GOING ORGANIC IN THE LONE STAR STATE: A DESCRIPTIVE STUDY OF THE GEOGRAPHY OF ORGANIC AGRICULTURE IN TEXAS

THESIS

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By

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DEDICATION

This thesis is dedicated to all the farmers and stewards of the land who give so much of their energy to coax from the earth the food that nourishes us, but most especially to Farmer John and the crew at Angelic Organics whose integrity, hard work and dedication to organic farming in the face of so many obstacles provides a wellspring of hope and inspiration in a time of great uncertainty.

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GOING ORGANIC IN THE LONE STAR STATE: A DESCRIPTIVE STUDY OF THE GEOGRAPHY OF ORGANIC AGRICULTURE IN TEXAS

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Organic farming in Texas has emerged as a solution to the detrimental environmental and economic effects of chemically dependent conventional agriculture. The exploration and analysis of the geography of the organic farms in Texas provides insight into how organic farming may fit into the broader scope of sustainable agricultural. This research illustrates the current geography of organic farms in Texas and provides an exploratory and descriptive study of factors relating to the distribution of organic farms in Texas. Data analysis suggests that organic farm location and characteristics in Texas are related to socio-economic characteristics of urban centers and environmental characteristics of natural regions of the state. Relationships between socio-economic and environmental variables and the location of organic farms in Texas are discussed.

Keywords: organic agriculture; sustainable agriculture; agricultural geography

CHAPTER I

INTRODUCTION

> "To have risked so much in our efforts to mold nature to our satisfaction and yet to have failed would indeed be the final irony."
>
> - Rachel Carson, in *Silent Spring,* 1962

Farmers and researchers are continually evolving new methods of agricultural production to meet the needs of changing societies and environments. Since the concept of sustainable development was adopted by international policymakers at the Rio Earth Summit in 1992, the issue of sustainability in all aspects of living has become increasingly important (Rogers 1993). The definition of sustainability, as defined by the Brundtland Commission in 1987, is: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Legg 2000, 2). In the realm of agriculture, policy makers and practitioners are looking for ways to develop and maintain sustainable agricultural practices to address the challenges facing agriculturalists, including: pollution and health risks resulting from chemical and energy intensive agriculture, soil erosion, loss of crop diversity, and increased competition for land and water resources (Barnett, Payne and Steiner 1995, 1; Harwood 1990, 8).

While there are multiple views and interpretations of the elements, goals, and practices of sustainable agricultural systems, a primary goal in developing sustainable agricultural practices is the reduction of the use of external and non-renewable inputs (i.e. synthetic chemicals) that have the greatest potential to cause environmental damage and pose hazards to human health (Edwards et. al. 1990, xv; Roling and Wagemakers 1998, 26). In his oft-quoted book *Agro-Ecology,* Miguel Altieri defines organic farming as "an agricultural production system that sustains agricultural production by avoiding or excluding the use of synthetic chemical herbicides and pesticides" (1995, 179). Organic farming offers solutions to the challenges of agricultural sustainability. Research that explores current trends in organic farming may provide knowledge that can benefit farmers and policy makers in efforts to implement more sustainable agricultural production systems (Harwood 1990, 15).

Organic farming in the United States grew at an average rate of 20% annually from 1990 to 1997 as farmers adopted organic production methods as a sustainable solution to counter the detrimental effects of chemical dependency in conventional agriculture (Lipson 1998). One study points out the prominent role that Texas plays in the national organic movement, however academic research on the geography of organic growing in Texas is non-existent (Fernandez-Cornejo et al. 1998, 71).

The exploration and analysis of the geography of the organic farms in Texas provides insight into how organic farming may fit into the broader scope of sustainable agricultural systems. This research is intended to illustrate the current geography of organic farms in Texas and provide an exploratory and descriptive study of the distribution of organic farms in Texas. The question explored is: "Where are organic farms located in

Texas and how do socio-economic and environmental variables influence this distribution?" Specific theories that relate to the broader research question are outlined Chapter III.

This thesis is not intended to demonstrate a complete model of a sustainable agricultural system, or establish conclusive cause and effect relationships between elements of the system. However, this research may serve as a starting for point for the sociological study of the sustainability of organic farming in Texas and lead to further research that evaluates the viability of organic farming in sustainable agricultural production systems.

CHAPTER II

BACKGROUND

Literature Review

As Dominic Hogg explains in *Technological Change in Agriculture* (2000, 1), "For more than ten thousand years, human beings have sought to transform their environment to ensure that their basic food requirements are met." Agricultural systems have been studied extensively by researchers for hundreds of years, with numerous and sometimes conflicting outcomes. The body of literature that explores the diverse elements and geography of agricultural systems is extensive and a complete review of this literature is beyond the scope of this research.

More recent concerns for the impact of agricultural practices on the environment, especially in the wake of the green revolution and industrialized agriculture, have also produced ample literature that addresses and seeks to define the elements of sustainable agricultural systems (Harwood 1990, 12-13). While recognition is given to the importance of the work that has been accomplished in these areas, discussion of literature will be limited to that which relates specifically to organic farming.

While the practice of organic farming is thousands of years old, the bulk of contemporary discourse on organic farming has occurred in the last thirty years. Attitudes expressed by policy-makers, regarding the potential for organic farming in the United States, may have shaped the focus of academic research during the 1970s. In his groundbreaking book *Organic Agriculture*, Robert C. Oelhaf illustrates a climate of resistance to change in agricultural production systems, as conveyed by this comment former Agriculture Secretary Carl Butz made in 1971: "Before we go back to an organic agriculture in this country, somebody must decide which 50 million Americans we are going to let starve or go hungry" (1978, 4).

Research in the 1970s and early 1980s tended to focus on the economic viability of organic farms and the efficiency of production practices in relation to conventional agriculture and the new environmentalism (Buttel et al. 1981; Buttel and Larson 1979; Cox and Atkins 1979; Klepper et al. 1977; Lockeretz et al. 1978; Lockeretz and Wernick 1980; Oelhaf 1978). Research on the sociological aspects of organic farming during this decade began with studies of farmers' decisions and motivations to adopt organic farming practices (Wernick and Lockeretz 1977).

With the introduction of the current concept of sustainability by the Brundtland Commission in the 1980s, the focus of research moved away from discussions of the economy and efficiency of production practices on organic farms. Instead, academicians struggled to define what types of practices constituted or contributed to sustainable agriculture. Research focused on the effects of general conservation measures and sustainable agricultural practices on agro-ecological systems (Buttel et al. 1981; Dunlap and Martin 1983; Heffernan and Green 1986; Kral 1984; Lockeretz 1986; Macrae et al. 1989; Nowack 1987).

In the 1990s, a focus on sustainable agro-ecological systems continues, along with a resurgence of sociological research in organic farming that explores agricultural paradigms and the attitudes, beliefs and values of organic farmers (Allen and Bernhardt

1995; Alteiri 1995; Barnett, Payne and Steiner 1995; Beus and Dunlap 1990; Beus and Dunlap 1991; Comer et al. 1999; Duram 1999; Edwards et. al. 1990; Egri 1999; Guthman 1998; Kaltoft 1999; Roling and Wagemakers 1998).

Research that focuses specifically on the geography of organic agriculture is not common in the academic literature, but does exist (Duram 1997; Duram and Larsen 2001; Ilberry, Holloway and Arber 1999; Van-Mansvelt 1998). Studies in the United States tend to be local or regional in scope and focus on California and the Mid-western states (Buttel et al. 1981; Guthman 1998; Duram 1999; Lockeretz and Wernick 1980). Studies that explore the innovation and diffusion of conservation and sustainable agricultural practices can also be found (Hernandez 1995; Nowack 1984; Nowack 1987; Saltiel, Bauder, and Palakovich 1994).

One descriptive study uses data collected in the 1994 USDA Agricultural Chemical Survey to characterize both social aspects and production practices of organic vegetable growers in the United States (Fernandez-Cornejo et al. 1998). The comprehensive study identifies Texas as an important state for organic vegetable production. Even with this standing, published research on organic farming in Texas is scarce. Two reports published by the Horticultural Extension Service at Texas A&M University address production and marketing aspects in a format that is intended to assist organic growers in establishing and maintaining economically viable farm operations in Texas (Hall, Edwards and Johnson 2001; Dainello 2001). However, published research that focuses on ecological and sociological aspects of organic farming in Texas is not available.

Research Relevance

The quest for sustainable, ecologically-sound approaches to farming, the relative dearth of research on organic farming at the national and state levels, national level interest in promoting marketability of organic products, and the significance of Texas in the organic production realm are factors that point to the importance of this research.

The Texas Center for Policy Studies points out, "Agriculture plays an important role in the Texas economy, but the condition of Texas agriculture and agriculture's impact on the environment are issues of concern, and have given rise to a quest for sustainable agriculture practices" (Texas Center for Policy Studies 2000a, 1). In 1995, in excess of one billion dollars was spent on pesticides and fertilizers for agricultural use, equaling one-third the net cash income received by all Texas farmers and ranchers for that year. For conventional farmers, farm chemicals represent the single largest yearly input cost for field-crop production (Texas Center for Policy Studies 2000b, 2). In 1997, the Natural Resources Conservation Service (NRCS) indicated that sixty-eight percent of cropland in Texas could benefit from some form of conservation treatment to preserve the soil's productivity and prevent erosion (Texas Center for Policy Studies 2000a). The Center for Policy Studies also points out: "farmers still face barriers to the adoption of alternative practices, including a lack of adequate research and training for farmers on alternative practices" (Texas Center for Policy Studies 2000b, 5).

The Organic Farming Research Foundation (OFRF), a non-profit organization in Santa Cruz, California, is studying the current lack of research in organic farming. OFRF recently completed a technical report evaluating the current status of organic farming research in land grant institutions and the level of financial support for organic farming research from the United States Department of Agriculture (Sooby 2001). The study found a scarcity of organic farming research literature available from Texas land grant institutions (Texas A&M College Station and Prairie View) and no acreage devoted to organic production research in Texas (Sooby 2001). Based on statistics contained in earlier OFRF studies, Mark Lipson (1998) highlighted the lack of federal funding for organic production research by pointing out that less than .1% of federal research dollars are spent on explicitly organic studies. In a recently published study, geographers Duram and Larson (2001) discuss problems of under-funding for research projects that meet organic farmer's needs within the USDA's Sustainable Agriculture and Research (SARE) program.

Recent passage of the USDA's National Organic Program rule and the establishment of the National Organic Standards Board are strong indicators of the importance of a burgeoning organic foods industry in the United States. A primary objective of the rule is to implement a system of national standards with the purpose of promoting marketability of organic products throughout the United States and internationally (United States Department of Agriculture 2000).

As of 1994, Texas was ranked third in the nation for organic vegetable production (eleven percent of the national market) behind California and Oregon (Fernandez-Cornejo et al. 1998, 71). Texas is currently home to ninety percent of the country's organic cotton farms, filling an important niche in the organic fibers market (Texas Center for Policy Studies 2000b).

Duram and Larson (2001, 1) address the relevance of geographic study in agriculture by stating: “Agricultural Geography seeks to understand the complex interactions among social and ecological processes in agriculture at various scales.” Research that addresses the interactions of social, economic and environmental variables by exploring the geography of organic farming in Texas may provide findings relevant to the sustainability of organic farming in Texas and may lead to new questions and directions for organic farming research in Texas and as well as other geographic regions in the Unites States.

CHAPTER III

METHODOLGY AND THE MODEL

Farm Data and the Theoretical Model

In 1988, the Texas Department of Agriculture developed one of the first organic farm certification programs in the country to inspect and certify organic farms (Texas Center for Policy Studies 2000b, 5). This research examines farms that are certified by the Texas Department of Agriculture (TDA) as organic. Texas Agriculture Code Title II § 18.001 (1993) defines organic farming as "a system of ecological soil management that relies on building humus levels through crop rotations, recycling organic wastes, and applying balanced mineral amendments and that uses, when necessary, mechanical, botanical, or biological controls with minimum adverse effects on health and environment."

The TDA currently inspects and certifies organic growers of organic food, feed and fiber as well as businesses that process or handle organic products. TDA does not yet certify livestock and poultry operations. While organic farming techniques may be used in many situations where the growers have not sought certification, it is beyond the scope of this study to include farms that are not certified by TDA.

A 1999 database of certified organic farms was obtained from the Texas Department of Agriculture, Organic Certification Program, via a Public Information Act request. The database, provided in Microsoft Excel format, includes the following information: organic farm names and locations (addresses including street, city, zip code, and county); crop type, acreage and field location for each plot; and organic or transitional status (farms in the process of converting to organic) for each plot (Texas Department of Agriculture 1999).

A preliminary look at descriptive and locational data from TDA indicates several factors that may influence the distribution of organic farms across the Texas landscape. A brief description of the characteristics and geography of the farms is provided in the following sections to emphasize the relationships between the data and the theoretical model for the research.

Farm Characteristics

Based on the 1999 calendar year data, Texas had a total of 149 certified organic growers, with farm sizes ranging from 150 square feet (.003 acres) to 3000 acres. A total of approximately 37,000 acres were planted in 1999 (including cover crops). The average farm size was 245 acres, while the median farm size was 23 acres. The larger farms tended to have less diversified cropping, generally in the range of two to five different cultivars of wheat, corn, soy, cotton, grain, peanuts or rice. The smaller farms tend to be more diversified with ten to forty-five varieties of vegetables, berries, herbs and seeds. Fruit and nut orchards are often grown mono-culturally, although some are also found in more diversified farms. Individual plots within the farms tend to have larger acreages devoted to cereals, grains, grasses and fruits, and smaller plots devoted to vegetables, herbs and seeds. In general on-farm crop diversity appears to increase with decreasing farm size. A small percentage (5%) of plots were labeled as transitional (not yet certified organic). Many of the transitional fields are in corn or cotton production, but some fruit and vegetable plots were also in transition.

Farm Geography

Observation of the location of organic farms suggests a couple of patterns (Fig. 1). First, the majority of farms are located in or clustered around counties that contain substantial urban areas, including Dallas, Fort Worth, Houston, San Antonio, Austin, El Paso, Lubbock, Amarillo, Beaumont, and the Rio Grande Valley. This clustering pattern suggests that proximity to urban centers influences organic farm location. Population, income, and consumer preferences in these centers may be providing markets for organic products that make the farms close to these centers economically viable (Hall, Edwards and Johnson 2001). Thus, the research examines the socio-economic aspects of organic farm location to obtain a better understanding of factors that contribute to the clustering around urban centers.

Another pattern has to do with the location of farms with respect to natural regions of the state (Fig. 2). The natural regions of the state represent differences in environmental variables - soils, topography, geology, rainfall, and native plant and animal communities - that will influence agricultural production in each area (Texas Parks and Wildlife 1996a). Clusters of farms appear in the Blackland Prairie region of Central and North-central Texas and in the High Plains region of the Texas Panhandle. The Blackland Prairie is a natural region where soil fertility and consistent rainfall make an ideal setting

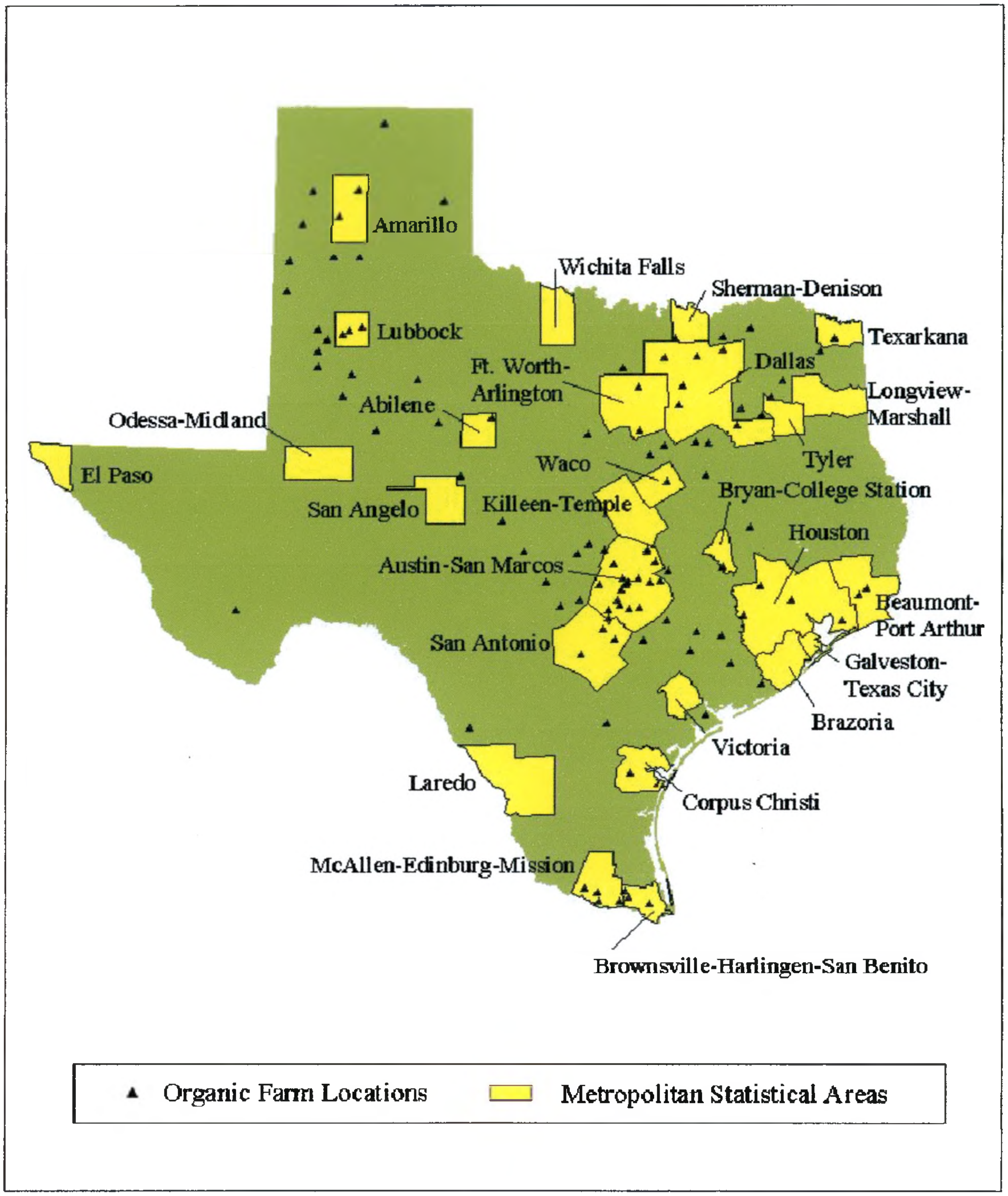

Fig. 1. Geographic location of organic farms in relation to urban areas. Base map from Texas Natural Resource Information System. Data layers from Texas Sate Data Center and Texas Department of Agriculture.

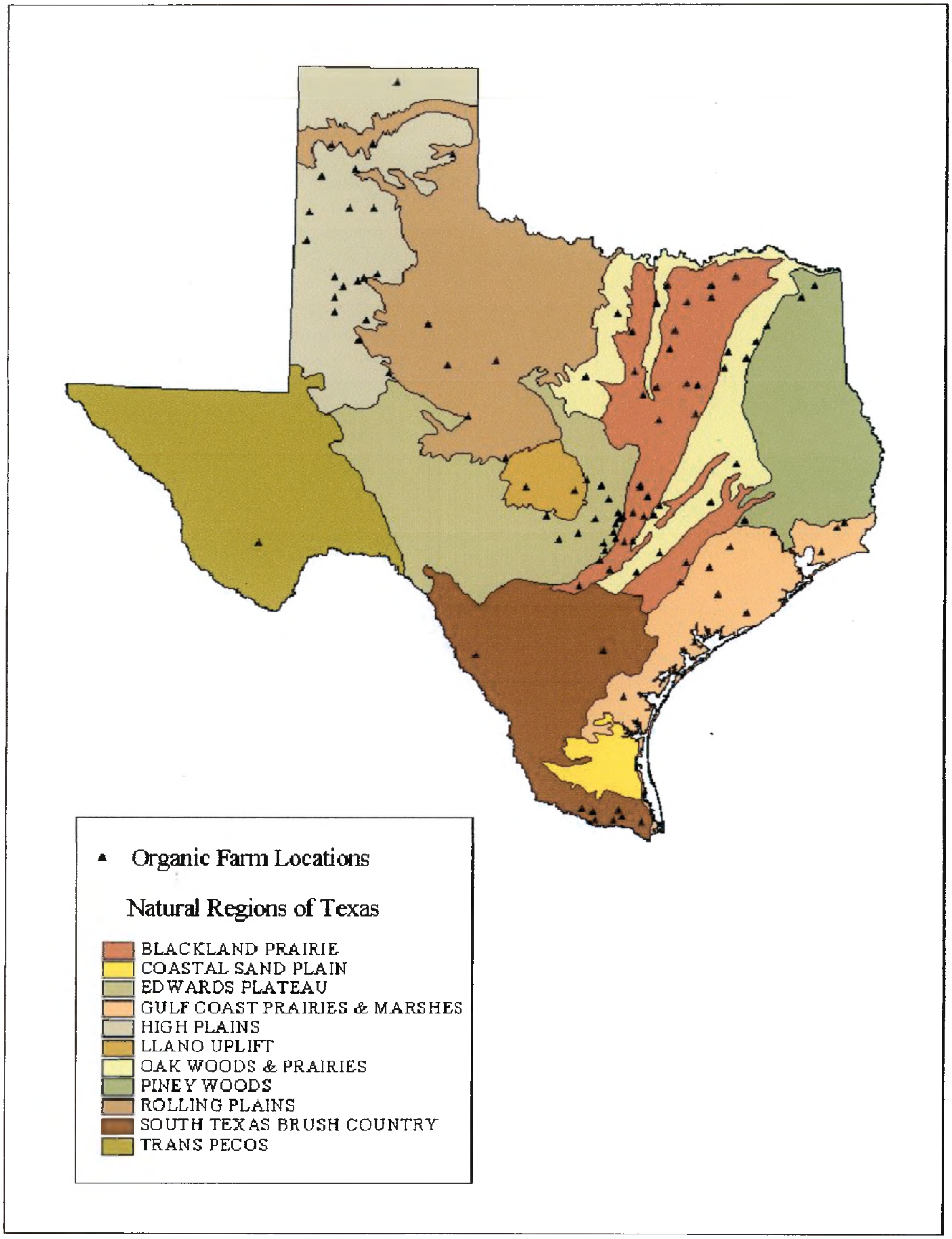

Fig. 2. Geographic location of organic farms in relation to natural regions. Base map from Texas Natural Resource Information System. Data layer from Texas Department of Agriculture.

as prime farmland (Faidley 1995, 81-2), but because of limited water resources and excessive erosional conditions, presents long-term environmental challenges for growers (Opie 2000). Both of these regions have traditionally contained substantial numbers of conventional farms (Faidley 1995, 81). The research will explore relationships between current characteristics of organic and conventional cropland within natural regions of the state to obtain a better understanding how environmental factors might play a role in organic farm location.

Theoretical Basis for the Research

A model that illustrates the key linkages between dimensions of sustainable agriculture was adapted to demonstrate the theoretical approach to sustainable agricultural systems (Legg 1999, 5). The adapted model is designed to show how certain variables play a role in defining the elements of geographic distribution of organic farms in Texas. The model describes interactions between variables - social, environmental and economic - and illustrates how the variables are affected by and contribute to the geographic location (and ultimately the sustainability) of organic farms (Fig. 3).

To illustrate how the model works, consider the clustering around urban centers. A sophisticated social environment found in densely populated urban centers might be expressed through a preference for organically grown foods. This social environment is conducive to an economic environment that provides markets to facilitate sales of organically grown produce. A positive economic environment, or access to consumers who want to purchase organically grown foods, may attract more organic growers to the

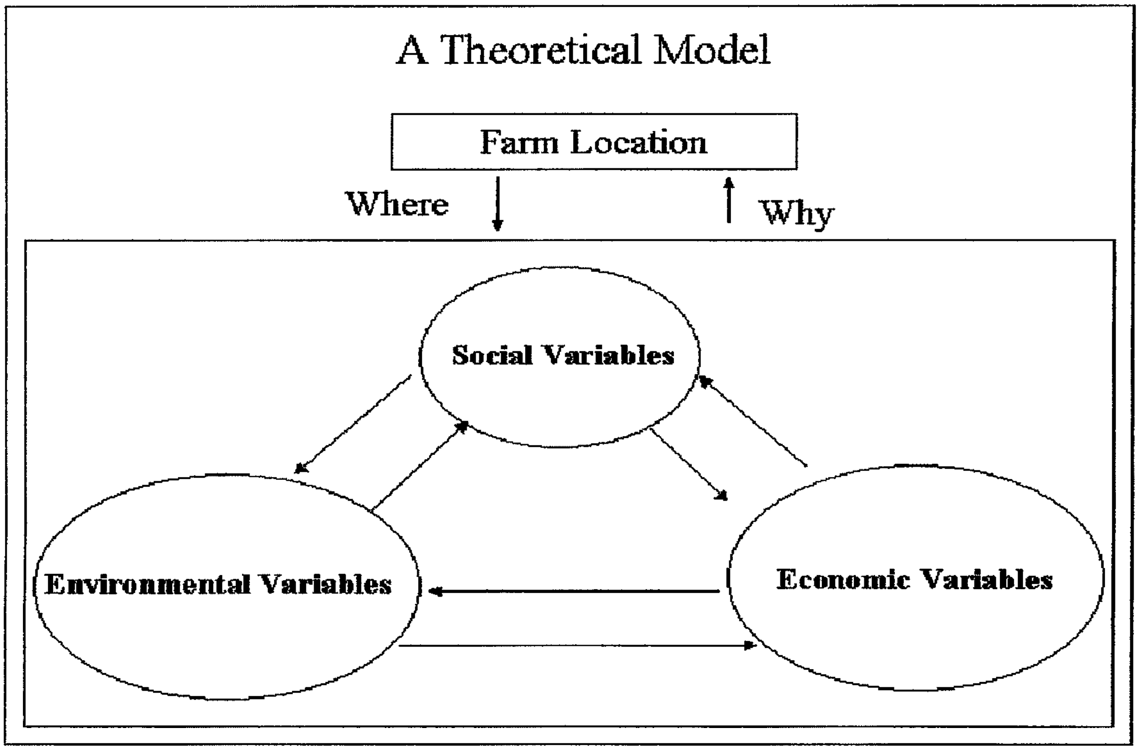

Fig. 3. Theoretical model for variables affecting farm geography. Model adapted from Legg (2001).

area. These growers may then expand the knowledge base and add to networking and support systems, establishing elements of a positive social environment for growers. The ring of variables helps to determine the spatial location of farms.

The complex nature of this model precludes full study of all of the variables for this research. Thus, the research focuses on interactions between farm geography and a limited number of social, economic, and environmental variables to:

a) provide a descriptive view of organic farm location and characteristics in relation to urban centers and their characteristics,

b) explore the interactions between farm location and characteristics with respect to socio-economic conditions in urban centers,

c) provide a comparative view of organic and conventional farm location in relation to natural regions of the state, and

d) analyze relationships between organic and conventional farm characteristics within natural regions of the state.

Based on these objectives, the following hypotheses were formulated:

I. Organic farm occurrence within urban centers is correlated with socio-economic conditions in those centers.

II. Distance to urban centers is positively correlated with farm size.

III. Distance to urban centers is negatively correlated with on-farm crop diversity.

IV. Organic farm occurrence is positively correlated with harvested cropland occurrence within natural regions.

V. Organic farm size is positively correlated with harvested cropland farm size within natural regions.

The first hypothesis test will determine whether significant linkages exist between the number of organic farms in urban centers and specific socio-economic characteristics of those centers. Urban centers provide a positive social and economic environment for the establishment of organic farms and the production and marketing of organic produce and goods. Correlations are expected between the variables that measure these characteristics. Thus, population density, per capita income levels, education levels, and the incidence of farmer's markets within urban centers will influence the number of farms and type of farms located in the centers.

The second and third hypothesis tests will determine whether distance to urban centers is related to individual organic farm size and on-farm crop diversity. Easier access to markets and consumer preference for a diverse range of organic produce and goods in urban centers influences the number and type of crops grown in close proximity to these areas, while land availability and costs limit the size of farms in these areas. As we move away from urban centers, the farms become larger due to greater land availability and lower land costs and less diverse because of transportation requirements to bring the products to market. Farms that are closest to urban centers will be smaller and have a greater number of crop types, while farms further from urban centers will be larger and less diverse.

Tests of hypotheses IV and V will determine if organic farm characteristics mimic conventional farm characteristics within natural regions. Correlations between organic and conventional farm characteristics within these regions will indicate a potential relationship between organic farm location and regional environmental conditions.

Exploration of these hypotheses will show that social, economic and environmental factors are critical elements that influence organic farm location. Thus the model for organic farm location provides a framework for studying the sustainability of organic farming systems in Texas.

Methods

Two distinct methods were used to interpret the data. The first method uses a series of maps to provide descriptive views of the current geography of organic farming in Texas, keeping in mind the objectives of the hypothesis testing. The second approach uses descriptive data analysis of specific variables to test the hypotheses.

Maps were created and interactions among the variables were analyzed with data aggregated at different levels. Regional, county, Metropolitan Statistical Area (MSA), zip code, and farm scale data were used. The MSA was used to represent urban areas (centers). The general concept of an MSA is that of a core area containing a large population nucleus, together with adjacent communities having a high degree of economic and social integration with that core (U.S. Bureau of the Census 1990). The standards provide that each MSA must include at least one city with 50,000 or more inhabitants or a Census Bureau-defined urbanized area (of at least 50,000 inhabitants) and a total metropolitan population of at least 100,000 (U.S. Bureau of the Census 1990). MSAs are delineated along county lines allowing for aggregation of county-level data for MSA-level use.

Data sources include the Texas Department of Agriculture (TDA), Texas Natural Resource Information System (TNRIS), Texas State Data Center (TSDC), U.S. Census Bureau (Census), U.S. Department of Agriculture (USDA), National Agricultural Statistics Service (NASS) and Woodes & Poole Economics. Data sources were chosen based on the availability of current data at the appropriate measurement levels. Calendar year 1999 data (population figures are estimated) were used where available. Total cropland density and average farm size figures from NASS were available for the 1997 calendar year only. Per capita income levels are based on 1998 income levels adjusted to 2001 dollars. Education levels are taken from the 1990 census. The raw data sets were manipulated to create consistent aggregation levels (zip code, county, MSA, and natural region) for visual comparison and descriptive analysis. Software packages used for data manipulation, mapping and analysis include: ESRI ARCVIEW GIS 3.2, Microsoft EXCEL, Microsoft ACCESS, and the Statistical Package for the Social Sciences (SPSS). Appendix A gives detailed definitions and explanations of the data used.

Mapping Methods

To create the base maps, a series of spatial data files in decimal degree format were obtained from TNRIS and imported into ARCVIEW. In order to create the various map layers (themes), data were obtained from the other sources in varying database and spreadsheet formats (Table 1). Raw data files were imported into Microsoft EXCEL and ACCESS programs to manipulate the data and create attribute tables for use in ARCVIEW. Thematic layers were then created in ARCVIEW by joining the raw data tables to attribute tables for the TNRIS base maps.

Table 1. Map Characteristics, Data Sources, and Data Characteristics

Map Title	*Base Maps and Thematic Layers*	*Source*	*Spatial Dimension*	*Aggregation Level*	*Symbolization*
Fig. 1. Location of Organic Farms in Relation to Urban Centers	• Administrative - counties ➢ Metropolitan areas ➢ Organic farm location	TNRIS TSDC TDA	Area Area Point	County MSA Zip Code	Choropleth Choropleth Point
Fig. 2. Location of Organic Farms in Relation to Natural Regions	• Natural Regions of Texas ➢ Organic farm location	TNRIS TDA	Area Point	Regional Zip code	Isarithmic Point
Fig. 7. Organic Farm Acreage and Statewide Population Density	• Administrative – counties • Statistical – zip code ➢ Organic farm acreage ➢ Population density	TNRIS TNRIS TDA TNRIS	Area Area Point Area	County Zip Code Zip code County	Choropleth Choropleth Graduated symbol Dot density
Fig. 8. Organic Farm Location and Urban Area Population Density	• Administrative – counties ➢ Organic farm location ➢ Population density	TNRIS TDA U.S. Census	Area Point Area	County Zip code MSA	Choropleth Point Choropleth
Fig. 9. Organic Farm Location and Urban Area Education	• Administrative – counties ➢ Metropolitan areas ➢ Organic farm location ➢ Education	TNRIS TSDC TDA U.S. Census	Area Area Point Area	County MSA Zip code MSA	Choropleth Choropleth Point Choropleth

Table 1. Map Characteristics, Data Sources, and Data Characteristics

Map Title	*Base Maps and Thematic Layers*	*Source*	*Spatial Dimension*	*Aggregation Level*	*Symbolization*
Fig. 10. Organic Farm Location and Urban Area Income	• Administrative – counties	TNRIS	Area	County	Choropleth
	➢ Metropolitan areas	TSDC	Area	MSA	Choropleth
	➢ Organic farm location	TDA	Point	Zip code	Point
	➢ Per Capita Income	Woods & Poole	Area	MSA	Choropleth
Fig. 11. Location of Organic Farms in Relation to Farmers Markets	• Statistical – zip code	TNRIS	Area	Zip Code	Choropleth
	➢ Metropolitan areas	TSDC	Area	MSA	Line
	➢ Organic farm location	TDA	Point	Zip Code	Point
	➢ Market location	USDA	Point	Zip Code	Point
Fig. 12. Organic Farm Size in Relation to Urban Center Location	• Administrative – counties	TNRIS	Area	County	Choropleth
	• Statistical – zip code	TNRIS	Area	Zip Code	Choropleth
	➢ Organic farm size	TDA	Point	Zip Code	Graduated Symbol
	➢ Metropolitan areas	TSDC	Area	County	Point
Fig. 13. On-Farm Crop Diversity in Relation to Urban Center Location	• Administrative – counties	TNRIS	Area	County	Choropleth
	• Statistical – zip code	TNRIS	Area	Zip Code	Choropleth
	➢ On-farm crop diversity	TDA	Point	Zip Code	Graduated Symbol
	➢ Metropolitan areas	TSDC	Area	County	Point

Table 1. Map Characteristics, Data Sources, and Data Characteristics

Map Title	*Base Maps and Thematic Layers*	*Source*	*Spatial Dimension*	*Aggregation Level*	*Symbolization*
Fig. 14. Organic Farm Location in Relation to Cropland Farm Density within Natural Regions	• Natural Regions ➢ Organic farm location ➢ Farms per square mile	TNRIS TDA NASS	Area Area Area	Regional Zip Code Regional	Isarithmic Point Isarithmic
Fig. 15. Organic Farm Acreage in Relation to Cropland Acreage within Natural Regions	• Natural Regions ➢ Organic farm acreage ➢ Avg. cropland acreage	TNRIS TDA NASS	Area Area Area	Regional Zip Code Regional	Isarithmic Point Isarithmic
Fig. 16. Organic Farm Size in Relation to Cropland Farm Size within Natural Regions	• Natural Regions ➢ Organic farm size ➢ Avg. cropland farm size	TNRIS TDA NASS	Area Point Area	Regional Zip Code Regional	Isarithmic Point Isarithmic

Notes: See Table 2 for data years. NASS *harvested cropland* figures provide the most appropriate approximation of "conventional" farm data. NASS raw data for harvested cropland included organic farm data, however organic farm data was subtracted from total harvested cropland figures to derive "conventional" farm data (referred to as "cropland" in this table). Explanations of terminology used for map symbolization and characteristics are available from other sources (Dent 1999, 233; Fitsimons 2000).

The format of the final maps closely mimics the Texas State Mapping System (Texas Natural Resource Information System 2001) projection parameters. A Lambert Conformal Conic projection, based on the GRS 80 spheroid and NAD 1983 datum, was used. Map units are expressed in meters and distance units are expressed in miles. Printed maps appear at an approximate scale of 1:6,000,000. Although the maps were created using Geographic Information System (GIS) software, the intended use is for cartographic visualization purposes. Greater precision in some of the data sets would be necessary in order to utilize the maps for extensive geographic analysis with ARCVIEW or other GIS software. A full discussion of the significance of the maps and what they indicate about the hypotheses and the geography of organic farms is included in Chapter IV.

Data Analysis Methods

Three data sets were compiled to test the five hypotheses. Each data set varies in size based on the level of aggregation (Table 2). For the first hypothesis, data were aggregated at the MSA level. There are twenty-seven MSAs in Texas, however only twenty-four of the MSAs have organic farms located within a sixty-mile radius of the MSA centroid. Seventeen of the MSAs contain organic farms within their geographic boundaries. The second data set is aggregated at farm level and contains one hundred and fourty-nine cases (hypotheses II and III). The fourth data set is aggregated by natural regions of the state, with ten of the eleven regions containing organic farms (hypotheses IV and V). The small size of the data sets present significant challenges for dealing with extreme values and outliers that skew the distribution of the data. For example, the Austin-San Antonio MSA is an extreme outlier in the MSA-level data set. This MSA

Table 2. Statistical Data Characteristics

	Variables	*Data Format*	*Source*	*Year*	*Aggregation*
Hypothesis I					
Dependent	Organic Farm Occurrence	No. farms per 100,000 persons	TDA	1999	MSA
Independent	Population Density	Persons per 100 square miles	U.S. Census	1999	MSA
	Personal Income	Dollars ($100,000) per capita	Woods & Poole	1998 (PI) 2001 ($)	MSA
	Education	Percent of population with bachelors degree or higher	U.S. Census	1990	MSA
	Farmer's Market	No. markets per 100,000 persons	USDA	2001	MSA
Hypotheses II & III					
	Distance to Urban Center	Miles (nearest 5 mile interval)	TDA & TNRIS	1999	Farm
	Farm Size	Acreage	TDA	1999	Farm
	Crop Diversity	Number of crop types	TDA	1999	Farm
Hypothesis IV & V					
	Harvested Cropland	Total cropland acres	NASS	1997	Natural Region
	Organic Cropland	Total organic acres	TDA	1999	Natural Region
	Cropland Farm Size	Mean acreage per farm	NASS	1997	Natural Region
	Organic Farm Size	Mean acreage per farm	TDA	1999	Natural Region
	No. Cropland Farms	Mean number of farms	NASS	1997	Natural Region
	No. Organic Farms	Mean number of farms	TDA	1999	Natural Region

contains twenty-five of the sixty-seven farms (34 %) that are located within MSAs. The other MSAs average between two and three organic farms each. If the Austin-San Marcos case is removed from the data set, the size of the data set is reduced by five percent and a case that appears to be important for consideration in the overall research question is negated from the analysis.

Data screening using SPSS revealed some limitations of the data and violations of basic assumptions for conducting regression analysis, making use of linear regression techniques inappropriate for one of the data sets. Descriptive statistics showed the MSA-level data set (hypotheses I) to be non-normal in distribution (Table 3). Scatter plots of the raw data indicated that the data were not consistent enough between MSAs to show correlations between variables at this measurement level (Fig. 4). Standard data transformations were used on the variables within this data set to resolve the violation of assumptions (Mertler and Vanatta 2001, 32; Johnson and Wichern 1982, 161; Kleinbaum, Kupper, and Muller 1988, 220-21). However, the violations were so severe within the data set that transformations of the variables did not enhance the data enough to make the use of the linear regression techniques practicable for this study. Therefore, a descriptive analysis approach is used to explore data interactions at the MSA level of aggregation. This approach will provide answers to the research question without the benefit of quantitative hypotheses tests, but with the benefit of the use of appropriate methods in making observations and drawing conclusions about the hypotheses. Unlike the MSA-level data set, the data aggregated at the farm and natural-region-levels were found to be appropriate for correlation analysis. The data set for the natural regions was created by assigning Texas counties to each natural region, based on visual observation of county

Table 3. Descriptive Statistics for MSA-Level Data

		Organic Farms	Population Density	Per Capita Income	Education	Farmers Market
N	Statistic	24	24	24	24	24
	Std. Error					
Range	Statistic	2.1988	6 32	1.9648	24.70	1 5832
	Std Error					
Minimum	Statistic	.0000	55	1.2759	11.10	0000
	Std. Error					
Maximum	Statistic	2.1988	6 87	3 2407	35.80	1.5832
	Std Error					
Mean	Statistic	.523239	2.6062	2 293329	18 5875	542364
	Std Error	120524	3904	.101011	1 2783	100102
Std Deviation	Statistic	.590442	1 9126	494852	6.2623	490400
	Std Error					
Variance	Statistic	349	3 658	.245	39 217	.240
	Std. Error					
Skewness	Statistic	1.199	1.098	-.286	1 195	.721
	Std. Error	472	472	.472	472	.472
Kurtosis	Statistic	1 112	175	.393	1 237	-.210
	Std Error	918	.918	.918	918	.918

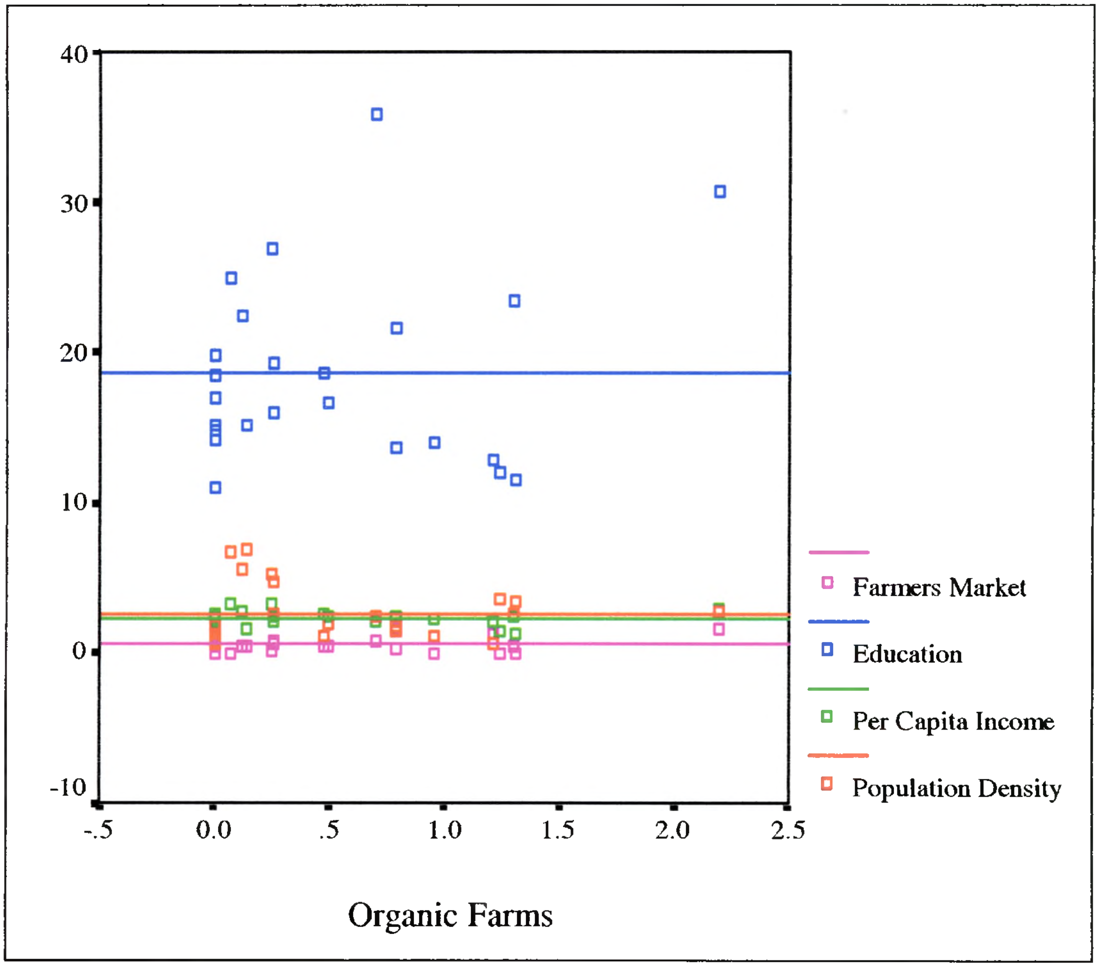

Fig. 4. Scatter plot of MSA-level data. X-axis shows dependent variable: number of organic farms per 100,000 persons). Y-axis shows independent variables: number of farmers markets per 100,000 persons, percent of population with bachelors degree or higher, dollars ($100,000) per capita, and persons per 100 square miles. Data sources shown in Table 2.

lines intersecting natural region boundaries. Counties were assigned to the natural region that contained the larger portion of the county. No attempt was made to interpolate area values or split counties between natural regions, however this approach is adequate given the scale and size of the data set. The farm and natural region raw data sets are slightly non-linear and non-normal, however data transformations of the variables did enhance the data set to the extent that correlation analysis could be used (Tables 4 and 5 and Figs. 5 and 6). Therefore statistical analysis of the data is used to explore interactions of the variables for the farm and natural region data sets.

The varying structure of the data sets and their corresponding limitations provide many clues about the geography of organic farms in Texas. Chapter IV focuses on analysis of the data sets and interpretation of how patterns in the data validate the hypotheses.

Table 4. Descriptive Statistics for Farm-Level Data

		MSA Distance	Farm Acreage	Crop Varieties
N	Statistic	143	148	148
	Std. Error			
Range	Statistic	2.83	13 82	3.85
	Std Error			
Minimum	Statistic	1 61	-5 81	00
	Std. Error			
Maximum	Statistic	4 44	8 01	3 85
	Std Error			
Mean	Statistic	3 1504	3 0141	1 4374
	Std. Error			
Std. Deviation	Statistic	.6978	3 0077	1.2113
	Std Error			
Variance	Statistic	.487	9 046	1.467
	Std. Error			
Skewness	Statistic	-.394	- 482	.333
	Std Error	203	199	.199
Kurtosis	Statistic	-.536	- 333	-1.136
	Std. Error	.403	.396	.396

Table 5. Descriptive Statistics for Natural-Region-Level Data

		Harvested Cropland Acreage	Organic Acreage	Cropland Farm Size	Organic Farm Size	Organic Farms	Harvested Cropland Farms
N	Statistic	11	10	11	10	11	11
	Std. Error						
Range	Statistic	3.98	9.17	2 85	6 46	33	25670
	Std Error						
Minimum	Statistic	11.71	.69	3 87	.00	0	278
	Std. Error						
Maximum	Statistic	15.69	9.86	6 72	6.46	33	25948
	Std. Error						
Mean	Statistic	13 7418	6 3045	5.1929	4.0356	13.55	9862 00
	Std. Error						
Std Deviation	Statistic	1 3560	2 9263	.8630	2.1111	12.12	8457.83
	Std. Error						
Variance	Statistic	1.839	8 563	.745	4.457	146.873	71534914 600
	Std. Error						
Skewness	Statistic	-.362	-.864	.510	-.829	.615	.776
	Std. Error	661	687	.661	.687	.661	661
Kurtosis	Statistic	-1 093	-.116	-.196	-.101	-1.186	-.040
	Std. Error	1 279	1.334	1.279	1.334	1.279	1 279

Notes: Harvested Cropland Acreage and Organic Acreage are not transformed variables. Other variables are natural log transformations of the raw data set.

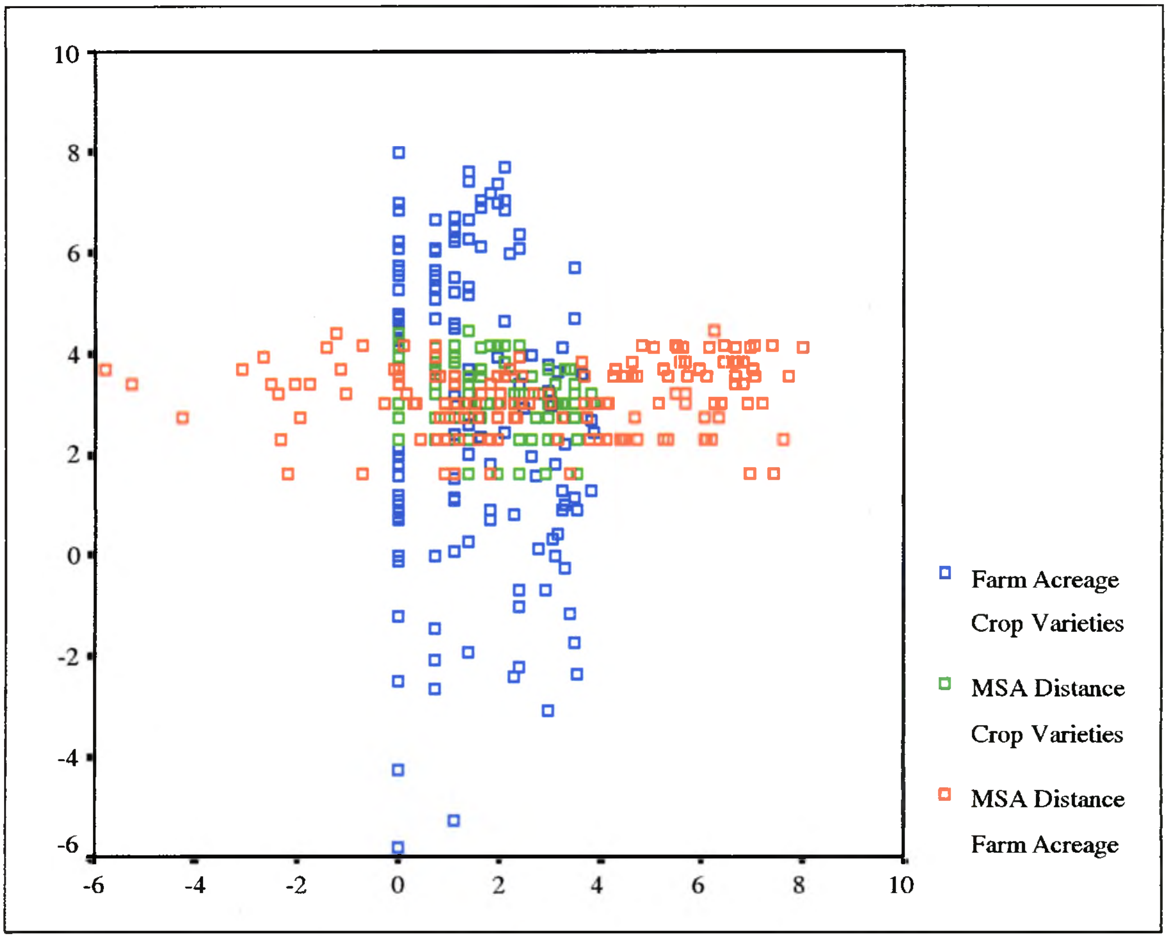

Fig. 5. Scatter plot of farm-level data. Variables transformed by natural log function are plotted as pairs to show relationships for bivariate correlation analysis.

Untransformed Variables *Transformed Variables*

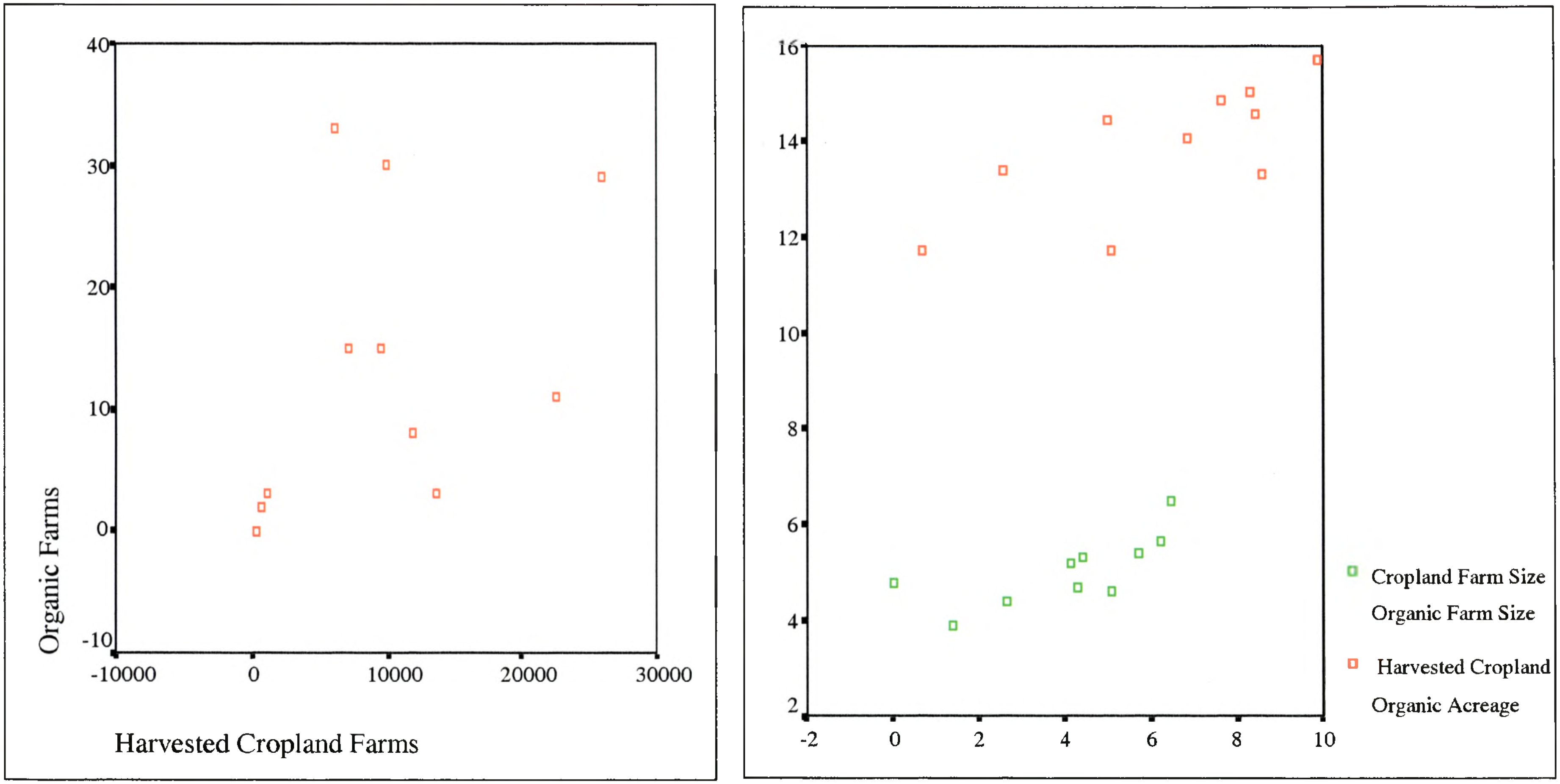

Fig. 6. Scatter plots of natural-region-level data. Plots show relationships for pairs of variables used in bivariate correlation analysis. Number of organic and harvested cropland farms remain as raw data for analysis. Transformed variables are natural log functions of raw data.

CHAPTER IV

ANALYSIS

Results and Interpretation

From visual observation of the geographic location of organic farms with respect to MSAs and natural regions of the state, it is apparent that there is some clustering of the farms within these geographic entities (Figs. 1 and 2). When attempting to evaluate the MSA data set, data patterns were not consistent enough to provide statistically measurable outcomes for the chosen variables. However, the maps and data do provide some insight into the interactions of organic farm location with respect to the socio-economic conditions found in the MSAs. In the following section, some generalizations about the MSA-level data will be made to illustrate a framework for conducting further research to explore the relationship between organic farm occurrence within MSAs and socio-economic characteristics of the MSAs. Statitsical analysis of farm-level data - relationships between farm characteristics and distance to the urban centers (MSAs) - was conducted and the results are explained in the following sections.

Analysis of the natural-region-level data set provided statistically quantifiable results. An explanation of the results of the analysis follows. Though the variables chosen for the MSA and natural area aggregation levels differ in their characteristics, it is possible that grouping of the MSA variables by natural regions would provide more consistent (linear and normal) data sets that could be used for statistical analysis. This possibility will be explained in more detail in Chapter V.

Metropolitan Statistical Areas and Farm Characteristics

The first two of the goals of the research - providing a descriptive view and exploratory analysis of organic farm location and characteristics in relation to urban centers – are met through evaluation of the MSA and farm-level data. The Metropolitan Statistical Area is an important conceptual entity for evaluating organic farm geography in Texas. Forty-five percent of organic farms in Texas lie within the geographic boundaries of the MSAs, and only two organic farms are located outside of a sixty-mile radius of an MSA (Fig. 1). However, only eighteen percent of organic farm *acreage* in the state is found within the boundaries of the MSAs.

The Austin-San Marcos MSA contains the largest number of organic farms – twenty-five farms with 1,529 total acres. The Beaumont-Port Arthur MSA has the largest organic cropland acreage – three farms with 2,618 total acres. For the complete data set, the mean number of farms per MSA is 2, while the mean acreage per MSA is 248. The median acreage per MSA is sixty-three. These values give an indication of the non-normal distribution patterns of the MSA-level variables, but also point to some interesting considerations with respect to the factors that might be contributing to farm characteristics within the MSAs.

Using the Austin-San Marcos and Beaumont-Port Arthur MSAs as examples, some general conclusions may be drawn about the socio-economic characteristics of these two MSAs in relation to the characteristics of the organic farms located within their respective areas. Consider first the population in these areas. A total of 1,136,968 persons inhabit the Austin-San Marcos MSA, while the population of the Beaumont-Port Arthur MSA is 379,052. Population density within the Austin-San Marcos MSA is 1.5 times that found in the Beaumont-Port Arthur MSA (Figs. 7 and 8). In the Austin-San Marcos MSA, there is one organic farm for every 45,500 people, while in Beaumont-Port Arthur there is one farm for every 126,350 thousand people.

There are eighteen farmers markets in the Austin-San Marcos MSA and one in the Beaumont-Port Arthur MSA (Fig. 11). Income and formal education levels are also higher in the Austin-San Marcos MSA (Figs. 9 and 10). The average farm size in the Austin-San Marcos MSA is 61 acres, while the average farm size in the Beaumont-Port Arthur MSA is 872 acres (Fig. 12). On-farm crop diversity is greater in the Austin-San Marcos MSA (Fig. 13) with an average of fifteen different crop types, primarily in herb, vegetable, fruit and nut production. On the other hand, rice, soybeans and legumes are the sole crops grown organically in the Beaumont-Port Arthur MSA.

Based on the comparison of these two cases a few assumptions can be made. Socio-economic traits in the Austin-San Marcos area provide a strong market for a diverse range of fresh organic produce. The presence of numerous small, diverse farms and a large number of farmers markets are indicative of the positive social and economic environment for small-scale organic herb, vegetable and fruit agriculture.

In the case of the Beaumont-Port Arthur MSA, it is logical to assume that lower population density and income levels provide for greater land availability and lower land cost for organic farms. The presence of a few large monocultural farms is indicative of a positive social environment for large-scale organic rice and soybean production. These

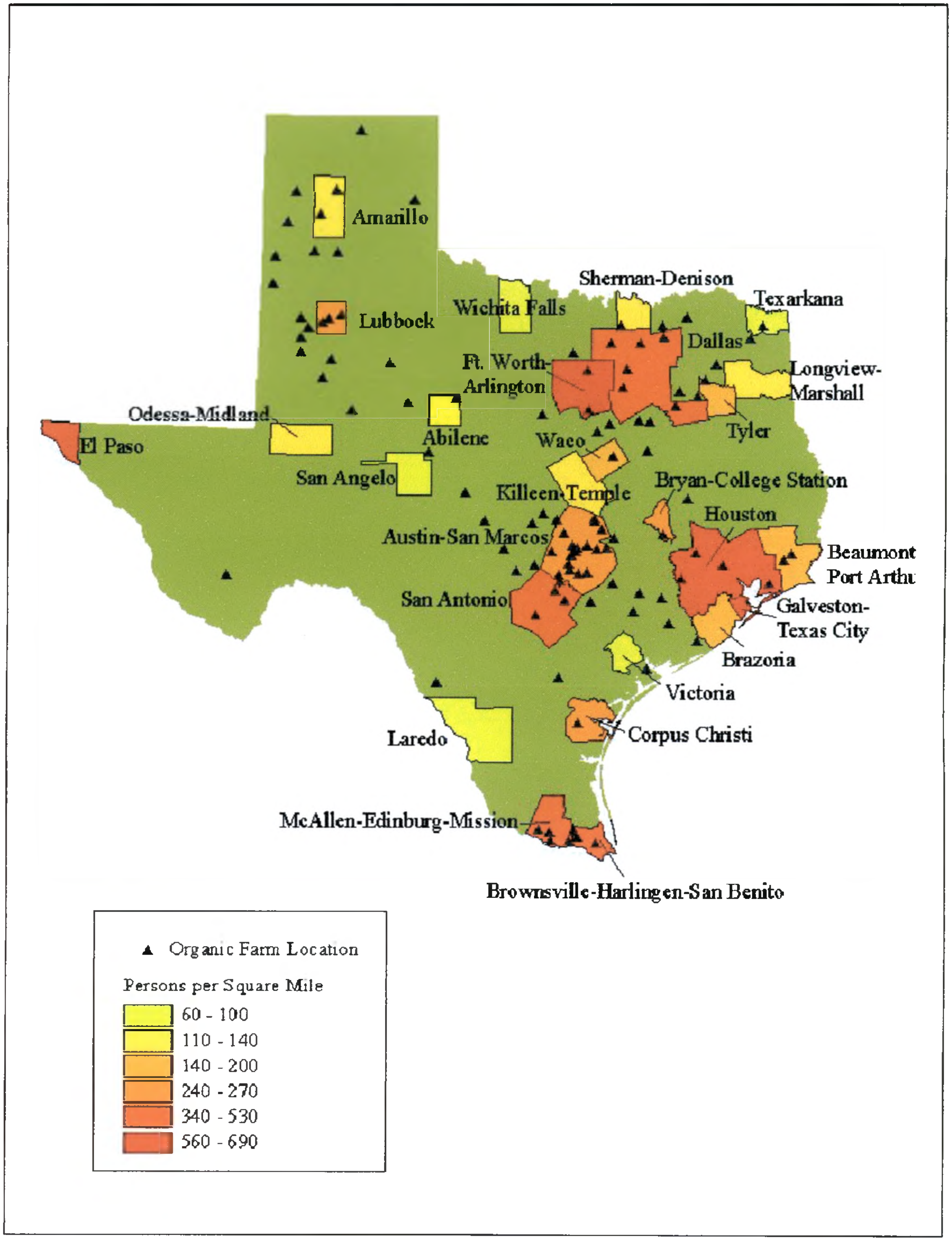

Fig. 7. Organic farm location and urban area population density. Base map from Texas Natural Resource Information System. Data layers from Texas Department of Agriculture, Texas State Data Center and U.S. Bureau of the Census.

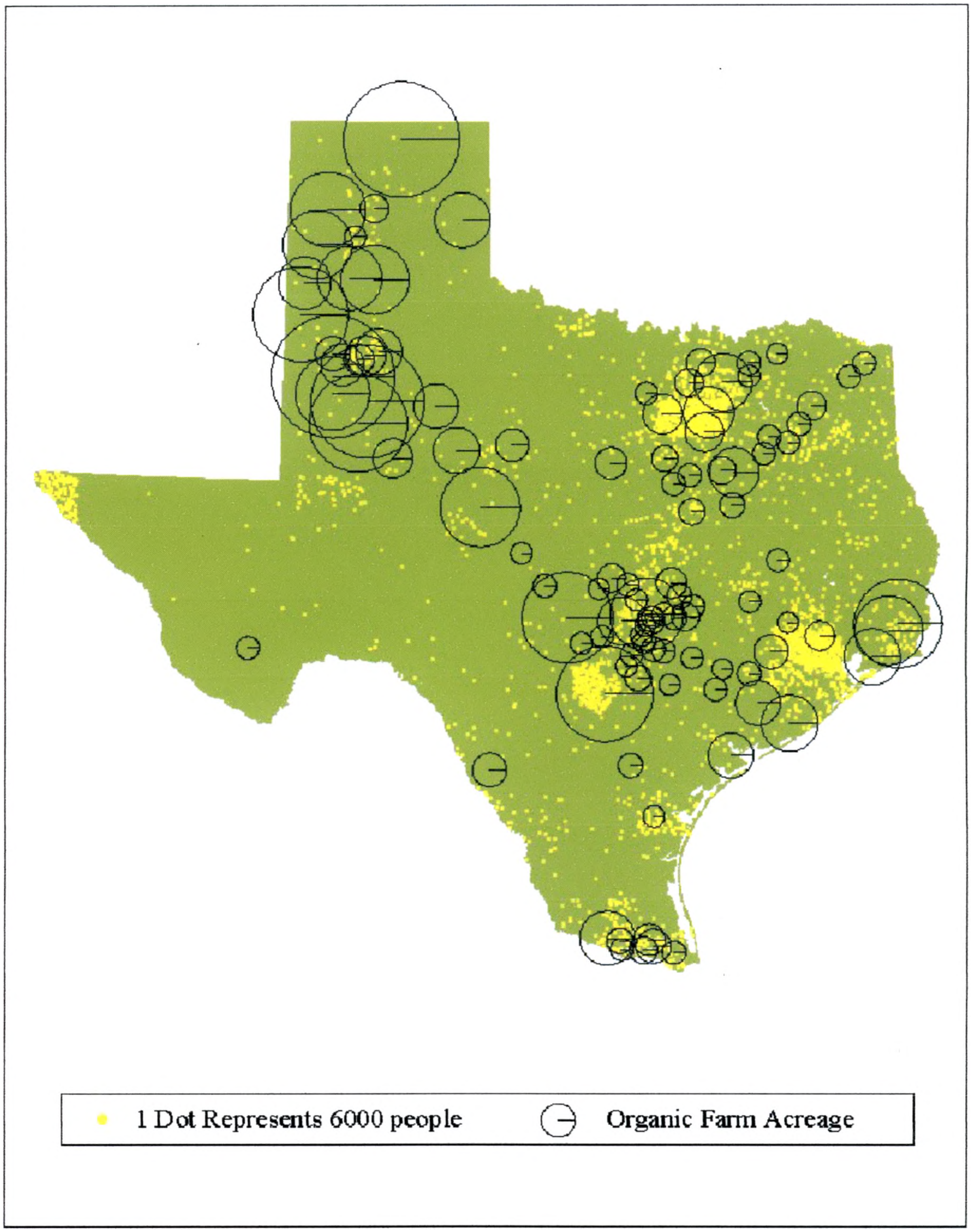

Fig. 8. Organic farm acreage and statewide population density. Base map and population data layer from Texas Natural Resource Information System. Farm data layer from Texas Department of Agriculture.

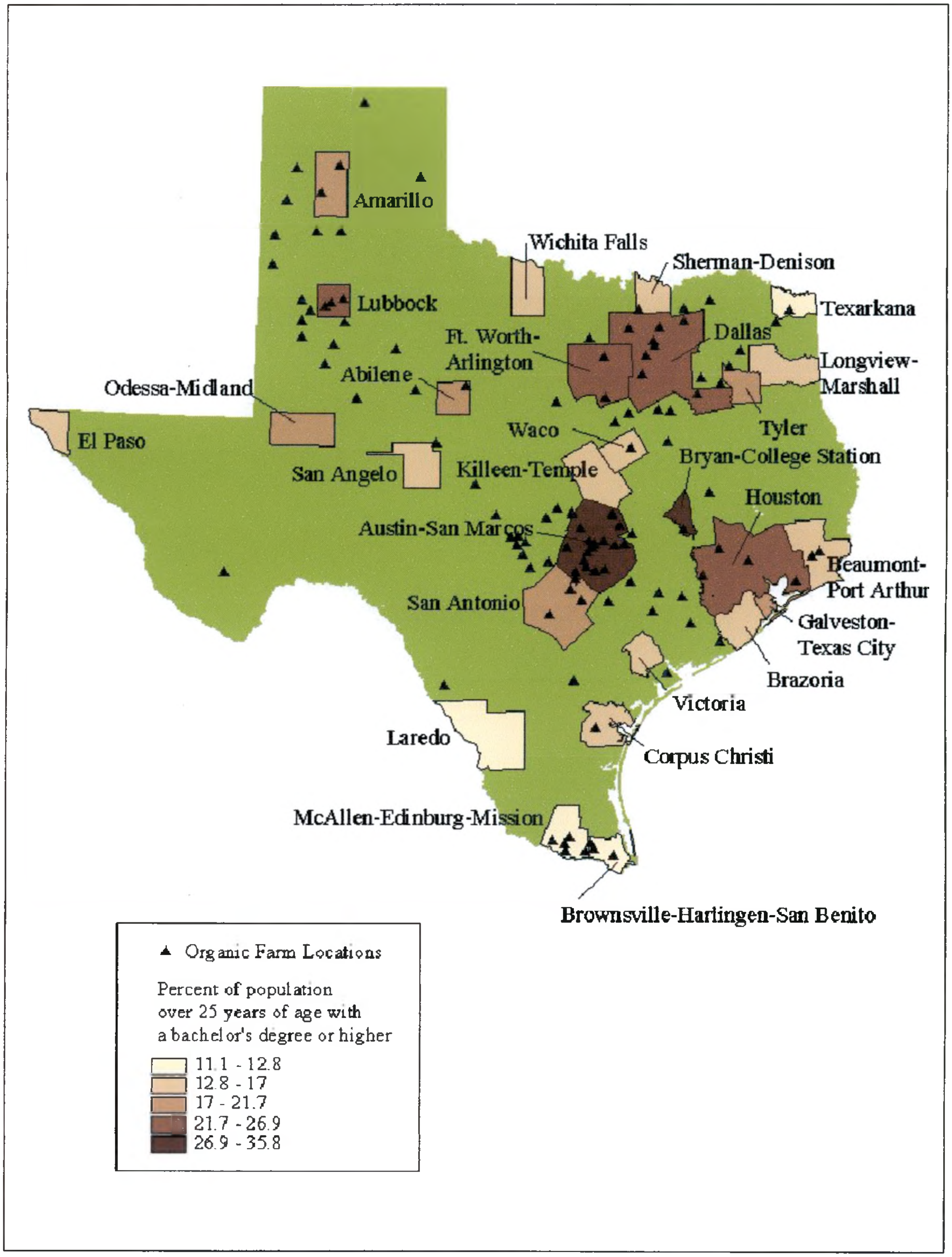

Fig. 9. Organic farm location and urban area education. Base map from Texas Natural Resource Information System. Data layers from Texas Sate Data Center, Texas Department of Agriculture and U.S. Bureau of the Census.

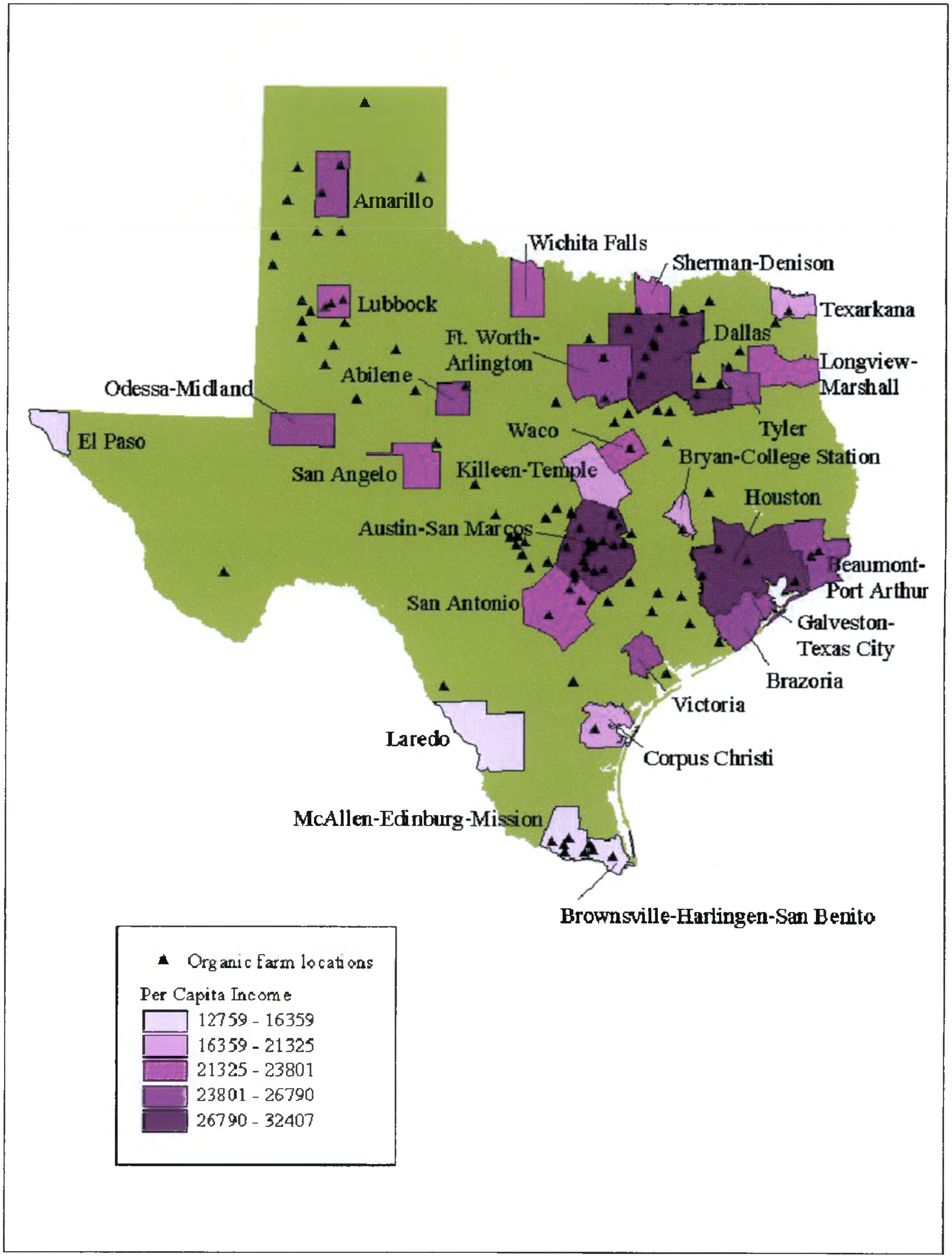

Fig. 10. Organic farm location and urban area income. Base map from Texas Natural Resource Information System. Data layers from Texas State Data Center, Texas Department of Agriculture and Woods and Poole Economics, Inc.

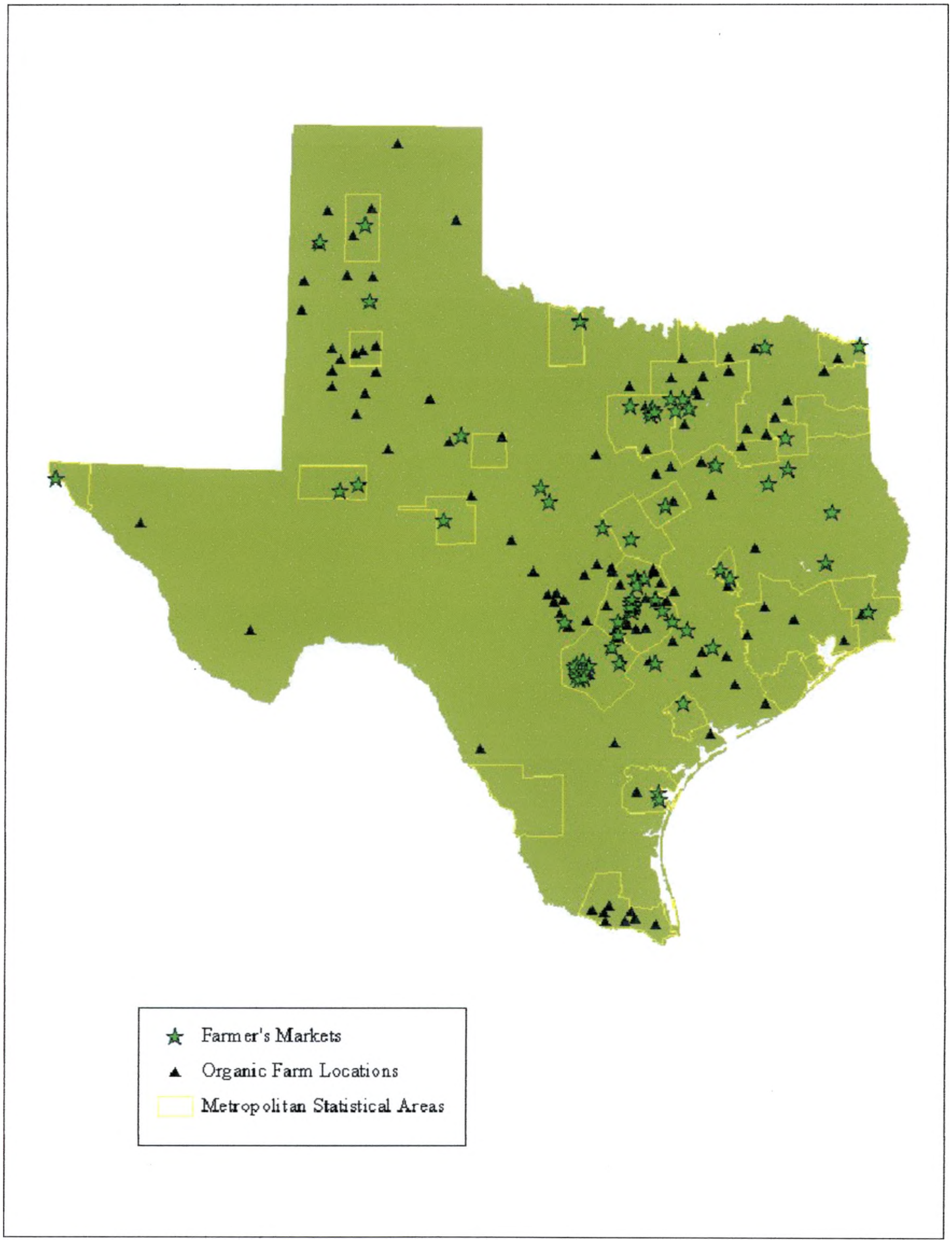

Fig. 11. Location of organic farms in relation to farmer's markets. Base map from Texas Natural Resource Information System. Data layers from U.S. Department of Agriculture, Texas Department of Agriculture and Texas State Data Center.

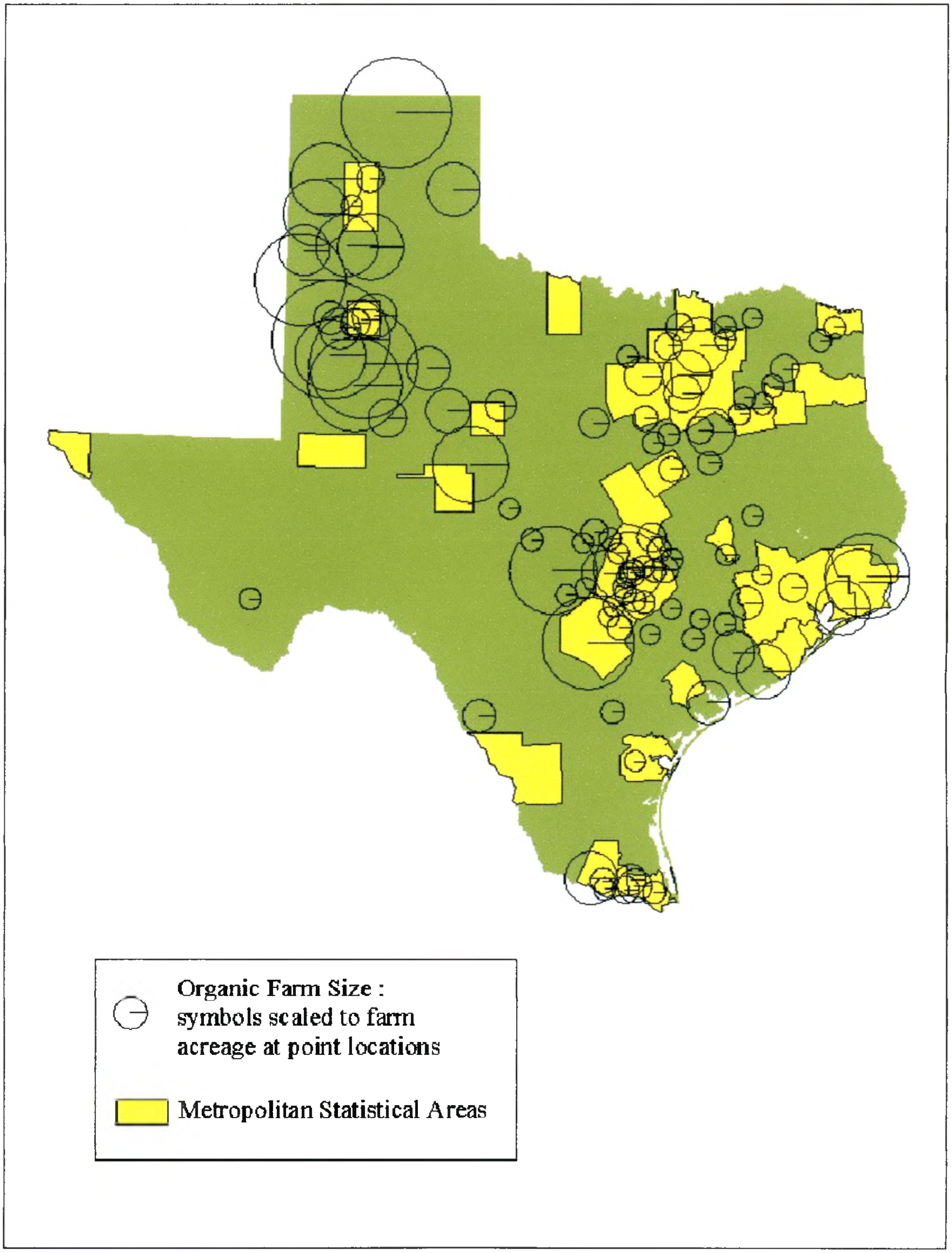

Fig. 12. Organic farm size in relation to urban center location. Base map from Texas Natural Resource Information System. Data layers from Texas Department of Agriculture and Texas State Data Center.

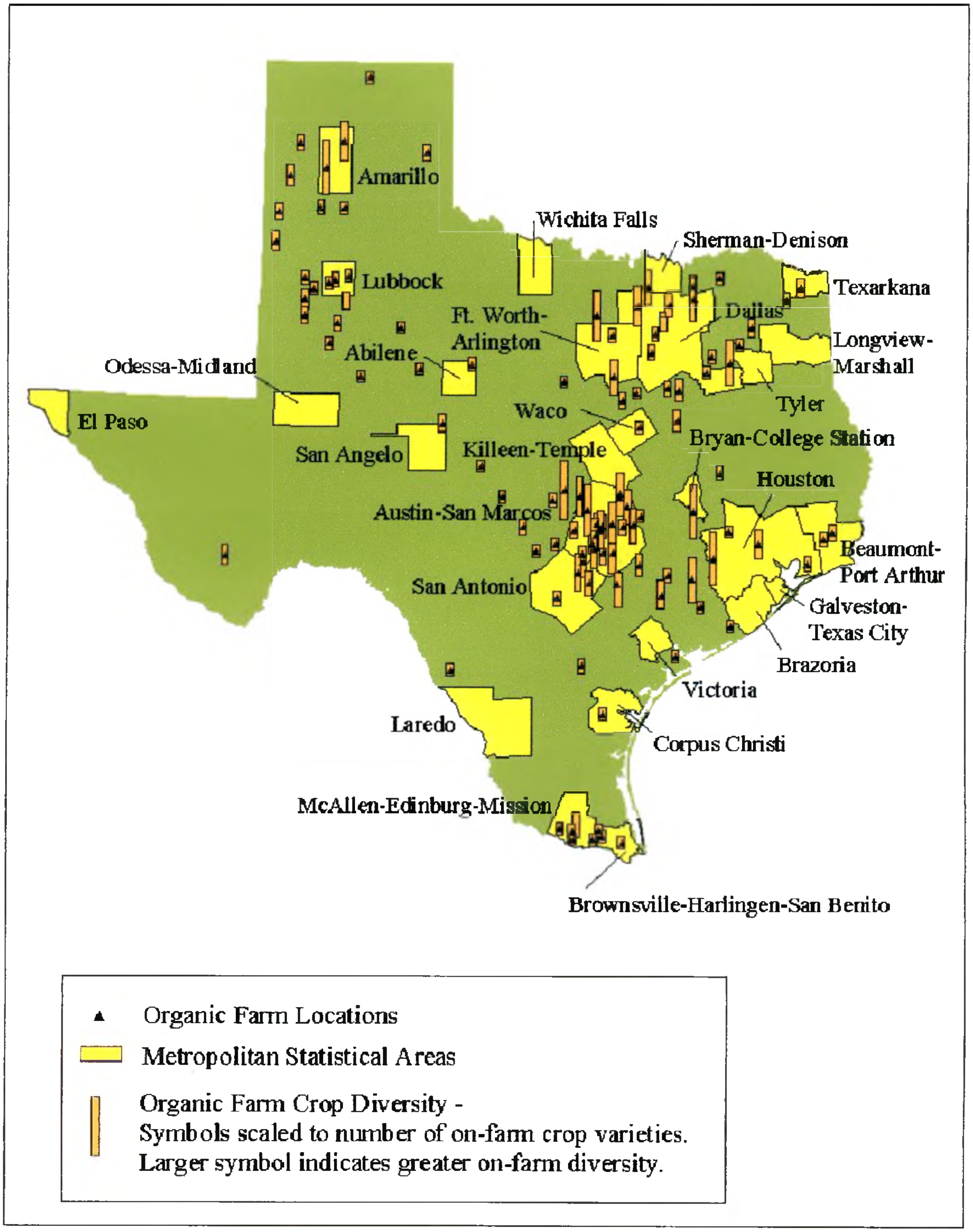

Fig. 13. On-farm crop diversity in relation to urban center location. Base map from Texas Natural Resource Information System. Data layers from Texas Department of Agriculture and Texas Sate Data Center.

assumptions are based on extreme outlier values – the number of farms in Austin-San Marcos and the organic acreage in the Beaumont-Port Arthur MSA – for two cases in the data set. But, in this case, the outlier values indicate a potential pattern in the geography of farms in relation to the MSAs. Other patterns can be found in the MSA data, but the non-normality and non-linearity of the data set limit the use of linear regression techniques (with the chosen variables) to test the hypotheses and statistically verify the patterns and relationships among the data. It is possible that a more complex approach to the statistical analysis might produce reliable results, however it is beyond the scope of this research to explore the myriad statistical procedures that might be used.

As all but two of the organic farms lie within a sixty-mile radius of an MSA, it is very likely that distance to the MSAs affects farm characteristics, because they are closely tied to the socio-economic conditions in the MSAs. Inspection of the maps indicates that farms tend to be smaller and more diverse in the Amarillo, Austin-San Marcos, Dallas and Houston MSAs (Figs. 12 and 13). Farms located in the Beaumont-Port Arthur, Lubbock, Brownsville-Harlingen-San Benito, and McAllen-Edinburg-Mission MSA tend to be larger and less diverse. Farms located outside of the MSAs also tend to be larger and less diverse, though the pattern appears to be more consistent within natural regions of the state.

The relationship between farm characteristics and distance to MSAs was analyzed using a Pearson two-tailed correlation analysis. The farm-level data set is slightly non-linear and non-normal in distribution, so correlation analyses of the raw data and the transformed variables (calculated as the natural log of the value) were performed. A significant correlation between the MSA distance and organic farm size was found in the raw data set (Table 6). Analysis of the transformed variables showed that the number of organic crop varieties is negatively correlated with the MSA distance at the .05 significance level, indicating that organic farms become less diverse with increasing distance to the MSAs (Table 7). Therefore, the data support hypothesis II and hypothesis III. The farm-level data set contains significant outliers like the MSA data set. It is expected that these outliers may be affecting the statistical results for the raw data, but the transformed data analysis shows promising results.

Natural Regions and Farm Geography

The natural regions provide another important conceptual entity (scale) for analyzing the factors that contribute to organic farm location in Texas. Comparisons of organic and conventional farm size and occurrence within natural regions of the state show both similarities and differences between the geography of organic and conventional agriculture in these regions. The largest number of organic farms is found in the Edwards Plateau region, with the second largest number occurring in the High Plains region (Fig. 14). These two regions also rank highest in terms of organic acreage with the High Plains region leading with 19,237 acres and the Edwards Plateau region containing 5,292 acres (Fig. 15). By comparison, the Blackland Prairie region contains the largest number of conventional farms, while the High Plains region contains the largest amount of acreage. The Edwards Plateau region ranks fourth (of eleven regions) in terms of both number and acreage of conventional farms. This may be explained by the fact that the Austin-San Marcos MSA, which is contained within the Edwards Plateau region, contains such a large percentage of organic farms. In terms of farm size, the data sets show some similarities.

Table 6. Correlation Matrix for Farm-Level Raw Data

		MSA Distance	Organic Farm Acreage	Crop Varietie
MSA Distance	Pearson Correlation			
	Sig. (2-tailed)			
	N			
Organic Farm Acreage	Pearson Correlation	.225**		
	Sig. (2-tailed)	.006		
	N	148		
Crop Varieties	Pearson Correlation	-.189*	-.195*	
	Sig. (2-tailed)	.022	.017	
	N	148	148	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 7. Correlation Matrix for Farm-Level Transformed Variables

		MSA Distance	Farm Acreage	Crop Varieties
MSA Distance	Pearson Correlation			
	Sig (2-tailed)			
	N			
Farm Acreage	Pearson Correlation	090		
	Sig (2-tailed)	287		
	N	143		
Crop Varieties	Pearson Correlation	-.182*	- 151	
	Sig. (2-tailed)	.030	.067	
	N	143	148	

*. Correlation is significant at the 0.05 level (2-tailed)

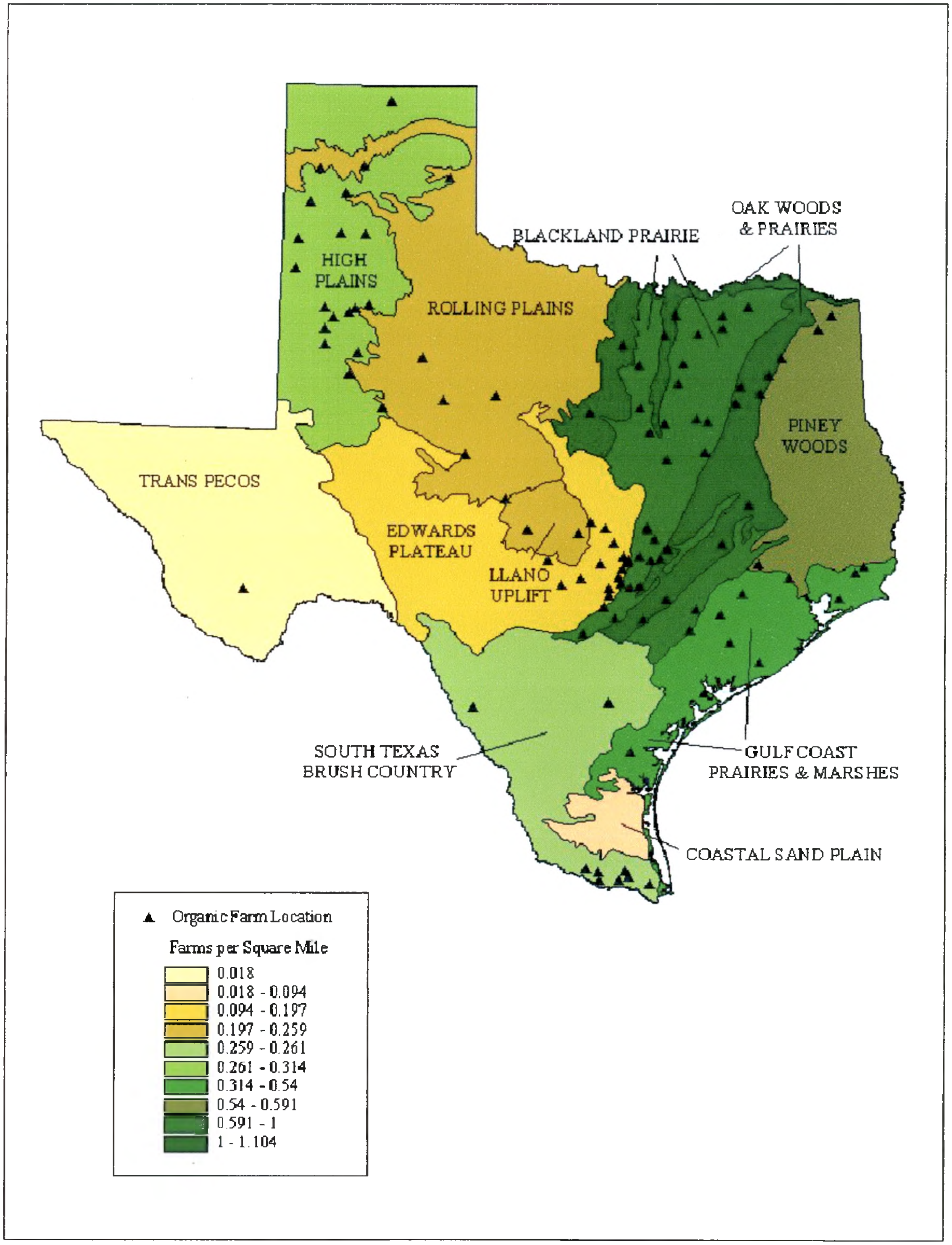

Fig. 14. Organic farm location in relation to cropland farm density within natural regions. Base map from Texas Natural Resource Information System. Data layers from Texas Department of Agriculture and National Agricultural Statistics Service.

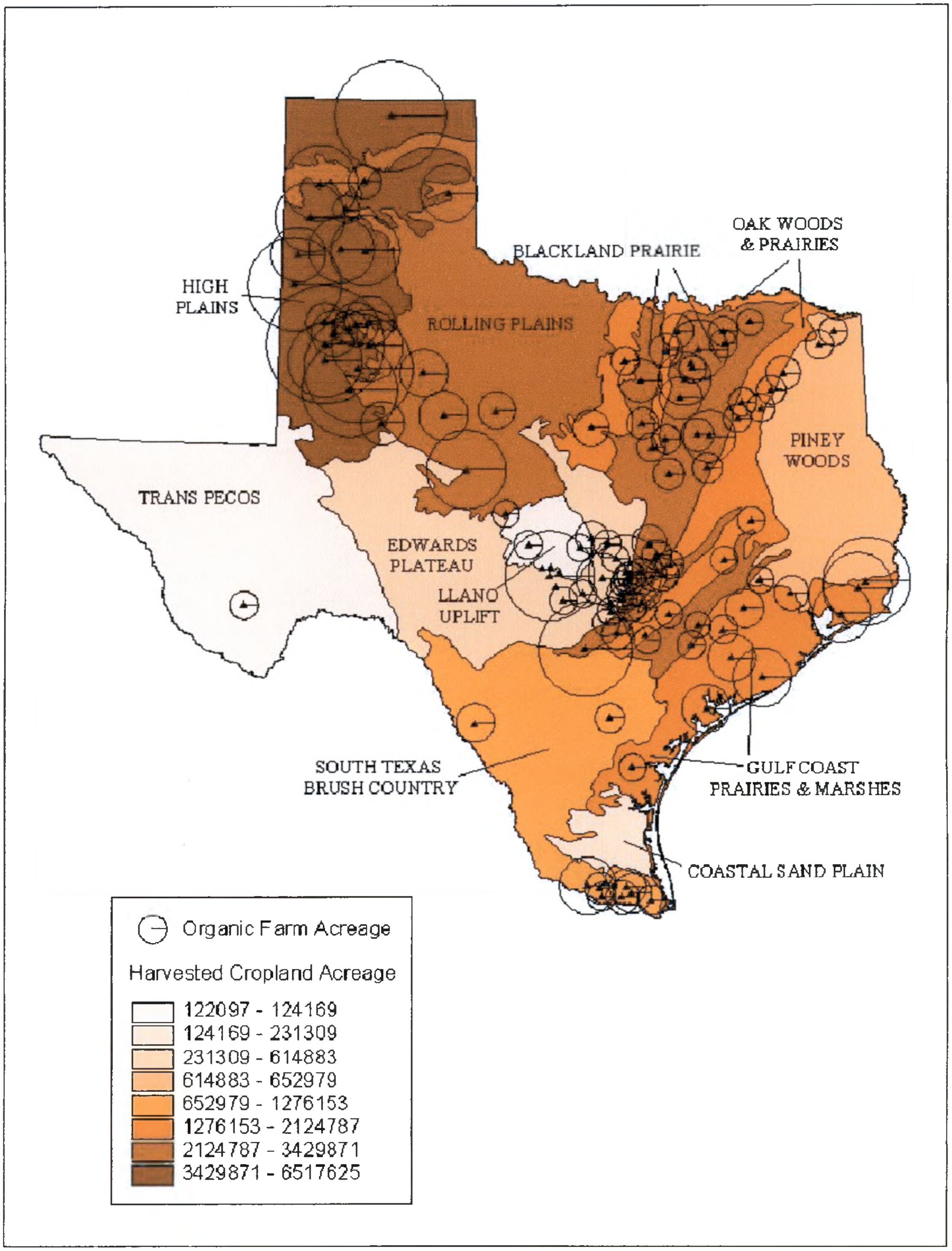

Fig. 15. Organic farm size in relation to cropland farm size within natural regions Base map from Texas Natural Resource Information System. Data layers from Texas Department of Agriculture and National Agricultural Statistics Service.

Excluding the Coastal Sand Plain, which has the largest average conventional farm size but no organic farms, the High Plains region ranks highest for both organic and conventional average farm size (Fig. 16). The Piney Woods region contains the smallest average conventional farm size and ranks second in terms of organic farm size. These similarities may indicate that environmental factors contribute to farm size within the regions, but as seen with the MSA and farm-level data sets, outlier values within the small data sets make verification of relationships difficult at this level of aggregation.

Tests of hypotheses IV and V were intended to validate that organic farm characteristics mimic conventional farm characteristics within natural regions. Analysis of the raw data at the natural-region-level data showed significant positive correlations (at the .001 level) between harvested cropland (i.e. conventional) acres and organic acres, between harvested cropland acres and organic farm size, and between organic acres and organic farm size (Table 8). However, these correlations are not completely reliable, because several of the variables in the data set are skewed in their distribution. So a Pearson two-tailed correlation analysis was run using transformed (by natural log) variables. With the transformed variables, positive correlations exist between organic and cropland farm size and between organic and cropland total acreage at the .05 significance level (Table 9). Additionally, a positive correlation between exists between organic farm size and total organic acreage at the .01 significance level. Hypothesis IV is not supported by analysis of the transformed data, but hypothesis V is. Based on these results, an alternative hypothesis – total organic farm acreage is positively correlated with cropland farm acreage – provides a similar measure to hypothesis IV and is supported by the data. These correlations may indicate that organic farm characteristics within natural regions

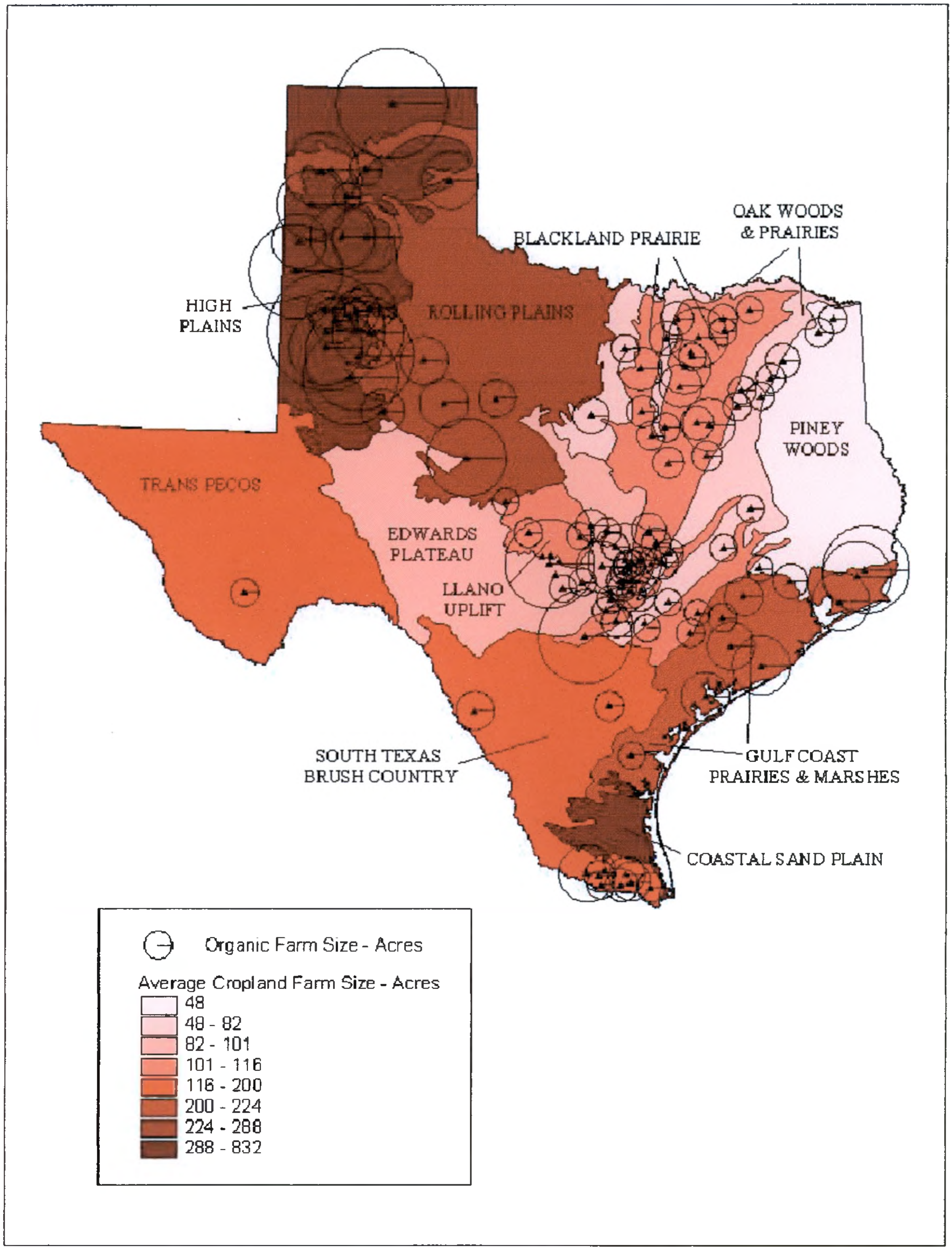

Fig. 16. Organic farm size in relation to cropland farm Size within natural regions. Base map from Texas Natural Resource Information System. Data layers from Texas Department of Agriculture and National Agricultural Statistics Service.

Table 8. Correlation Matrix for Natural-Region-Level Raw Data

		Harvested Cropland Farms	Organic Farms	Harvested Cropland Acres	Organic Acres	Cropland Farm Size	Organic Farm Size
N	Statistic	11	11	11	11	11	11
	Std Error						
Range	Statistic	25670	33	6395528	19237	784	641
	Std Error						
Minimum	Statistic	278	0	122097	0	48	0
	Std. Error						
Maximum	Statistic	25948	33	6517625	19237	832	641
	Std Error						
Mean	Statistic	9862 00	13 55	1796429.00	3322.73	258 09	168 45
	Std Error						
Std. Deviation	Statistic	8457.83	12.12	1927139.31	5652.32	253 56	222.38
	Std Error						
Variance	Statistic	71534914.600	146 873	3713865934978.400	31948736.818	64291.491	49452.273
	Std Error						
Skewness	Statistic	.776	615	1.609	2.607	1.706	1.425
	Std Error	.661	661	.661	661	661	661
Kurtosis	Statistic	-.040	-1.186	2.884	7.465	1.978	.877
	Std Error	1.279	1 279	1.279	1.279	1.279	1 279

Table 9. Correlation Matrix for Natural-Region-Level Transformed Variables

		Harvested Cropland Farms	Organic Farms	Harvested Cropland Acreage	Organic Acreage	Cropland Farm Size	Organic Far Size
Harvested Cropland Farms	Pearson Correlation						
	Sig (2-tailed)						
	N						
Organic Farms	Pearson Correlation	.407					
	Sιg (2-tailed)	.214					
	N	11					
Harvested Cropland Acreage	Pearson Correlation	682*	.615*				
	Sig (2-tailed)	.021	044				
	N	11	11				
Organic Acreage	Pearson Correlation	.208	743*	.743*			
	Sιg (2-tailed)	564	014	014			
	N	10	10	10			
Cropland Farm Sιze	Pearson Correlation	-.434	- 013	.126	.637*		
	Sιg. (2-tailed)	.183	971	.711	.048		
	N	11	11	11	10		
Organic Farm Sιze	Pearson Correlatιon	.053	.551	638*	.959**	.732*	
	Sιg (2-tailed)	.885	099	.047	.000	.016	
	N	10	10	10	10	10	

* Correlation is signιficant at the 0 05 level (2-tailed)

Notes: Harvested Cropland Acreage and Organic Acreage are not transformed variables. Other variables are natural log transformatιons of the raw data set.

are influenced by other variables at the natural-region-level, however further tests are required to determine which variables – social, economic, or environmental – are contributing to the correlation. Data analysis does not directly validate this theory, but it does demonstrate the validity of the theoretical model.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Hypotheses and the Theoretical Model

The research hypotheses provided a framework for evaluating the nature and extent connections between social, economic and environmental variables and organic farm location that are described by the theoretical model. Hypothesis I states that organic farm occurrence within urban centers is correlated with socio-economic conditions in those centers. While the MSA data did not support the first hypothesis, the data patterns indicate that socio-economic conditions do influence organic farm location. In the case of the Austin-San Marcos MSA, where the largest cluster of organic farms is located, a positive social and economic environment for small-scale, diverse organic farms is evident in a large population with high income and education levels. This pattern can also be seen in other MSAs with similar socio-economic conditions such as Dallas, Fort Worth-Arlington, and Houston.

In the MSAs that have lower population densities and income levels, small numbers of large, mono-cultural farms are found. This pattern is evident in the Beaumont-Port Arthur MSA, Brownsville-Harlingen MSA, McAllen-Edinburg-Mission MSA and similar MSAs. The patterns in the data provide evidence that the MSA is a useful geographic entity for validating the connections between socio-economic conditions and organic farm location as illustrated by the theoretical model. The data also indicate that organic farm characteristics, such as farm size and crop diversity, may be related to socio-economic conditions in the MSAs.

While the theoretical model does not address farm characteristics, hypotheses II and III define relationships between farm characteristics and distance to the MSAs. Hypothesis III, which states that distance to urban centers is negatively correlated with on-farm crop diversity, is supported by statistical analysis. Hypothesis II was not supported statistically, however patterns in the data indicate that there is a relationship between distance to urban centers and individual farm size. Therefore, farm characteristics are linked to the ring of variables in the model and should be included in future study.

While specific environmental variables were not used to validate the theoretical model, data aggregated at the natural-region level demonstrates that eco-regional variability influences organic farm location and characteristics. Tests of hypotheses IV and V were designed to validate that organic farm characteristics are correlated with conventional farm characteristics within natural regions. Conventional farm characteristics have traditionally been linked to varying environmental conditions among the natural regions. For instance, the plains regions of the state have traditionally contained very large farms that produce grains, cotton and soybeans as the primary crops, while the prairies regions of the state have contained smaller, more diverse farms that produce vegetables, fruits and nuts. These same patterns are evident in the organic farm characteristics. Statistical analysis verified that the size of organic farms is positively correlated with the size of conventional farms and that total organic acreage is positively correlated with conventional organic acreage. The similarities between organic and conventional farm characteristics within natural regions of the state support the theoretical assumption that environmental factors influence organic farm location. The natural regions serve as useful geographic entities for data aggregation and could be very beneficial for studying influences of environmental factors on organic farm location in future studies.

Directions and Considerations for Further Research

The maps created for this study provide the most useful view of the geography of organic farms in Texas. The statistical analyses used in this study require some modification to verify relationships between some of the variables chosen for the research. In the case of hypothesis I and the MSA-level data set, it was not appropriate to quantify the relationship between the occurrence (surrogate for location) of organic farms and the socio-economic variables within the MSA. Based on the results of the tests of the other hypotheses, a better approach might be found in comparing farm characteristics (farm size and crop diversity) with socio-economic conditions in the MSAs. Another possible approach involves grouping the MSA level data by natural region and comparing farm characteristics with socio-economic characteristics for the data groups. One model could test farm size and crop diversity (for organic and conventional farms separately) as dependent variables against population, income, education, and farmers markets as independent variables. Another model could compare the farm characteristics of organic and conventional farms within MSAs and groups of MSAs. These tests might provide a more comprehensive and measurable view of relationships of the between farm location and socio-economic variables.

Based on the results of tests of hypotheses IV and V, alternative research models might test farm acreage, farm size and crop diversity (for organic and conventional farms separately) as dependent variables with eco-regional variables such as land use, precipitation, soil types, erosion, ground and surface water availability and vegetation types as independent variables. Organic and conventional farm data sets could be compared to evaluate the relationships between these two types of production systems within natural regions of the state.

Approaches that have been used in studies of organic agriculture in other regions of the United States also provide numerous potential directions for continued study of the geography of organic farming in Texas. Comparisons of economic, social and environmental considerations in production practices between conventional and organic production systems could provide more insight into the long-term sustainability of organic farming in Texas. Different models might compare a broad range of variables at different scales, such as: production practices such as irrigation, intercropping, tillage and mechanization; social considerations such as attitudes and paradigms of farmers, consumers and research establishments; economic considerations such as costs of production inputs and transportation, market prices obtained for products, and yields based on land area used. Given the lack of research on organic production systems in Texas, the possibilities for research design are virtually limitless and numerous opportunities exist for conducting research to assist policy makers and practitioners in evaluating the geography of organic farming in Texas and providing answers to issues of the sustainability of organic agriculture systems in Texas.

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