Results

Necessary criteria to include in the mapping analysis were identified in meetings with Scott Park and Mike McGirr to be; local farm locations and types of products offered for cluster identification; proximity to meat processors (for farms producing meats) for easier management; proximity to roads and highways for efficient distribution; and areas with fertile soil and low-slopes for potential incubator farm inclusion. Additional but secondary criteria cited for consideration included; proximity to local and state farmers' markets for easier potential sale; node placements in North Carolina for observation of successful node/hub infrastructure; proximity to primary distribution facilities for South Carolina for potential partnership; and recognition of ARC (Appalachian Regional Commission) Counties and Tier III and IV Counties for potential funding opportunities and avenues.

In total, 1,759 farms dispersed throughout South Carolina, North Carolina, Tennessee, and Georgia within a 161 kilometer (100 mile) radius of Greenville County, South Carolina were categorized and plotted as a result of this assessment (see Table 1). Six weighted overlays were performed and identified best potential locations for node implementation based on hot spots of farm clusters, proximity to processors, proximity to roads and highways, and areas of fertile soil and no/low-slope. Results are organized by category of the weighted overlays, and the "suitability" distinction is a representation of "preference values that are on a relative scale...that is, a preference of ten is twice as preferred as a preference of five" (Esri, 2011).

3.1 Weighted Overlay with Five Hot Spot Outputs

Locations are highlighted by the first overlay function weighting consideration of red meat production hot spots, poultry production hotspots, dairy production hot spots, vegetable/fruit production hot spots, specialty item hot spots, proximity to processors, road networks, and highway systems, and areas of prime farmland and no/low-slope (Figure 3). One area in northern Laurens County was assessed from the overlay to have the highest suitability here, with a seven out of ten rating. Additional identifications included eight sites with a six out of ten suitability rating all located within Greenville County, and eleven sites with a five out of ten suitability rating, ten located within Anderson County and one located within Greenwood County. A node that included infrastructure to benefit all farm production types would be best located in the northern region of Laurens County.

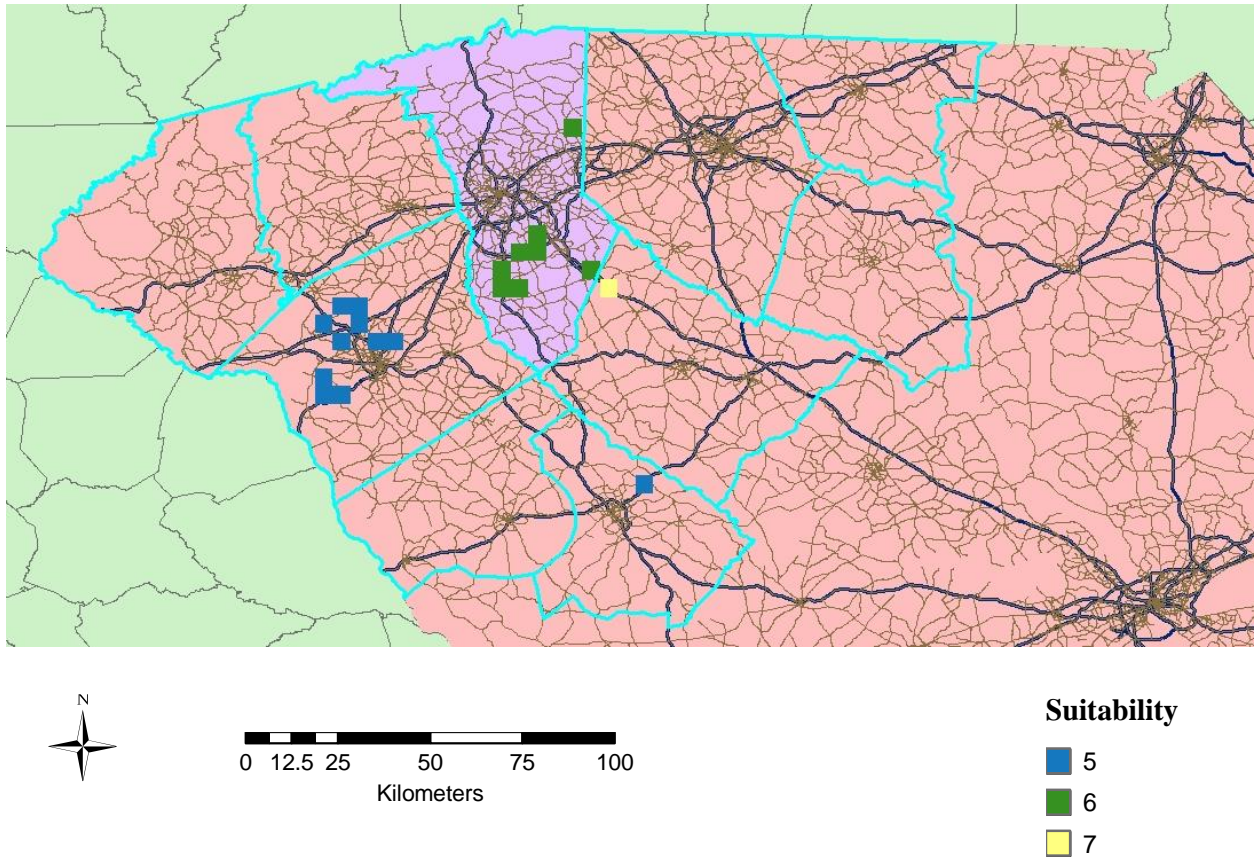


Figure 3. "Weighted Overlay with Five Hot Spot Outputs". This map illustrates the sites identified within the Upstate area that have preference ratings of five, six, and seven (out of ten) for a node establishment that may include infrastructure for all farm production types. Source: author.

3.2 Weighted Overlay with Only Red Meat Categories

Locations are identified by this overlay weighting red meat production hot spots, proximity to meat processors, road networks, and highway systems, and areas of prime farmland and no/low-slope (Figure 4). There was no area that resulted with a standout suitability rating from this function, and 150 sites dispersed throughout eight out of the ten Upstate counties were determined to have a six out of ten suitability rating. A node prioritizing red meat production infrastructure would have best placement in the general regions of central Anderson County, southern Greenville County, western Spartanburg County, and north central Cherokee County.

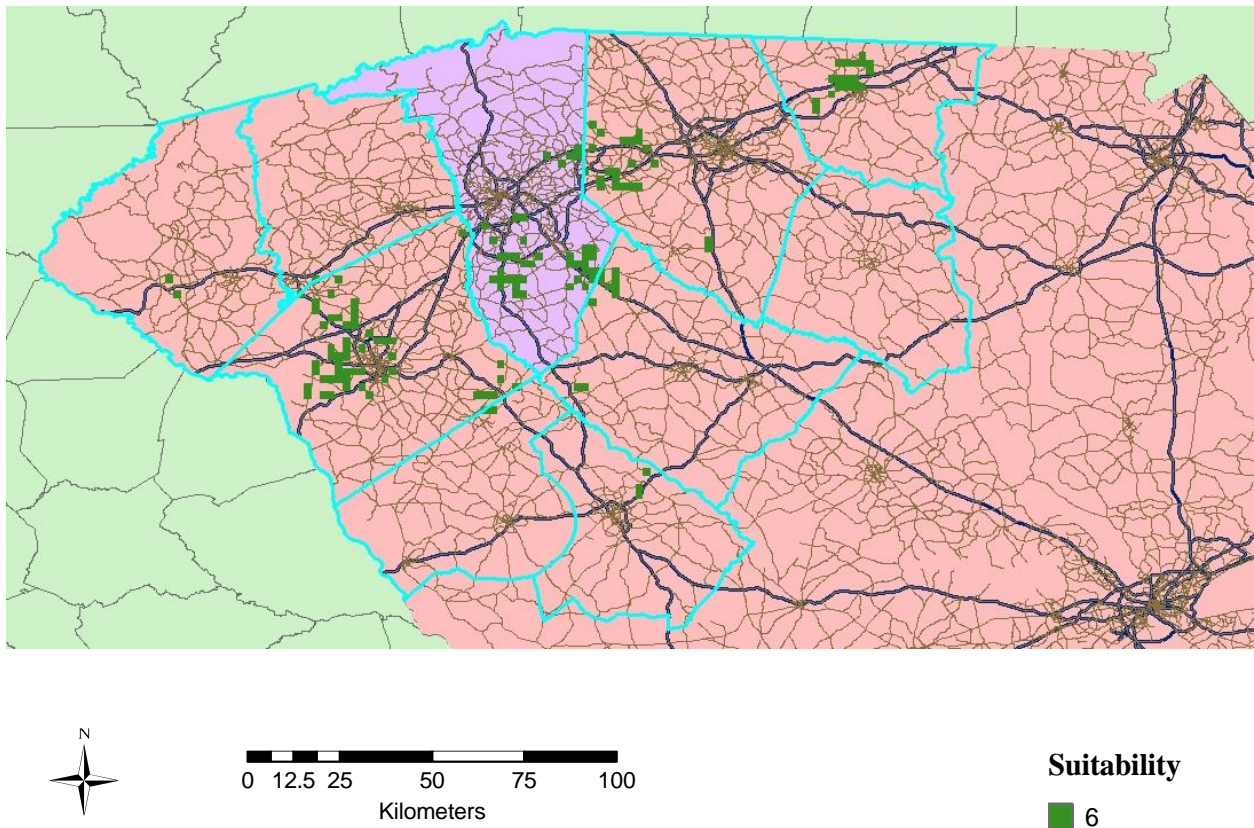


Figure 4. “Weighted Overlay with Only Red Meat Categories”. Contained within this map are identifications of sites all with a preference rating of six (out of ten) in which a food production node prioritizing infrastructure for red meat production may wish to be implemented. Source: author.

3.3 Weighted Overlay with Only Poultry Categories

Locations are recognized by this overlay weighting poultry production hot spots, proximity to meat processors, road networks, and highway systems, and areas of prime farmland and no/low-slope (Figure 5). Twelve sites located in Spartanburg, Laurens, and Greenville Counties were differentiated from the overlay to have highest suitability here, with nine out of ten suitability ratings. One hundred and fourteen additional sites dispersed throughout all Upstate counties except Union County were calculated to have a suitability rating of six out of ten. A node prioritizing poultry production infrastructure would be best located in southwest Spartanburg County or northern Laurens County by the border of Greenville County.

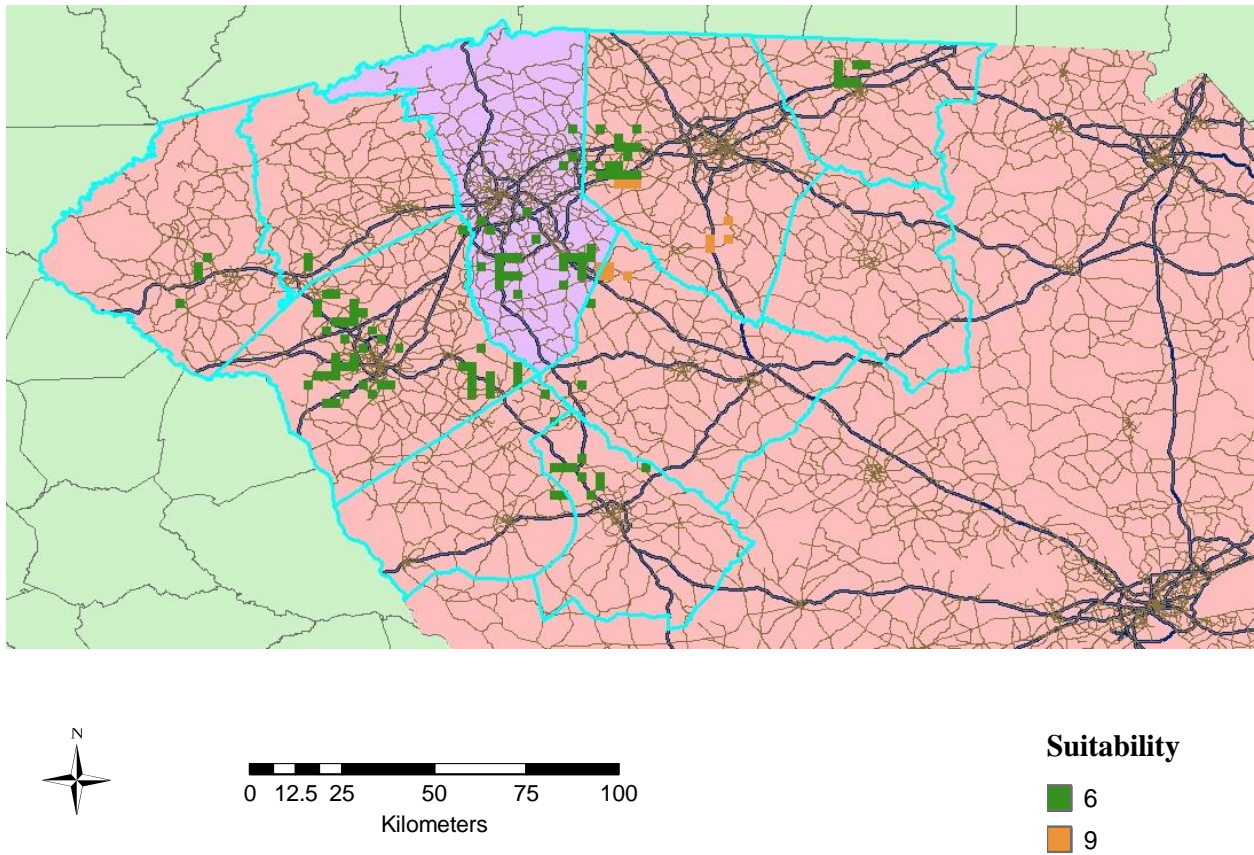


Figure 5. “Weighted Overlay with Only Poultry Categories”. This map highlights sites with preference ratings of six and nine (out of ten) in which a node placement prioritizing poultry production infrastructure could be established. Source: author.

3.4 Weighted Overlay with Only Dairy Categories

Locations are defined by this overlay weighting dairy production hot spots, proximity to road networks and highway systems, and areas of prime farmland and no/low-slope (Figure 6). There was no area measured with a standout suitability rating here, and 569 sites dispersed throughout all Upstate counties except for Union County were determined to have a six out of ten suitability rating. Additionally, one site located in Greenville County was assessed to have a five out of ten suitability rating. A node prioritizing dairy production infrastructure would be best located in the general regions of western Anderson County, southern Greenville County, northern Laurens County, central Spartanburg County, or central Cherokee County.

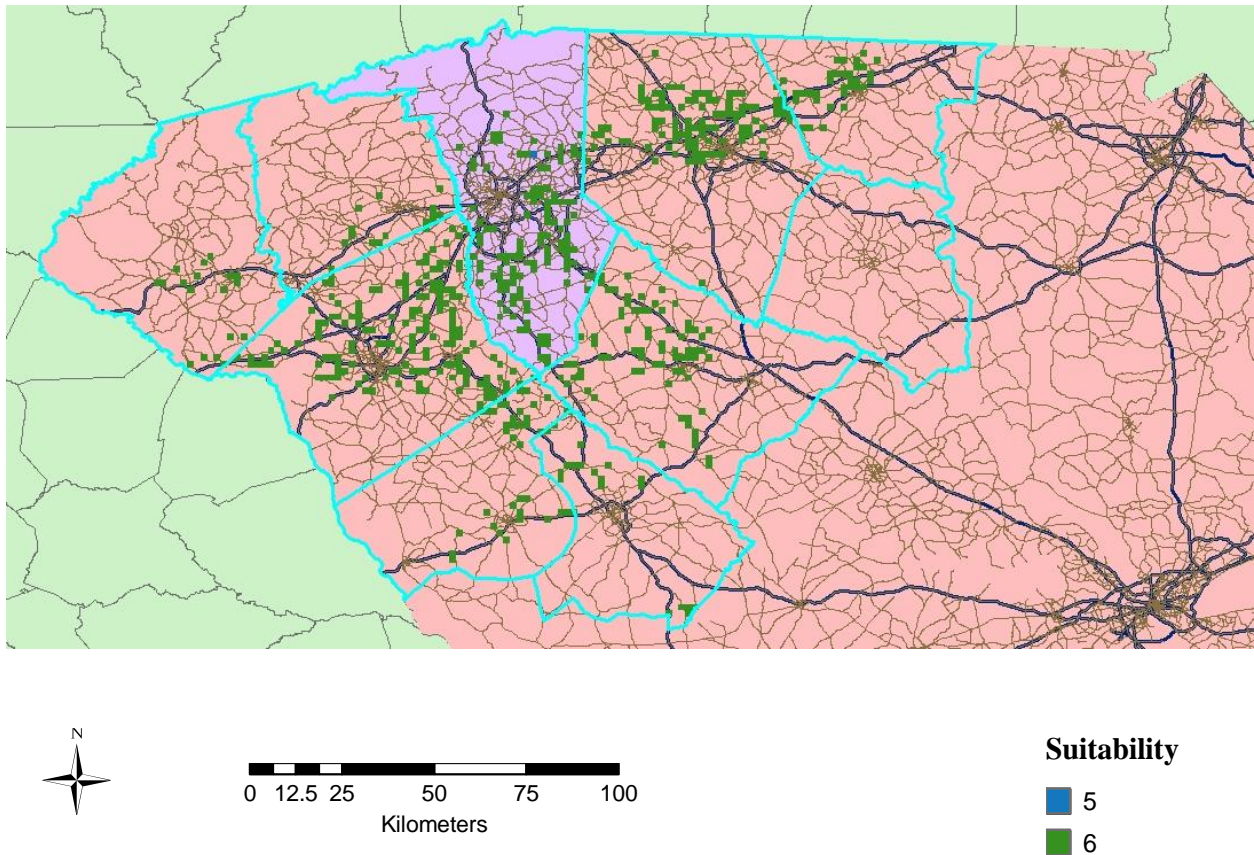
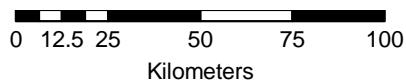
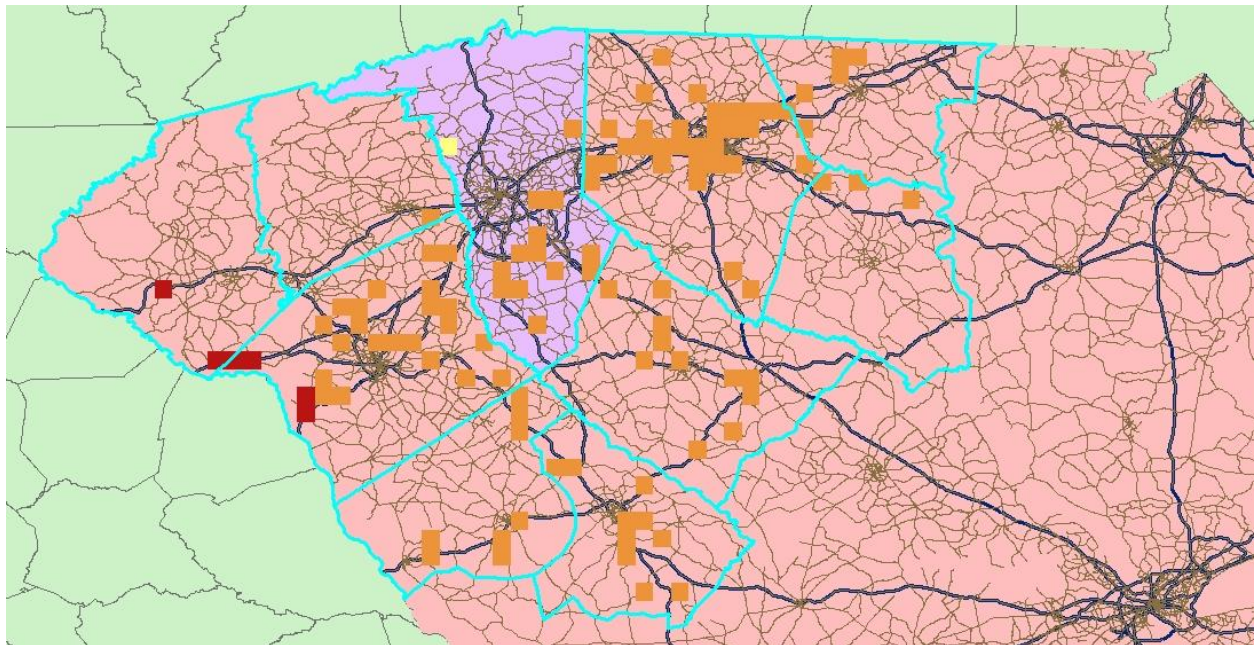


Figure 6. “Weighted Overlay with Only Dairy Categories”. Illustrated in this map are potential food production node sites with preference ratings of five and six (out of ten) that would prioritize infrastructure for dairy production. Source: author.

3.5 Weighted Overlay with Only Vegetable/Fruit Categories

Locations are highlighted by this overlay weighting vegetable/fruit production hot spots, proximity to road networks and highway systems, and areas of prime farmland and no/low-slope (Figure 7). Six sites located in Oconee and Anderson Counties were distinguished from the overlay to have highest suitability here, with ten out of ten suitability ratings. One hundred and four additional sites dispersed throughout all Upstate counties aside from Oconee County were calculated to have a suitability rating of nine out of ten, and one site in Greenville County was judged to have a seven out of ten suitability rating. A node prioritizing vegetable/fruit production infrastructure would be best placed in southwest Oconee County or northwest Anderson County.



Suitability



Figure 7. “Weighted Overlay with Only Vegetable/Fruit Categories”. This map identifies sites with preference ratings of seven, nine, and ten (out of ten) for potential node implementation that prioritized infrastructure for vegetable/fruit production. Source: author.

3.6 Weighted Overlay with Only Specialty Item Categories

Locations are identified by this overlay weighting specialty item production hot spots, proximity to road networks and highway systems, and areas of prime farmland and no/low-slope (Figure 8). One hundred and seventy-five sites located in Anderson, Greenville, Laurens, and Spartanburg Counties were marked from the overlay to have highest suitability here, with nine out of ten suitability ratings. Sixteen sites in Pickens and Anderson Counties were measured to have a seven out of nine suitability rating, and 113 sites dispersed throughout six counties were determined to have a suitability rating of six out of ten. Additionally, one site in Oconee County was assessed to have a five out of ten suitability rating. A node prioritizing specialty item production infrastructure would be best placed in the general regions of southern Greenville County or central Spartanburg County.

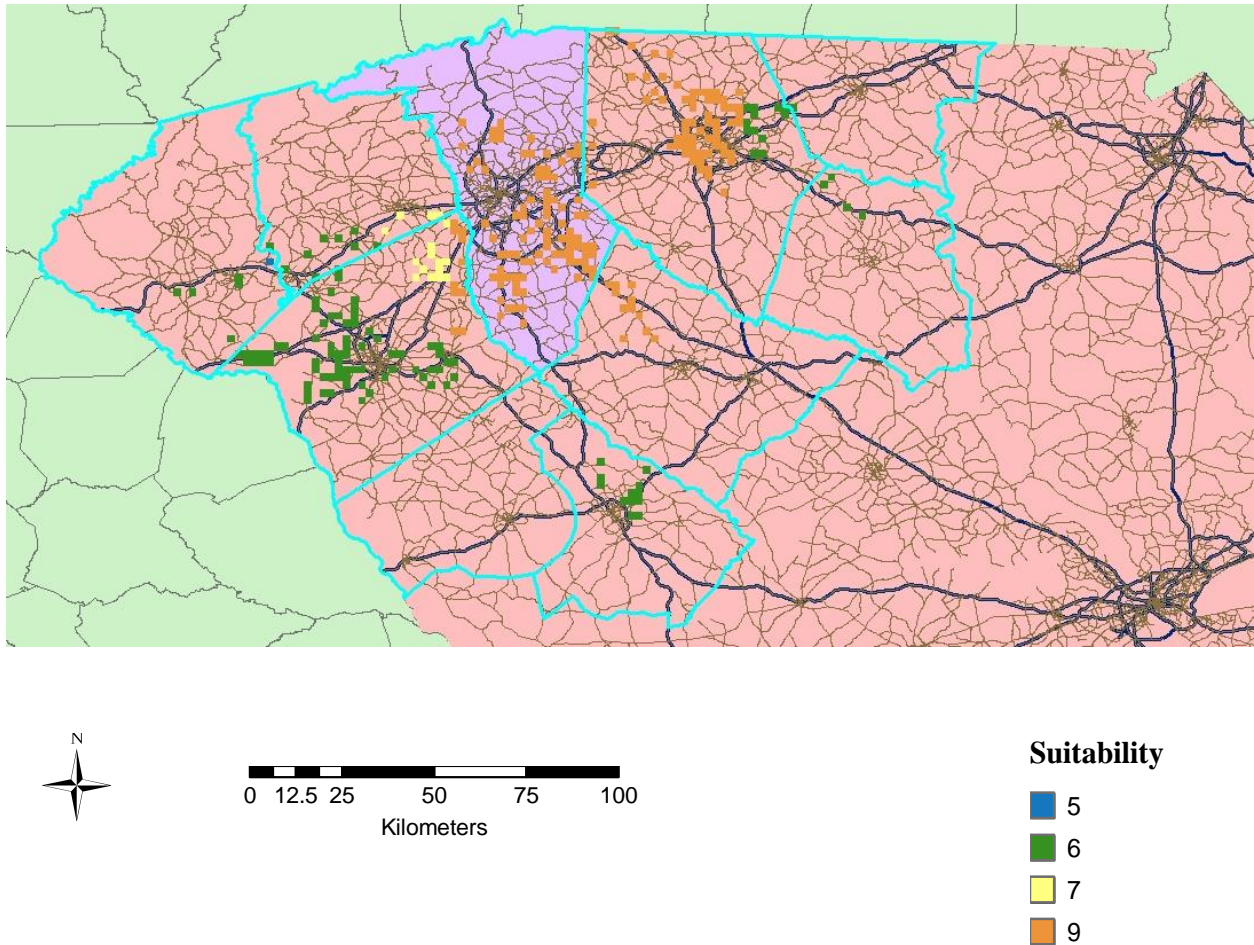


Figure 8. “Weighted Overlay with Only Specialty Item Categories”. Highlighted in this map are potential food production node sites with preference ratings of five, six, seven, and nine (out of ten) that would prioritize infrastructure for specialty item production. Source: author.

3.7 Suitability for Food Production Node Implementation

Preferences derived from the overlays shown above yielded the following results (Table 2). Laurens County featured as having a highest suitability for five out of the six overlays performed. Greenville, Anderson, and Spartanburg Counties followed, having a highest suitability rating for four out of the six overlays performed.

Table 2. Suitability for Food Production Node Implementation

Production Hot Spots	Upstate Counties with Highest Suitability
All (Figure 3)	Laurens
Red Meat (Figure 4)	Oconee, Anderson, Abbeville, Greenwood, Greenville, Laurens, Spartanburg, Cherokee
Poultry (Figure 5)	Greenville, Laurens, Spartanburg
Dairy (Figure 6)	Oconee, Pickens, Anderson, Abbeville, Greenwood, Greenville, Laurens, Spartanburg, Cherokee
Vegetable/Fruit (Figure 7)	Oconee, Anderson
Specialty Item (Figure 8)	Anderson, Greenville, Laurens, Spartanburg

Table 2. “Suitability for Food Production Node Implementation”. Displayed here is a compilation of the counties in which each type of food production node would have the highest suitability based on the overlays above. Source: author.

4 Discussion

This discussion will begin with a general look at the issue of local food development from a macro perspective and will then move into a micro scale view of local food systems, and specifically, why certain criteria for node location determination were chosen and specific node placement proposals. Subsequently, an in-depth analysis of food production nodes will consist of critiques on assumptions and nodes themselves, and then conversely, provide links to economic benefits, social benefits, state participatory measures, resilience, and food security and the right-to-food. The final segment of the discussion will be an extrapolation of the future local food production must play in the face of impending global natural disasters.

4.1 The Macro View

People throughout the world continue to be exceptionally far-removed from the origins of what they eat, and as such, social, economic, and environmental systems within local communities suffer. In an article by Ilbery and Maye (2006), it was discussed that “whilst promoting a mantra of ‘convenience, cleanliness and consumer choice’, concentration of power at the retail end of the food chain has brought heavy criticism, especially in terms of delimiting food standards and ethical trade relations” (p. 352), including the reality of “various food scare episodes, growing consumer mistrust in standardized food production methods, and ethical and environmental concerns associated with how and where food is produced” (Ilbery & Maye, 2006, p. 353). These apparent drawbacks to industrial food production and distribution underscore the fact that the promotion of local food networks could positively address many of these lower standard issues which increasingly crop up with foreign and long-distance trade.

In response, a growing trend has been witnessed in recent years of many looking to alternative, more local options as their primary food sources. It was detailed in a USDA Economic Research Report that more and more consumer demand for locally produced and marketed food is generating increased interest in the local food movement throughout the United States (Martinez et al., 2010), and this is largely due to the fact that locally produced foods “offer a closer ‘connection’ with the point of production and an opportunity to support the local economy” (Ilbery & Maye, 2006, p. 353).

Food production nodes provide an infrastructure which supports this very ideal of offering consumers a closer “connection” with their food and food producers. Nodes are the building blocks to larger food hubs, and the Western Rural Development Center (WRDC) elaborates that these hubs are exponentially filling a market niche that the current food distribution system is not adequately addressing; the aggregation and distribution of food stuffs from small and mid-sized farmers into more local and regional wholesale market channels (retail, restaurant, and institutional markets) is properly facilitated (2012). Additional services provided by a food hub may also include warehousing, shared processing, and food waste management (Horst et al., 2011).

4.2 Chosen Criteria

The best locations for potential node placement were determined by evaluating the primary indicators of farm clusters, proximity to meat processors (where necessary), proximity to road networks and highway systems, and areas of prime farmland and no/low-slope. These criteria were specifically chosen as a result of discussions with Greenville County representatives as well as through research of local materials such as the assessment by Meter and Goldenberg (2013). These measures dictated that nodes would be optimally located in areas with significant clusters of farms producing similar wares for maximum inclusion of locals, close proximity to processors for farms prioritizing meat production for easier management, close proximity to road networks and highway systems for most efficient distribution, areas located on fertile soil/prime farmland and low/no slopes for the possible addition of an incubator farm. Incubator farms are especially significant as their purpose is to catalyze the foundational education of emerging farmers on row crop management, such that beginners can garner a more holistic understanding of the farming process. To this point, it was highlighted that, “Training and technical assistance is important since about 25% of those who begin local food businesses do not have previous experience in agriculture” (WRDC, 2012, p. 18).

4.3 Proposed Node Placements

Action research as a method was utilized extensively as the state requested around five suggestions for optimal food production node development be identified. Assessing this quantitatively, weighted overlays were performed using GIS software to provide such an in-depth quantification of where a food production node would be best located in the Upstate of South Carolina. Six different overlays were thus

conducted to provide suggestions for node development that could target the prioritization of varying production infrastructures. The following five proposed site areas were narrowed from the results, considering first the preference ratings generated by the different overlays and then the associated funding options that may be available for establishment in each targeted region.

4.3.1 Suggested Node Placement One: Northern Laurens County

A food production node, and specifically, a node that may include infrastructures for all production types, is proposed in the northern region of Laurens County. One site in this particular area was determined to have a preference value of seven, and was the only identification that represented the highest suitability for a node that would contain all production types.

4.3.2 Suggested Node Placement Two: Western Spartanburg County

A food node, and particularly, a node that would prioritize poultry production, is suggested in the western area of Spartanburg County. The sites in this area were assessed to have a preference value of nine, and are allotted a preference over those similarly identified in Laurens County, as Spartanburg is an ARC County where Laurens is not, and as such, is viable to be considered for federal funding.

4.3.3 Suggested Node Placement Three: Northwest Anderson County

A node, and specifically, one that may prioritize vegetable/fruit production, is proposed in the northwest region of Anderson County. The identified sites in this area were calculated to have a preference value of ten, and as Anderson County is also an ARC County, federal funding for such a project is potentially available.

4.3.4 Suggested Node Placement Four: Southeast Greenville County

A food production node, and particularly, one that may prioritize specialty item production, is suggested in the southeast region of Greenville County. Identified sites in this area were evaluated to have a preference value of nine, and federal funding would be an option for node implementation here as Greenville is an ARC County.

4.3.5 Suggested Node Placement Five: Central Cherokee County

A food node, and specifically, one that may prioritize red meat and/or dairy production, is proposed in the central region of Cherokee County. While all identified sites (in Cherokee as well as in other counties) in both of these production overlays had only a highest preference value of six, there may still be merit in implementing such a production node in Cherokee. As Cherokee County is both an ARC County with potential for federal funding, and a Tier III County, which makes it viable for state funding, success of node creation may be more easily realized with greater possibilities for financial support. By placing a node in such a Tier III County that is not as economically secure as Tier I and II Counties, more opportunities may exist for county economic growth and prosperity.

Coupled with these five location suggestions are two further considerations. First, as discussions within the state of South Carolina are currently progressing with regards to the implementation of a food hub in the downtown area of Greenville (in Greenville County), the placement of supporting node infrastructure will likely be influenced by this establishment. Second, potential interactions with nearby North Carolina food hubs will also be a determinant of ultimate food node location selection, as South Carolina may wish to partner with already existing infrastructures.

The engagement here of qualitative action research and quantitative problem-solving methods to advocate food production node creation supports the need for “systematic use of networks for the utilization of expertise and the promotion of social learning” as defined by Kates et al. (2001, p. 641). This research will benefit stakeholders from farmers to developers to state agencies, and fills a research gap within the local food development nexus, specifically in the state of South Carolina. That said, there are certain critiques on assumptions and critical considerations that should enter discussions on food production nodes.

4.4 On Assumptions

While the results presented will prove useful and valuable on a real scale, there are a number of assumptions made throughout this process that could ultimately influence results and may have limited certain conclusions.

For example, in terms of background knowledge and foundational understanding, research on food production nodes, and specifically in the South Carolina region, is quite limited. As such, the assessment conducted by Meter and Goldenberg (2013) of the Crossroads Resource Center is considered here as the primary source of food production node fundamental understanding, which may carry with it some limitations or overall bias.

Second, the limitations mentioned within the methodology may have affected final node placement proposals. As magnitude of production could not be taken into account for this study, perhaps more appropriate GIS methods than optimized hot spot analysis could have been utilized to produce more accurate results. These “more accurate” results could weight more highly for example, a node placement that may benefit farms with a higher production scale who could utilize facilities to a greater extent than a smaller production farm may. While there is a considerable amount of South Carolinian, North Carolinian, Tennessean, and Georgian farms taken into account in this study, any farms not included here could have impacted final conclusions. Excluded farms may be unregistered farms or farms not found at the time of search or farms that may be registered but only with other associations aside from the five tapped for this research. Some discrepancies may also be present in the actual functions/equations performed within the GIS process. Specifically, the proximities (buffer values) and slope degrees articulated by the author may in certain instances not be most suitable. Derivation was based loosely on the example provided by Bolstad (2008, p. 488), where general criteria for home-site selection was outlined. Slopes less than 30 degrees were categorized as “not too steep”, and road distances were characterized as 300 meters (.2 miles) being “far enough from road to provide privacy”, and 2000 meters (1.2 miles) being “not isolated” (Bolstad, 2008, p. 488). These variables were adjusted, considering the slight difference in nature of this site selection, but it is recognized that these values may be subject to improvement. Additionally, any other unknown indicators that may have high influence on node establishment that were excluded from evaluations may affect results.

Next, there are relevant considerations surrounding such criteria as proximity to highway systems. On the one hand, by weighting areas that are nearer to highway systems as more favorable, more efficient transport and distribution would be facilitated, but on the other hand, support and improved infrastructure for already-developed areas/counties may create a further divide between these regions and areas perhaps in greater need of such development infrastructure. As a result, this may be a potential drawback to criteria consideration.

Lastly, there may be bias associated with suggested node locations. Proposals were based on addressing suitable placements for the different production categories as opposed to addressing various sites within one category that may have higher preference ratings than those of other categories.

In summary, assumptions were necessary to fulfill the research goals, but are recognized to perhaps influence overall results. Nevertheless, these assumptions notwithstanding, the data compiled and processed serve a very real and valuable function, opening the door of opportunity for follow-up research to be conducted.

4.5 Potential Drawbacks Surrounding the Food Production Node Concept

There are three weaknesses that stand out with regards to the establishment of local food node infrastructure. The first speaks to the acknowledgement that while these networks will notably benefit small and mid-size farmers, certain consumer groups, local and state economies, and local food development pursuits, more impoverished communities will likely not experience the same benefits. According to the US Census Bureau (2014) from 2008-2012 assessments, 17.6% of the state's population falls below the poverty level, which means that about 1/5 of South Carolinians do not have sufficient resources to acquire the more expensive, healthier foods on the market. It is often the case that local food products are more expensive and it is the larger retailers that retain the lowest prices for many basic commodities (Dowler, 2008). This being the case, it would seem that the development of such local food support systems may not be beneficial to all parties within the surrounding local communities. This may be where the supporting theory of food security "misses", so to speak; while food nodes are accompanied by everything from improvements to accessibility, health, and education, to economic and social benefits, the actual ability to purchase and acquire what the node would bring to the table will not be a reality for some. It is here one concedes that food production node implementation is not a "silver bullet" in solving local food development issues.

The second limitation that pertains to food production node webs is that of geographic applicability. That is, one wonders if such infrastructures would be at all successful in regions such as the Corn Belt. With the Breadbasket States producing largely cash-crops and being a major world exporter of meat and grains (Hatfield, 2012), viability of local food development may prove to be a much lower priority than

intensity of agricultural production. Due to the Midwest's focus on generating large-scale exports, there seems little room to significantly develop the presence of local, more specialized wares.

Last is a consideration of uncertain future climate events. Because food production node construction and design are largely functions of current production trends, any exponential variation in type or amount of farm commodities may adversely influence the effectiveness of any one node. Climate change is a "wild card", and should an area supported by a node be excessively impaired by its volatility, the prosperity and longevity of the food production node could certainly be diminished.

4.6 Nodes and Links to Economic Benefits: A Local Lens

With respect to this potential for economic growth on a local and regional scale, as community agriculture, municipal, local, and state economies are improved, there exists a "multiplier" effect generated from direct sales of locally produced goods; that is, for every one dollar spent, the resulting economic benefit is greater than one dollar (WRDC, 2012). Restated, a significant boost in buying local would translate into a corresponding boost in the overall economy.

Currently, farmers find themselves limited by the lack of appropriate processing and distribution infrastructure that would allow them to tap into larger retail and commercial food markets, especially in areas where demand for local foods is increasing (WRDC, 2012). By implementing a well-planned node to hub infrastructure, however, small and mid-sized farmers can better access the larger institutional markets (Foley, Goodman, & McElroy, 2012), and would be facilitating this in a way that creates jobs and keeps a greater percentage of the earned dollar in the farmers' pockets (WRDC, 2012). To put this into relative but very real terms, it was estimated that, "If each Palmetto State resident purchased \$5 of food directly from a South Carolina farm each week, this would yield \$1.2 billion in revenue for the state's farmers" (Meter & Goldenberg, 2013, p. 26). By eliminating the middlemen that become necessary for more long-distance sale, farmers are able to secure more of a net profit for their products.

From this analysis, it is clear that the establishment of food production nodes would exert significant impact from an economic perspective, and especially empowering smaller and mid-size farmers who find themselves quite limited by insufficient facilities and outlets for sales.

4.7 Nodes and Links to Social Benefits: A Local Lens

From a social standpoint, food production nodes and connected infrastructures (i.e. hubs) provide a forum for a stronger interconnection between consumers and fellow consumers and consumers and their producers/farmers alike. Social connections, relationships, and education are all fostered through such local food web establishments, and relationship-building between consumers and farmers is enhanced; consumers know more about where their food is coming from and feel more of a connection to the source (Franklin et al., 2011). Individual health awareness is also cultivated here, as consumers become more educated about the specifics of what has gone into the growth of their food, and thus feel more control over their diets and overall nutrition.

Heightened emphasis on smaller, more intimate networks such as food nodes allows for maximum strengthening of community welfare and fresher food choices as local food producers are exposed to greater development opportunities. Contrary to conventional food hubs that are often geared towards ensuring the economic advantage of commercial retailers, sustainability-oriented community food infrastructure promotes community cohesion, social gain, increasing healthy eating options, and improving local food access options (Franklin et al., 2011). Such establishments also provide the possibility of community members becoming more actively involved in any part of the farming and growing process, as they are closer to their food source and can ultimately exert a greater influence on the product selection offered by their nearby farmers.

4.8 Role of the State

To establish a food production node most successfully, there must be coordinated involvement from and serious investment by appropriate state agencies. Not only will these agencies facilitate planning and development, but they will also be responsible for securing any funding or financial capital that may be needed for the project. On the planning and development front, Meter and Goldenberg (2013) suggest that the state must consciously cultivate customers that will be dedicated to and value local foods and the support of small farms. This notion is supported by the FAO (2014) as well; one publication stipulated that state responsibilities to eradicate food insecurity must be translated into policy and program enactment as well as into provisions for sufficient financial backing. On this financial front, it was highlighted that, “Funding is needed to move a more sustainable food system forward and to support the organizations and businesses working to affect this change” (Foley et al., 2012, p. 3).

Appropriate funding opportunities for the relevant proposed nodes above are addressed for exactly this purpose.

Intended purposes of this particular research effort included not only being able to provide the Greenville County Community Development and Planning's Department of Planning and Code Compliance with a greater knowledge base of relevant indicators for node construction, but also to propose specific suggestions (based on map documents) of where a food node may be best placed in the Upstate. Through this mixed-methods approach, complex multi-dimensional issues such as the development of the local food movement are able to be carefully dissected into more manageable components. As one recent article concluded, "...the opportunities created through the linking of diverse actors provide fertile ground for the emergence of new solutions to broad-based complex problems" (Campbell & MacRae, 2013, p. 559). The collaboration of various actors and stakeholders in this project can provide the necessary framework for success. Through the delivery of a successfully created food node, sustainable solutions on a local scale will be fostered and realized more fully going forward.

4.9 Nodes and Support of Development Themes: A Global Lens

By illuminating the spotlight on optimal node placement areas and the deeper value food production nodes bring to the table, the FAO Development Themes of resilience, and food security and the right-to-food, are considered as likely positive results of node implementation.

4.9.1 Resilience

"Resilience must be embedded in the institutional, social, economic and environmental dimensions of sustainable development, in efforts at all levels to fight hunger and malnutrition" (FAO, 2014).

A resilient system is one that includes, but is not limited to, considerations of food chain crises prevention, social protection, and financial risk transfer (FAO, 2014). A food production node would allow for local systems to prosper, minimizing any future shocks that may result from global uncertainties, and financial security would be better controlled with more local and in-state exchanges. To achieve this ultimate goal, it was described in an article by Blay-Palmer, Landman, Knezevic, and Hayhurst (2013) that the best practices to engage in to increase production-consumption of local

sustainable food are, “improved processing, transportation and distribution infrastructure; increased public procurement; and public education...[this] foster[s] resilient, regenerative local ecologies through just, equitable, healthy food communities” (p. 522). A node would effectively catalyze each of these factors and would support the longevity and prosperity of local food networks.

4.9.2 Food Security and the Right-to-Food

“Ensuring food security requires action in multiple dimensions, including:...inclusive and responsible investments in agriculture and rural areas, in health and education; empowering small producers; and strengthening social protection mechanisms for risk reduction” (FAO, 2014).

The County of Greenville (2012) determined in its recent Food System Assessment that formidable but surmountable challenges continue to face the local food system and that the worst case scenario may be an inconsistently supplied food supply system, which means that strengthening social protection mechanisms for risk reduction through food production node implementation should certainly be one prioritized avenue.

With regards to accessibility, it was revealed in a report by Foley et al. (2012) that there exists a noticeable “lack of access to fresh, healthy, affordable food in many low-income, underserved rural and urban neighborhoods” (p. 3). An enhanced local food web including nodes and larger hubs would effectively reduce this lack, and provide more options for fresher foods. To this point, the WRDC (2012) commented that, “Quite a few food hubs make a concerted effort to expand their market reach into underserved areas where there is lack of healthy, fresh food” (p. 11).

On the health and education front, food production nodes would not only offer an additional space to procure healthier, locally-sourced food, but would also serve as a platform for increased engagement with local producers and their wares. This particular benefit is quite crucial, as highlighted by the following accounts. It was described by Meter and Goldenberg (2013) that, “Many farmers selling direct to state consumers report that they have to explain to their customers what a carrot looks like when it comes out of the field, since many have never seen one before” (p. 32). Another farmer attests that, “One day I was at the market and I saw someone take a bite out of a banana – without peeling it. People will see a zucchini squash here and have no idea what it is” (Meter & Goldenberg, 2013, p. 40).

It is apparent that such an infrastructure that could materially address these community food security and right-to-food concerns (and in particular, a food node), should be implemented in an immediate timeframe to combat these pressing issues. Broken down, it is argued that in the immediate term, a food production node should be established in the Upstate region; in the intermediate term, local food system development should take the form of a more integrated system that is comprised of about ten nodes dispersed throughout the state that support around three larger infrastructures such as food hubs; and in the long term, local food webs and networks should be continually monitored such that adaptations can be enacted in response to changing climates and markets.

4.10 Going Beyond Food Production Nodes

It is noteworthy to understand that not only are specific development projects such as food node creation encouraged here, but also a focus on determining more sustainable solutions from community perspectives. That is, reliance should be intensified on systems that can be more easily regulated on municipal and state scales.

One can contextualize this, for example, by looking at the recent disaster of the severe drought currently plaguing the state of California. This drought has already considerably impacted communities on local, regional, national, and global scales alike, and will persist to further shape each of these markets. California was ranked in 2012 as first in total agricultural exports, both overall and in four specific categories; dairy, vegetables, fruits, and tree nuts (USDA, 2012). This multi-billion dollar trade is now significantly in jeopardy as extreme heat events and wildfires continue to ravage the Golden State and wreak havoc on agricultural productivity.

South Carolina is only one of the regions that relies on imported goods from California, and such dependencies on a presently failing, far-removed system is not sustainable. The increase and improvement of local food options on a large scale that could supplement a sizable portion of long-distance imports would serve to strengthen the resilience of individual communities.

5 Conclusion

This assessment of local food development opportunities in the form of food production nodes determines the best criteria to consider when identifying potential node placement, pinpoints five optimal locations in Upstate, South Carolina for possible food node establishment, and examines links to the frameworks of resilience and food security and the right-to-food.

Through the utilization of action research and GIS mapping, a viable, actionable reference addressing a vital research gap in local food systems was able to be generated. Specifically, the data compiled and processed will serve a very real and valuable function, particularly for the Department of Planning and Code Compliance, and will effectively open the door of opportunity for future follow-up research to be conducted.

Such research may take the form of, but is in no means limited to, the three following possibilities. First, the evaluation of the potential for additional node implementations within South Carolina that would further supplement the local food web may be at the forefront of future focus. Coupled with this may be the determination of optimal locations for potential larger food hub placement in South Carolina that would be supported by this interconnected node network. Third may be the assessment of the potential for food node and hub infrastructure development in other states.

It is argued that the immediate improvement and maturation of local food options and sourcing, such as with food production node formation, is necessary in ensuring a more resilient and food secure community and would act as a gateway for myriad other economic and social opportunities for farmers and consumers alike. Through this project, one research gap present in the local food network discussion was bridged, making way for strides towards a more sustainable future.

References

- Adger, W. N. (2000). Social and ecological resilience: Are they related? *Progress in Human Geography*, 24(3), 347-364.
- ASAP Appalachian Grown. (2014). *Farms* [Data set]. Retrieved from http://www.buyappalachian.org/search/all_farms
- Blay-Palmer, A., Landman, K., Knezevic, I., & Hayhurst, R. (2013). Constructing resilient, transformative communities through sustainable “food hubs”. *Local Environment: The International Journal of Justice and Sustainability*, 18(5), 521-528.
- Bolstad, P. (2008). *GIS fundamentals: A first text on geographic information systems* (3rd ed.). White Bear Lake, MN: Eider Press.
- Brydon-Miller, M., Greenwood, D., & Maguire, P. (2003). Why action research. *Action Research*, 1(1), 9-28.
- Bunyard, P. (1996). Industrial agriculture- Driving climate change? *The Ecologist*, 26(6), 290.
- Callum-Penso, L., & Burns, A. C. (2013, July 25). Local foods market blossoming in Greenville. *Greenville Online*. Retrieved from http://www.greenvilleonline.com/article/20130725/BUSINESS02/307250007/Local-foods-market-blossoming-Greenville?nclick_check=1
- Campbell, A. M., & MacRae, R. (2013). Local Food Plus: The connective tissue in local/sustainable supply chain development. *Local Environment: The International Journal of Justice and Sustainability*, 18(5), 557-566.
- Carolina Farm Stewardship Association. (2014). *Members* [Data file]. Retrieved from Carolina Farm Stewardship Association
- Centers for Disease Control and Prevention. (2012). *South Carolina: State nutrition, physical activity, and obesity profile* (National Center for Chronic Disease Prevention and Health Promotion: Division of Nutrition, Physical Activity and Obesity State Profile). Atlanta, GA: U.S. Public Health Institute.
- Certified South Carolina. (2014). *Certified SC Members* [Data set]. Retrieved from <http://www.certifiedscgrown.com/Certified/Members>
- Christie, L. (2012, April 5). 10 fastest growing U.S. cities. *CNN Money*. Retrieved from http://money.cnn.com/galleries/2012/real_estate/1204/gallery.US-Cities/9.html
- County of Greenville. (2012). *Greenville area food system assessment*. Greenville, SC: Greenville County Planning Commission.

- Crossroads Resource Center. (2013). *Making small farms into big business: A plan for infrastructure investments to connect small farms in South Carolina to local markets*. Minneapolis, MN: Meter, K., & Goldenberg, M. P.
- Dowler, E. (2008). Food and health inequalities: The challenge for sustaining just consumption. *Local Environment: The International Journal of Justice and Sustainability*, 13(8), 759-772.
- Esri. (2011). *How weighted overlay works*. Retrieved from <http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#//009z000000s1000000.htm>
- Esri. (2013). ArcGIS for Desktop: Advanced Desktop GIS Mapping (Version 10.2.1) [Software]. Available from <http://www.esri.com/software/arcgis/arcgis-for-desktop>
- Esri. (2014). *Optimized hot spot analysis (spatial statistics)*. Retrieved from <http://resources.arcgis.com/en/help/main/10.2/index.html#//005p00000058000000>
- Food and Agriculture Organization of the United Nations. (2014). The Post-2015 Development Agenda and the Millennium Development Goals. Retrieved from <http://www.fao.org/post-2015-mdg/mdg/en/>
- Forbes. (2014). In pictures: The 15 best cities for young adults. *Forbes*. Retrieved from: <http://www.forbes.com/pictures/mhj45effk/13-greenville-s-c/>
- Franklin, A., Newton, J., & McEntee, J. C. (2011). Moving beyond the alternative: Sustainable communities, rural resilience and the mainstreaming of local food. *Local Environment*, 16(8), 771-788.
- Georgia Market Maker. *Business Search* [Data set]. Retrieved from <http://webapps.foodmarketmaker.com/marketmaker/#GA/food/productsearch/2226/13>
- Hatfield, J. (2012). Agriculture in the Midwest. In *U.S. National Climate Assessment Midwest Technical Input Report*. Available from the Great Lakes Integrated Sciences and Assessments (GLISA) Center, http://glisa.msu.edu/docs/NCA/MTIT_Agriculture.pdf
- Hill, H. (2008). Food miles: Background and marketing. *National Sustainable Agriculture Information Service*, 1-12. Retrieved from <https://attra.ncat.org/attra-pub/summaries/summary.php?pub=281>
- Horst, M., Ringstrom, E., Tyman, S. K., Ward, M. K., Werner, V., & Born, B. (2011). Toward a more expansive understanding of food hubs. *Journal of Agriculture, Food Systems, and Community Development*, 2(1), 209–225.
- Ilbery, B., & Maye, D. (2006). Retailing local food in the Scottish-English borders: A supply chain perspective. *Geoforum*, 37, 352-367.
- Kates, R. W., Clark, W. C., Gorell, R., Hall, J. M., Jaeger, C. C., Lowe, I.,...& Svedin, U. (2001). Sustainability science. *Science*, 292(5517), 641-642.

- Local Harvest. (2014). *Family Farms* [Data set]. Retrieved from <http://www.localharvest.org/organic-farms/>
- Martinez, S., Hand, M., Da Pra, M., Pollack, S., Ralston, K., Smith, T.,...& Newman, C. (2010). Local food systems: Concepts, impacts, and issues. *USDA Economic Research Report, 97*, i-80.
- McIlvaine-Newsad, H., Merrett, C. D., & McLaughlin, P. (2004). Direct from farm to table: Community-Supported Agriculture in western Illinois. *Culture and Agriculture, 26*(1-2), 149-163.
- Moses, J. W., & Knutsen, T. L. (2007). *Ways of knowing: Competing methodologies in social and political research*. New York, NY: Palgrave Macmillan.
- Pothukuchi, K. (2004). Community food assessment: A first step in planning for community food security. *Journal of Planning Education and Research, 23*, 356-377.
- Ragin, C. C., & Amoroso, L. M. (2011). *Constructing social research: The unity and diversity of method*. California, USA: Pine Forge Press.
- RSF Social Finance. (2012). *Bridging the gaps: Funding and social equity across the food system supply chain*. San Francisco, CA: Foley, K., Goodman, T., & McElroy, B.
- Soike, M., & Dripps, W. (2014). *A comparative analysis of consumer profiles among farmers markets and Community-Supported Agriculture (CSA) participants in the Upstate of South Carolina* (Unpublished thesis). Furman University, Greenville, SC.
- South Carolina Food Policy Council. (2013). *Growing food & opportunities in South Carolina: Economic and community development through healthy food access*. Greenville, SC: SCFPC.
- South Carolina Market Maker. (2014). *Business Search* [Data set]. Retrieved from <http://webapps.foodmarketmaker.com/marketmaker/#SC/food/productsearch/2226/45>
- United Nations. (2013). *The Millennium Development Goals Report*. New York, NY: UN.
- United States Department of Agriculture. (2012). *State agricultural exports: Commodity detail by state* [Data file]. Retrieved from <http://www.ers.usda.gov/data-products/state-export-data.aspx#.U24kOfmSwkM>
- Western Rural Development Center. (2012). *Local and regional food hubs boost rural economies*. Logan, UT: WRDC.