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Encouraging Organic Agriculture: The Effects of Conversion Subsidies

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ENCOURAGING ORGANIC AGRICULTURE: THE EFFECTS OF CONVERSION SUBSIDIES

BY

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This thesis is approved as a creditable and independent investigation by a candidate for the Master of Science degree in Economics and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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ABSTRACT

ENCOURAGING ORGANIC AGRICULTURE: THE EFFECTS OF CONVERSION SUBSIDIES

SARAH ADAMS INKOOM

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This thesis examines the importance of conversional subsidies in accounting for an increase in organic acreage in the 12 North-Central States in the United States. Monthly time series data that spans from January 2002 to December 2014 was used in the analysis. Empirical evidence suggests that increase in organic acreage is due in part to the availability of conversion subsidies. Without government assistance, most small-scale farmers are not sufficiently motivated to switch to organic production due to the high initial costs involved in transitioning. Further, increased institutional support could facilitate organic adoption and its absence is detrimental to increasing the rate of adopting organic production methods.

Key words, NOSB, NOP, USDA, ARMS, organic, acreage, subsidies, certified farmers, transitioning cost.

CHAPTER 1: BACKGROUND OF STUDY

U.S. agricultural sustainability may be improved by way of various innovative approaches, one of which includes organic agriculture. In accordance with the National Organic Standards Board (NOSB), "organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is also based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony." Under organic cropping systems, the fundamental components and natural processes of ecosystems such as soil organism activities, nutrient cycling, and species distribution and competition are used as farm management tools (Greene and Kremen, 2003). Others authors such as Watson et al. (2007) are of the opinion that organic agriculture is distinct from conventional agriculture because of its alternative agricultural practices, worldview, and values.

Despite long and complicated processes and practices involved with moving toward production systems based on organic agriculture, the adoption of an organic approach to producing agricultural products has been on the rise over the past decades. In particular, organic agriculture has grown substantially since emerging in the 1940s, as measured by the area of certified lands, organic programs, and the organic farmland acreage. For instance, cropland acres devoted to organic production methods increased from 1.3 acres to 3.7 acres between 2002 and 2014 (McBride et al. 2015). In addition, consumption of organic food has risen by double digits annually, as the public demands increasing amounts of organic fruits and vegetables from Whole Foods, Wal-Mart, and other retailers and farmers' markets (Haedicke, 2016).

Some researchers have analyzed the motivations for the adoption of organic systems. For example, Fairweather (1999) found that most Midwestern organic farmers use organic methods out of concern for their own health, their families and their livestock. An additional reason for the popularity of organic agriculture is its limited use of resources and the absence of the use of synthetic nitrogen. The latter can have negative environmental consequences when overused, such as pollution of groundwater and waterways. Organic farming methods often require additional manual work on the farm, but reduce farm workers' exposure to pesticides and other chemicals. While economic concerns are important, they are not always the main reasons farmers choose an organic approach. Researchers such as Rigby and Cáceres (2001) identified other reasons, including concerns about soil degradation, marketing and market incentives, and lifestyle choice (ideological, philosophical or religious) as motivating factors for farmers in their conversion decision-making process.

Dobbs and Pretty (2000) showed that key factors contributing to the increase in the number of organic crop acres include the existence and availability of government policies and subsidies. They documented that government policies and private conversion incentives such as cost-sharing transition expenses, supporting research and extension, assisting in market development and ensuring the quality of organic certification have been effective factors in encouraging farmers to switch to organic production methods. In addition, targeted subsidies may help enable farmers gain the financial ability to transition to organic production and thereby reduce their reliance on agricultural chemicals. Distinguishing between farmers who do and those who do not require conversion subsidies may help evaluate which policies encourage such conversions and which ones offset one another. This will provide a foundation for decision makers for comparing transition costs related to management and yield, and will help farmers make sound decisions regarding risk management practices. The positive effects of conversion subsidies and other policies on the transition from conventional toward organic agriculture suggest that, vice versa, the absence of favorable policy instruments could hinder the adoption of organic systems. Hence, quantifying the effects of the (lack of) incentives may aid policy makers in designing appropriate policies to encourage conversion and in identifying market-based policies that could have similar effects as subsidies, but with less interference.

The demand for organic products is linked in part to the perception among some consumers that organic food is more healthful than food produced based on conventional agricultural production methods. In addition to the personal health benefits that some consumers associate with consuming organic products, social considerations are a driving force of the purchasing behaviors among consumers. MacRae et al. (2007) conducted a study in Ontario, and found that organic farmers are less dependent on off-farm income and they appear to be more involved in direct marketing than their conventional counterparts. The authors further stressed that direct marketing is closely connected to community involvement. The authors also found that organic agriculture practitioners had a greater capacity to mobilize community resources for local development than did farmers using conventional production techniques, including relatively larger degrees of active participation in local government, and comparatively higher levels of new community economic development structures and new businesses creation.

Another set of reasons for the increase in the adoption of organic agriculture includes the consistent support organic farmers receive as compensation for possible losses they may face in the first three years of transitioning, the availability of organic price premiums, the adequacy of technical advice and knowledge, as well as a general environmental awareness of organic systems which are gaining recognition worldwide. For instance, farmers committed to soil conservationist may be more willing to adopt organic agriculture than other farmers because they share positive attitude and motivation regarding improving soil quality and limiting soil erosion.

1.1 Problem Statement

While there appears to be agreement in the literature that favorable subsidies and high market demand affect the adoption of organic systems, few studies have examined the barriers to acquiring these subsidies and their role in hindering the transition from traditional to organic agriculture. Thus, a critical research question is whether conversion subsidies provide farmers with sufficient incentives to switch to organic production while maintaining levels of profitability comparable to those achieved using conventional production methods. In addition, the literature provides little information on the relationship between the availability of market information, training and management systems and farmers' decisions to convert their operations to organic production. Against this background, this study seeks to examine the role of conversion subsidies in encouraging farmers to switch their operations to using organic agricultural practices.

1.2 Objectives

The broad objective of this study is to examine the importance of conversional subsidies in accounting for an increase in organic acreage in the United States over the past decades. The specific objectives of this thesis are to analyze:

- whether favorable conversion subsidies are positively related to farmers' decisions on whether to switch to organic production,

- various persistent barriers that may keep farmers from switching to organic agricultural production,
- market demand forces that incentivize farmers to transition to organic production, and
- environmental sustainability challenges of organic production practices.

1.3 Justification

The use of subsidies can help farmers gain the financial ability to transition toward organic production and shift toward reduced and no-chemical production systems. Therefore, the results of the study will be of importance to farmers interested in practicing organic farming, but also to consumers, and other actors in the organic production sector, as well as researchers concerned with organic production practices. By distinguishing between farmers requiring such subsidies to convert to organic production and those who do not, it may be possible to evaluate which policy variables offset or reduce transition effects and which ones encourage the conversion to organic methods. This will provide a foundation for decision makers in considering transition costs related to production and risk management practices associated with sustainable and organic farming in the United States.

1.4 Organization

This thesis is organized in six main chapters. Chapter 2 includes a review of empirical and theoretical literature on the adoption of organic agriculture practices, and is divided into three sections. The first section contains an overview of the organic agriculture sector. The second deals with market incentives and policy instruments affecting the organic agriculture sector in the United States, including subsidies designed to smoothen the transition to organic agriculture, and pull and push factors affecting the adoption of organic agriculture. The final section provides a discussion of outcomes from previous studies related to the adoption of organic agriculture.

Chapter 3 discusses the research design, methodology, and variables used in the research. This chapter discusses the theoretical model, empirical model estimation, variables used in the analysis, descriptive statistics, and analytical methods used.

Chapter 4 introduces the data analysis procedures and summarizes important trends of the organic agriculture sector. The final section of this chapter discusses projected increases in the adoption of organic agriculture production methods and the linkage between farmers' past and future decisions regarding the adoption of organic agriculture practices. Chapter 5 contains a discussion of findings associated with the study's objectives. The chapter also includes a description of the regional distribution of the subsidies, and examines the reasons for the increase in organic agriculture adoption.

Chapter 6 contains an investigation of determinants of organic agriculture adoption. The chapter also provides a discussion of modeling procedures, and reports the results of the regression models. The final section of this chapter provides the main findings of the discussed models, and contains a summary, limitations, conclusions, and recommendation of the study.

CHAPTER 2: LITERATURE REVIEW

This chapter contains a review of the relevant literature on subsidies and policies affecting the adoption of organic production methods. The chapter is divided into three sections. The first gives an overview of the organic agriculture sector that includes information on the following: conversion policies that seek to motivate farmers to transition to organic farming, barriers to transitioning to organic farming, market forces shaping organic agriculture, and environmental sustainability benefits of practicing organic farming practices. The second section provides a discussion of utility maximization and product characteristics incorporating the decision to switch to organic production methods, while the third looks at the empirical literature concerning organic agriculture.

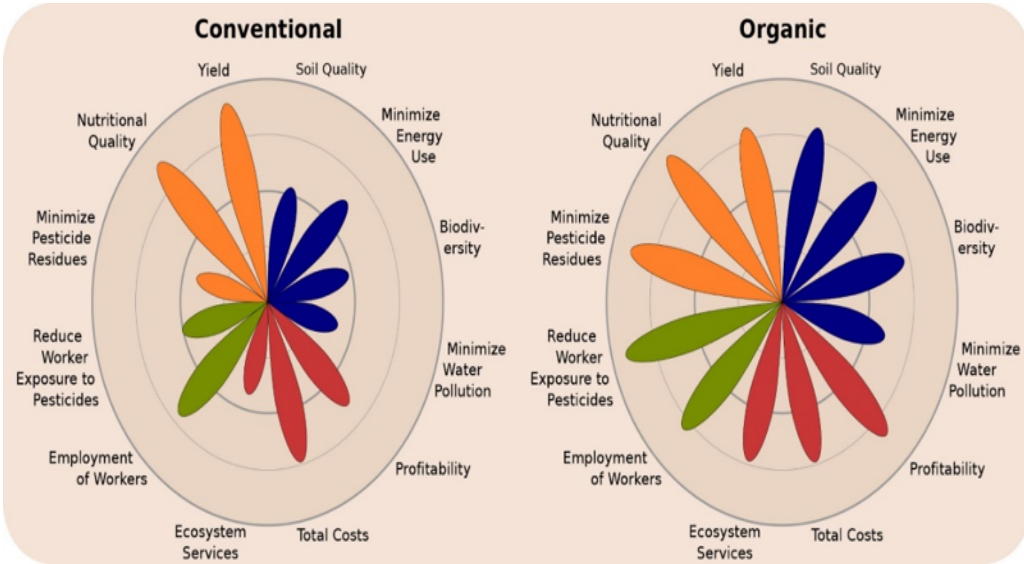
2.1 An Overview of the Organic Agriculture Sector

"Certified Organic" is a labelling term that indicates that the agricultural products were produced by way of approved methods that integrate cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balances, and conserve biodiversity (ERS-USDA, 2001). In the Unites States, the National Organic Program (NOP) provides the federal regulatory framework governing organic food. In addition, the Organic Food Production Act of 1990 required that the USDA develop national standards for organic products (Ellsworth, 2001).

According to Kassam et al. (2009), sustainable agriculture is a way of growing or raising food in an ecologically and ethically responsible manner. This includes adhering to agricultural and food production practices that do not harm the environment. Such systems must be resource-conserving, socially supportive, commercially competitive and environmentally sound. Due to this, organic agriculture holds a special place under the sustainable agriculture umbrella, since it embodies most of the qualities of sustainable agriculture. For instance, USDA organic standards seek to ensure that the production of organically-produced food preserves natural resources and biodiversity, supports animal health and welfare, does not use genetically modified ingredients, and does not use livestock feed additives.

Reganold and Wachter (2016) found that organic agriculture has an important role in producing an adequate and sustainable global food supply. The authors reviewed hundreds of published studies on organic agriculture which provided evidence that organic farming can produce sufficient yields, be profitable for farmers, protect and improve the environment, and is safe for farm workers, as illustrated in Figure 1. The authors suggest that organic agriculture is associated with greater biodiversity of plants, animals, insects and microbes, as well as with more genetic diversity than conventional farming. They further found evidence that organic farms tend to store more soil carbon, have better soil quality, cause less soil erosion, and have a greater ability to adapt to changing conditions than do their conventional counterparts. The authors also suggest that organic agriculture has the ability to be profitable in the long run, and to minimize energy and pesticide residuals.

Figure 1: Organic Agriculture as a Subset of Sustainable Agriculture



Source: Reganold, & Wachter (2016).

2.2 Forces Stimulating Organic Agriculture

Policies pertaining to organic agriculture are evolving in the United States, and so is the infrastructure to support the adoption of organic agriculture practices. Many changes in organic agriculture are market-driven as organic food production faces a rapidly-growing demand in the United States and other industrialized countries. U.S. national organic policy aims to develop standards governing the production, processing and labeling of organically produced food. Since 1990, the Organic Food Production Act (OFPA) has supported the USDA's effort to provide research, technical assistance, risk management and other support for farmers who are transitioning toward organic production. As a result, funding for organic research, financial assistance for conservation practices, certification cost-share assistance programs, and data collection increased in the 2014 Farm Bill relative to previous farm bills (Stubbs 2014).

A key reason for the growing interest in organic agriculture is the increased number of government initiatives enacted to support organic agriculture. For instance, the 2002, 2008 and 2014 farms bill each supported organic agriculture in data collection, national organic cost-share programs, and organic agriculture research and extension initiatives. These government funds provide a platform for transitional organic farmers to be educated and provide an advocacy role for the organic industry at the federal level. Lohr and Salomonsson (2000) found that government research and policy initiatives often play key roles in the adoption of new farming technologies and systems.

The organic community generally agrees on the need to promote organic agriculture policies and fund research relevant to production practices that seek to improve efficiency and sustainability for farmers who become organically certified. For example, DeLonge et al. (2016) documented the need for conducting research on organic farming, for helping organic agriculture achieve its full potential, and for offering relevant education to the public. According to the authors, organic agriculture has the potential to maintain low input costs and achieve price premiums, which can lead to improved profit margins and contribute to maintaining a sustainable environment.

Watson et al. (2007) provide further evidence that the ability of farmers to obtain favorable subsidies provides an important incentive for conversion. In addition, a number of researchers have found that government and private conversion policies are the main forces behind the increase in organic acreage. Similar findings were documented by Padel (2001), and Van der Ploeg et al. (2000), who found that government and private conversion policies such as cost-sharing transition expenses, supporting research and extension, assisting in market development and insuring the quality of organic certification are effective factors in encouraging farmers to switch to organic production methods.

2.3 Subsidies

The nature of organic agriculture subsidies is evolving in the United States, and so is the infrastructure to support the adoption of organic agriculture practices. Lohr and Salomonsson (2000) found that farmers requiring subsidies tend to manage large and diversified farms and are more concerned about organic inspection, quality and adequacy of technical advice than are conventional farmers. The 2014 farm bill modified the system of subsidies for organic farming by dividing them into three groups: subsidies for farms during the period of conversion to organic farming systems; subsidies for organic extensification; and continuous subsidy schemes for organic farming[1]. These subsidies consist of various types of support, e.g. subsidies for the maintenance of permanent grassland, and those encouraging a reduction in nitrogen fertilizer applications. Governmental support for organic agriculture is implemented by means of subsidies paid directly to those farmers who adopt and/or maintain environmentally-friendly practices for a period of at least five years. To obtain this support, participating farmers must develop production methods that do not involve the application of chemicals such as pesticides.

A particular focus of the government has been on reducing greenhouse gases (GHGs), which may help mitigate climate change. Organic farming may contribute to reducing GHGs by promoting the use of reduced amounts of energy, which could lessen the negative impact on the environment relative to conventional agricultural practices. Thus, most organic subsidies aim to promote environmentally friendly farming methods, such as organic agriculture practices.

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[1] Organic extensification can be defined as the process (or trends of developing an extensive production system, i.e. one which utilizes large areas of land, but with minimal inputs and expenditures on capital and labor.

2.4 Collaborations with Private Entities

The U.S. federal government has provided financial support to farmers who transition from conventional to organic production methods. Best (2008) documents that these direct organic transition payments to farmers increased significantly since the 1990s and acted as incentives to move toward increasingly sustainable practices. Though federal financial supports provide benefits to organic farmers, the funds may not be enough to encourage farmers to switch to organic production. This has led private agencies to provide financial support for encouraging farmers to modify their production systems. In a study conducted in Canada, MacRae et al. (2007) showed that the increase in organic production over two decades was not only due to the existence of policy support and government-provided financial incentives for organic farming, but also because of the availability of private funding. The study's findings are relevant to general settings because organic production systems have the potential to provide social benefits that exceed the purely private benefits that farmers consider when making investment decisions.

Mosier and Thilmany (2016) examined the policies and prospects of organic agriculture, and focused especially on the government's role in ensuring support for organic agriculture. The authors found that as the organic farm sector expands, university-based research and technical assistance, federal cost-share funds, and other private, state, and federal supports for organic farmers begin to emerge. Policies such as the Agricultural Risk Protection Act implemented in 2000 continue to support the growing organic industry and are based on the widely-held view that organic agriculture involves good farming practices and is worthy of support. This recognition has led private entities to cooperate on supporting organic agriculture in the United States.

2.5 Market Incentives

The amount of farmland under organic management has grown steadily during the last decades in the United States, as farmers strive to meet increasing consumer demand for organic food products in both local and national markets. Certified organic crop acreage nearly tripled between 2002 and 2014, from 1.3 million to 3.7 million acres. However, while organic farming continues to grow at an impressive rate worldwide, demand for organic food and beverages is far outpacing supply (Nesheim et al. 2015). While the gap between the domestic demand and supply has been filled by imports, the costs associated with importing organic foods are high – the United States spends more than $1 billion each year on organic food imports (Greene 2012). The high price of imported organic food products provides incentives for domestic producers to increase their production of organic food products, or for farmers using conventional production techniques to adopt organic agricultural practices.

Dimitri and Greene (2002) document the development of organic agriculture, and show that it has grown substantially since the emergence of organic agriculture in the 1940s and particularly so over the past two decades. A contributing factor to the growing interest in organic products is rising demand for organic food products. For example, results of a 2013 survey conducted by the Organic Consumer Association in the United States showed that 63 percent of respondents purchased organic foods and beverages on a regular basis, and 40 percent of respondents indicated expecting that organic food products would be an increasing part of their diet within one year. The respondents cited health and nutrition matters as reasons for buying organic food, followed by taste, food safety and environmental concerns. Reganold et al. (2011) found that consumer demand is also growing for products that take into account environmental and social accountability among farmers, including considerations of animal welfare, ecosystem services, worker safety and welfare and resource conservation. The authors argue that organic agriculture practices provide answers to these demands, by way of using “value-added traits” and using the notion of “sustainability” in branding of organic products. These market forces could help explain the rise in the demand for organic food – not only in the United States but also for the world as a whole.

According to the Organic Trade Association (OTA) 2015 organic industry survey, the industry saw its largest annual dollar gain ever in 2015, with an increase of $4.2 billion in sales, up from the $3.9 billion in new sales recorded in 2014. Of the $43.3 billion in total organic sales, $39.7 billion were organic food sales, up 11 percent from the previous year, and non-food organic products accounted for $3.6 billion, up 13 percent. Nearly 5 percent of all the food sold in the U.S. in 2015 was organic. The market encompasses $5.7 billion worth of organic produce sold in supermarkets, big-box stores and warehouse clubs; $4.7 billion sold by specialty and natural retailers; and $2.7 billion in direct sales, including at farmers' markets, by community-supported agriculture (CSA) projects and online. The survey indicated that the more organic producers know about the market and what consumers want; the better the organic producers, distributors, and retailers can respond to meet the needs of organic consumers.

2.6 Push Factors Associated with Moving to Organic Agriculture

The need for agricultural sustainability has played an important role in shaping not only the path of organic agriculture in the United States but also the country’s general agricultural policies, as recognized by Youngberg and DeMuth (2013). This is because organic agriculture is often viewed as being able to provide solutions to some of the problems – real or perceived – associated with conventional agricultural practices, such as environmental degradation, depletion of non-renewable resources, and food safety issues (Lampkin and Padel 1994). DeLonge et al. (2016) found that consumer demand is increasing for products that are perceived to incorporate environmental and social accountability aspects in their production, including considerations of animal welfare, ecosystem services, worker safety and welfare, and resource conservation.

With the idea of organic production in place, the impact of its activities on the ecosystem is important to sustainable agriculture. Pechrová (2014) suggested that by avoiding the use of agrochemicals, organic agriculture will help make food relatively 'free' of synthetic chemicals and thus healthier in comparison to food produced based on conventional agricultural practices. In addition, organic farming has a favorable effect on the environment, which may partially compensate for its relatively high production costs, so making subsidies available to motivate farmers to transition toward organic agriculture could be justified from a social efficiency point of view.

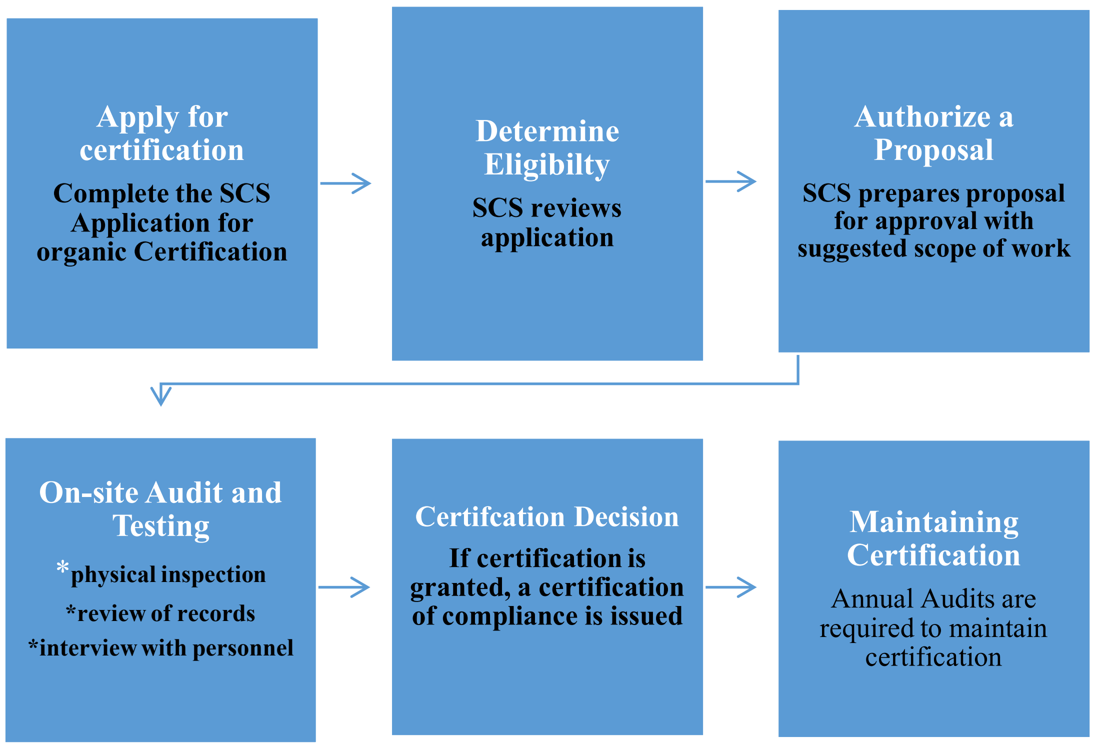
2.7 Inhibiting Factors for Organic Agriculture

Any one motivation may be sufficient to lead a farmer to consider growing organic products. Vice versa, any one constraint can potentially prevent a farmer from actually adopting organic agriculture practices. In the absence of financial support, agricultural producers may face a number of obstacles in their consideration to transition from conventional to organic production systems. These obstacles include 1) high transitioning cost; 2) low profitability; 3) lack of marketing infrastructure; 4) misperceptions and lack of organic knowledge; and 5) lack of institutional support, each of which will be tackled in the following sections.

2.7.1 High Transitional Cost

The steps involved with the conversion to organic agricultural are both time-consuming and costly. Figure 2.2 shows the possible sequence prior to achieving organic status. During the process, which usually takes a transition period of about 36 months, farmers and facilitators are restricted to sell, label or represent their products as “organic” and farmers are not allowed to use the USDA organic certifying agent’s seal without fully fulfilling the entire sequence involved in the certification. Because of this costly process, the USDA Organic Certification Cost Share Program takes it upon itself to provide organic producers and handlers with assistance. Constance et al. (2015) discussed the role of government assistance in the organic adoption process. The authors found that without government involvement, most small-scale farmers are not motivated to transition due to the associated high initial costs. To most farmers, the organic certification process requires time and expense and involves rigorous on-site production verification.

Figure 2: Flow Diagram Showing Possible Sequence to Achieving Organic Status.



Source: USDA-AMS-OID-2014.

2.7.2 Low Profitability

The perceived lack of profitability of organic systems is a key obstacle to considering a transition to organic production systems. These and other obstacles were documented by Farmer et al. (2013), who identified possible barriers such as the cost of organic production, farm labor, fertility management, yields, insect pest management, and access to organic inputs. The authors noted that organic production tends to be more labor intensive and more reliant on manual work than conventional agriculture, while yields may be relatively low. Offermann (2003) found that an important aspect of the profitability of organic farms is the opportunity to receive farm-gate price premiums for organically-produced goods over and above conventionally produced product prices. Crowder and Reganold (2015) found that when no organic premiums were available in a given year, gross returns, benefit/cost ratios, and investment in organic production were significantly lower for that particular period than when premiums were available. Therefore, motivating farmers to transition to or expand organic farming requires price premiums, and in the absence of price premiums and other financial incentives, agricultural producers will likely refrain from adopting organic production practices.

2.7.3 Lack of Marketing Infrastructure

The 2014 USDA organic survey indicates that farmers' ability to market their product is among the most important concerns when they consider switching to organic production systems. Although marketing channels for organic food have expanded in recent years, insufficient infrastructure, such as lack of established purchasing, storage, and distribution channels can still hinder growers interested in adopting or expanding their production to accommodate organic food demand.

In 2015, the organic agriculture industry experienced significant growth despite its continued struggle to meet the seemingly unquenchable consumer demand for organic products. Supply issues persisted to dominate the industry, as organic production in the U.S. lagged behind consumption. In response, the organic industry joined in collaborative ways to invest in infrastructure and education, by advocating for policies to advance the sector, and individual companies invested in their own supply chains to ensure a dependable stream of organic products for the consumer.

2.11 Lack of Organic Knowledge

Several researchers have shown that farmers' decisions are hindered due to a lack of knowledge on ways to achieve sufficient levels of profitability with organics. Most farmers assume their yields might drop below those achieved using conventional farming methods, mainly because their use of synthetic and mined fertilizers would drop. As a result, farmers who give high importance to economic concerns are less likely to adopt organic agriculture than other farmers who may be motivated by other concerns. Dobbs and Pretty (2004) noted that the lack of adequate research-based information and educational support for new transitioning farmers learning how to use organic production techniques pose strong barriers in the transition process.

2.12 Lack of Institutional Support

Many studies, including work by Constance and Choi (2010), have considered the reasons for the relatively slow growth in organic agriculture adoption. The authors found that increased institutional support could facilitate organic adoption and that its absence was detrimental to increasing the adoption of organic agriculture production methods.

Many organizations, most of which are nongovernmental organizations (NGO), have been involved in promoting sustainability and organic farming in the United States (Fransen et al. 2016). Most of these participatory extension systems were established by NGOs and aim at developing analytical skills of farmers to encourage them to take initiatives and add to their knowledge. Mostly, these institutional initiatives seek to encourage and ensure that extension workers commit to providing training and for supervision of farmers and help organize peer visits to promote experience-sharing and networking. For instance, the Center for Food Safety founded in 1997 and headquartered in Washington D.C., is a nonprofit advocacy organization that promotes food systems that are safe, sustainable and environmentally friendly. The center set up a type of social control system in 2003 to ensure that farmers comply with organic agriculture requirement in terms of managing their landscape, enhancing biodiversity, and producing food in environmental sustainable ways. This social system is also expected to ease and reinforce solidarity in organic farmers' associations and communities (Moumouni et al. 2013). To sum up, the institutional support for organic farmers can promote and ensure learning (by encouraging training, preparation and use of inputs, and sustainable farming), networking (joining farmer associations), attending meetings, facilitating outside peer visits, and ensuring mutual encouragement, (Constance and Choi, 2010).

2.8 Conclusion

This review shows that farmers' transition from conventional to organic agriculture is driven by several factors, such as the availability of subsidies and market demands forces. In addition, farmers face several barriers when transitioning. While organic agriculture has the potential to play an important role in helping to sustain the environment, little attention has been given to the role of favorable subsidies in motivating farmers to transition to organic farming. This study seeks to examine the importance of subsidies in stimulating the development of the organic agriculture sector in the United States.

CHAPTER THREE: METHODOLOGY

This chapter presents the methodological framework for conducting the study, and explains the variables used in this thesis. It also describes the statistical methods and models used to test whether subsidies influence organic adoption. Using secondary data, I test the hypothesis that policies such as organic transition subsidies are positively related to increasing the adoption of organic agricultural practices. The analysis utilizes the statistical software Stata, JMP and Simetar to provide summary statistics, conduct correlation analyses and perform regressions.

3.1 The Adoption Decision

The adoption decision of a new technology is essentially a choice between two alternatives, the traditional technology and the new one. As such, choice models developed in consumer theory have been used to motivate adoption decision models. In this context farmers are assumed to make decisions by choosing the alternative that maximizes their perceived utility (Fernandez, 1998). Thus, a farmer is likely to adopt if the utility of adopting, I_1*, is higher than the utility of not adopting, I_0*. However, only the binary random variable I (taking the value of one if organic agriculture practices are adopted and zero otherwise), observed as utility $I*$, is a latent variable and as such is treated as a random variable.

In the context of the adoption of organic agriculture, $I_j * = V_j + e_j$, where V_j is the systematic component of $I*$, related to the utility of adopting $(j = 1)$ and not adopting $(j = 0)$. Assuming a linear utility function, the utility of adopting is $I_1* = \gamma_1 Z + e_1$, and the utility of not adopting is $I_0* = \gamma_0 Z + e_0$ where γ is the parameter vector and the stochastic component e_j accounts for unobserved variations in preferences and errors in perception and optimization by the farmer.

3.2 Empirical Model and Estimation

The empirical model and estimation are based on Lohr and Salomonsson's (2000) work, but with a few modifications. Their model suggests that the utility of a farmer adopting organic agriculture should be greater than that associated with the /conventional production methods, so the adoption equation is:

$$I_1* = {}_{\gamma 1}Z + e_1 > I_0* = {}_{\gamma 0}Z + e_{0.}$$

The major reason for the modification is that the previous authors used primary data, which enabled them to accurately capture individual farmers' decisions to convert to organic production methods with the help of subsidies. To derive a testable model, we assume: (a) the adoption of organic agriculture is dependent on organic policies or subsidies offered, (b) income from organic agriculture is due to increasing consumer demand, which induces the adoption of organic agriculture, (c) the probability that farmers will adopt organic agricultural practices is higher if they receive these incentives or subsidies than without them, and (d) due to cost minimization created by these organic subsidies, farmers' indirect utility derived from adopting organic practices is greater than without the assistance of subsidies.

Based on these assumptions, the probability P that a given farmer adopts organic agriculture practices or not is given by: $P\ (I_J* = 1) = f\ (S_i + Inc_i\ ;\ A_i) + \varepsilon_{j1} > P\ \ (I_J* = 0) = f(S_0 + Inc_i\ ;\ A_i) + \varepsilon_{j0,}$ where f denotes the cumulative normal distribution. If the disturbances (e) are independently and normally distributed, then their differences $(e_0 - e_1 = \mu)$ will also be normally distributed and the probit transformation can be used to model the farmer's adoption decision. In the preceding equation $(I_J* = 1)$ represent the probability that organic agriculture is adopted in a given period and $P\ (I_J* = 0)$ indicates the situation when organic agriculture isn't adopted in a given period. The variable Inc_i represents all other income generated from organic agriculture in a given period and A_i represent all other behavioral variables that may affect the decision to adopt organic agriculture.

3.3 Modelling the Impact of Subsidies on the Adoption of Organic Agriculture

To examine the impact of subsides on the adoption of organic agriculture, we specify that: (i) the outcome of a utility maximizing choice reflects the farmers' decision to transition toward adopting organic practices; (ii) an individual farmer's indirect utility function associated with adopting organic agriculture depends on the subsidies offered; (iii) farm income depends on sales, and (iv) other behavioral characteristics and institutional factors that affect adoption decision. Given the utility maximizing equation:

$$\Delta Orgacrge = f\,(1, S_i + Inc_i; A_i) + \varepsilon_{j0} \qquad (1)$$

where a farmer's utility derived from adopting organic agriculture is represented by positive changes in organic acreage, S_i represents organic subsidies available, Inc_i denotes the income obtained from producing organic products, and A_i indicates other behavioral characteristics and institutional factors that affect the adoption of organic agricultural practices.

$$\Delta Orgacrge = f\,(0, Inc_i; A_i) + \varepsilon_{j0} < 1 \qquad (2)$$

Equation 2 shows that the marginal utility of farmers adopting organic agriculture or increasing their organic acreage is less than 1 when the adoption of organic practices is not related to the subsidy which is designated by 0.

$$\Delta Orgacrge = f\,(1, S_i + Inc_i; A_i) + \varepsilon_{j1} > \Delta Orgacrge = f\,(0, Inc_i; A_i) + \varepsilon_{j1} \qquad (3)$$

Consequently, Equation 3 shows that the indirect utility derived from the adoption of organic practices with the subsidy is greater than without it. In the equations above, ε_{j1} and

ε_{j0} represent the random factors that influence the indirect utility function. These random variables are independent and identically distributed random variables with zero means.

3.4 The Utility Difference Model

The following equation (4) shows that if the expected differences between the two utility functions in equations 1 and 2 is greater than zero, then an organic subsidy is needed to stimulate farmers' decision to adopt organic agriculture production methods.

$$\Delta Orgacrge = \beta f\,(Inc_i, S_i, A_i) + m_i \qquad (4)$$

Note, the decision of interest here is solely to identify if the subsidy has a significant influence on adopting organic agriculture practices. The functional form that depends on observed explanatory variables is denoted by $f\,(.)$ and β denotes the vector of estimated parameters. Similar to the error term in the earlier equation, m_i represents all other unobserved factors that influence if a subsidy is needed for the adoption of organic agriculture. Since the random variables ε_{j1} and ε_{j0} are independent and distributed with zero means, the difference in the error terms of the indirect utility function is defined as ε_{j1} - ε_{j0}.

One of the most important determinants of the transition to organic agriculture is ensuring an easy conversion process. Most economic research shows that a high percentage of farmers with a low marginal cost of conversion or a high marginal benefit would convert without the need for subsidies. However, according to Lohr and Salomonsson, there is no one indicator of ease of conversion. This means that the availability of subsidies must be considered important and highly necessary if farmers respond to it positively as an incentive for conversion.

3.5 Indirect Utility Function

The specification of the indirect utility function to assess the objectives of this thesis is as shown in equation 5:

$$\Delta Orgacrge = \beta_0 + \beta_1 \mathrm{Inc_i} + \beta_2 \mathrm{S_i} + \beta_2 \mathrm{A_i} + \mathrm{m_i}, \quad (5)$$

Where $\Delta Orgacrge$ denotes the change in the adoption of organic agriculture, Inc_i denotes the income from organic agriculture, S_i represents organic subsidies, and A_i indicates other behavioral characteristics and institutional factors that affect the adoption of organic agricultural practices. By specifying the components of S_i and A_i, we will be able to test which factors influence the adoption of organic agriculture using the OLS regression equations below:

- Δ Orgacrge = $\beta_0 + \beta_1$ * fedsub + β_2 * Orgsales + β_3 * Orgprogm+ β_4 * Orgcertcost + $\beta 5$ * Orgcertfms+ β_6 * Nocsp + m_1 (6)
- ΔOrgacrge= $\beta_0 + \beta_1$ * Equipfund + β_2 * Orgsales + β_3 * Orgprogm + β_4 * Orgcertcost + β_5 * Orgcertfms + β_6 * Nocps + m_2 (7)
- ΔOrgacrge= $\beta_0 + \beta_1$ * Otcap + β_2 * Orgsales + β_3 * Orgprogm+ β_4 * Orgcertcost + β_5 * Orgcertfms + β_6 *Nocps+ m_3 , (8)

Where variables *fedsub, Equipfund,* and *Otcap* represent S_i from equation *(1),* and are explained in Table I. All other variables are elements of the vector A_i. Mosier and Thilmany (2016) found that the adoption of organic agricultural practices depends on a variety of factors, such as structural and economic characteristics. The authors also found that structural characteristics such as economies of scale, ownership structure and family owned farm businesses organization were vital considerations for adopting organic agriculture practices. However, a growing number of studies, especially on the profitability of organic agriculture, stresses the importance of motivating farmers in their decision-making process when adopting organic practices. Based on the availability of data, we consider both economic and non-economic factors in this study.

3.6 Variables

To assess the extent to which the adoption of organic farming is influenced by targeted subsidies, we use data on eight independent variables to test the internal determinants of organic adoption growth. Due to the unavailability of data on selected variables, some factors are not included, though they might have influenced results. For instance, the USDA does not have data on marketing/sales outlets. Table 1 provides a description of the variables, and Table 2 provides summary statistics of the variables included in the analysis.

Table 1: Description of the Variables

Model Variable	Variable	Description	Units
Dependent Variable	Orgacrge	Acres of organic cropland operated on in the selected geographical area of the study.	1,000 USD
Independent variables	Nocsp	Number of farms enrolled in organic cost-share programs.	count
	Fedsub	Federal subsidies paid to organic farmers in each state. Each farmer qualifies for such funding as long as it is certified and has already been through the 3 years of transitioning phase.	1,000 USD
	Equipfund	Environmental Quality Incentive Program funds provided to eligible applicants and land for supporting the environmental sustainability of organic operations.	1,000 USD
	Otcap	Organic Conservation Technical Assistance program fund provided through Natural Resource Conservation Service (NRCS) to farmers to facilitate wider adoption of organic farming and to improve consumer access to organic products.	1,000 USD
	orgsales	Derived from the sale of organic products by state.	1,000 USD
	orgcertcost	Organic certification costs incurred each year, including organic application fees, annual inspection fees, training and educational fees, and annual certification fees.	1,000 USD
	Orgcertfms	Number of farmers fully converted or in conversion to organic methods from 2002 to 2012.	count
	orgprogm	Number of certified organic farms or business operations that sell, label or represent products as organic.	1,000 USD

Organic acreage serves as the dependent variable in assessing the impact of subsidies on organic adoption. Organic acreage represented by the variable “Orgacrge” is calculated by summing up the yearly acres of organic acreage in each state data in 2002, 2007, 2008, 2010, 2011, 2012, and 2014. The U.S. Department of Agriculture‘s organic database could not account for missing years because organic surveys are not conducted yearly.

In order to capture the effect of the adequacy of technical and economic advice on the organic agriculture adoption rate, the number of organic farms in each state enrolled in cost-share programs is included. The "Nocsp" variable represent the likelihood of farmers converting to organic agriculture due to acquiring knowledge and education on organic agriculture. Knowledge of the application of organic technology and marketing is considered particularly important to farmers who are new to organic agriculture. The significance of including Nocsp is to suggest that the availability of organic education and research has the potential of helping farmers maximize their resources when converting to organic agriculture.

The potential to sell organic products can influence the adoption of organic agriculture. Rigby and Young (2001) cited marketing opportunities and market incentives as being leading motives for adopting organic techniques. The availability of marketing opportunities can substantially reduce the need for organic subsidies received by farmers in converting to organic agriculture. According to Klonsky and Greene (2005), increased demand for organic products affects organic adoption because it will lead to additional marketing outlets, and will increase the number of organic products in these outlets and finally increase the entry rate of mainstream food manufacturers into organics. This ripple effect will eventually cause farmers to respond to such demands by adopting organic agriculture practices.

The number of farmers converted or in the process of conversion to organic production is also considered an important factor. The USDA began tracking the number of certified organic producers in 2002. In 2014, there were 19,474 organic farmers in the United States which represented a 250% increase since their initial count in 2002, suggesting that practices are on the rise, as discussed earlier.

Organic certification costs are represented by the variable "Orgcertcost" and are included as one of the independent variables. Such costs represent an important impediment to converting to organic agriculture. These costs normally include the organic application costs, soil management and rotational costs and inspection costs. Most farmers believe organic certification is cumbersome, expensive and most importantly time consuming, so they may hesitate to convert to organic agricultural practices.

Organic subsidies are grouped into three major variables; "Equipfund, Fedsub and Otcap". While there is widespread interest in organic agriculture, it still represents only a small portion of total utilized agricultural area in the United States. To most farmers, adopting organic practices is considered rather risky because this mode of farming presents uncertainties in the areas of input costs and output (yields). Thus the switch to organic production is often perceived as a risky adventure to these farmers as they are uncertain about almost every aspect of organic farming. To overcome impediments to adoption, the U.S. promotes the practice mainly through subsidy-driven policies.

Table 2: Descriptive Variable Statistics

Variables	***Mean***	***Standard Deviation***	***Min***	***Maximum***
Orgacrge (1000)	136,657	154,725	211	951
Nocsp (count)	140	191	10	1,052
Fedsub (1000)	117,805	65,327	4,384	309,606
Equipfund (1000)	23,012	20,388	2,776	100,187
Otcap (1000)	13,891	5,928	7,336	36,460
Orgsales (1000)	135,247	301,560	103	2,231,000
Orgcertcost (1000)	491	664	36	5,527
Orgcertfms (count)	443	550	35	2,805
Orgprogm (counts)	531	666	45	4,462

Units of all the variables are in thousands except organic farms and organic programs which are in numbers.

3.7 Hypotheses

Using state-level data collected for the North Central U.S. states, we test specific hypotheses related to factors affecting the necessity of subsidies in the conversion and adoption of organic agriculture in general. Four specific null hypotheses were formed.

(a) *Hypothesis I* – the null hypothesis is that there is no significant difference in the adoption of organic agriculture with the availability and acquisition of organic subsidies by farmers, while controlling for other determinants. The alternative hypothesis is that organic subsidies received by or available to farmers must be viewed as being important since farmers respond to this incentive to convert. Therefore, this financial incentive is expected to be positively related to the adoption of organic agriculture.

(b) *Hypothesis II* – the null hypothesis is that there is no significant growth effect in the adoption of organic agriculture associated with an increasing demand for organic products while controlling for other relevant determinants. On the other hand, increasing the sales of organic products is considered the biggest incentive to farmers in their decision making process, and therefore is expected to positively correlate with the adoption of organic adoption.

(c) *Hypothesis III* – the null hypothesis is that there is no significant effect on the adoption of organic agriculture from the acquisition of adequate information and knowledge of organic practices, while controlling for the other relevant determinant of adoption of organic agriculture. It is expected that passive awareness or organic agriculture should positively affect adoption, even without subsidies.

(d) *Hypothesis IV* – the null hypothesis is that the existence of transitioning costs does not have any significant effect on the adoption of organic agriculture while controlling for other relevant factors. On the other hand, certification costs continue to pose a dilemma to farmers when transitioning to organic agriculture, therefore this variable is expected to be negatively related to conversion to organic agriculture.

Given the available data, running multiple OLS regressions may cause statistical problems such as perfect collinearity, heterogeneity and possibly endogeneity. Therefore, tests for heterogeneity and collinearity are carried out in order to check for deviations from the underlying assumptions about statistical properties required for consistency and robust inference. We test for heterogeneity by running a "Breusch-Pagan test." The above processes help in making unbiased analysis and enhancing asymptotic efficiency in the results.

CHAPTER 4: DATA AND DESCRIPTIVE ANALYSIS

4.1 Global Importance of Organic and Sustainable Agriculture

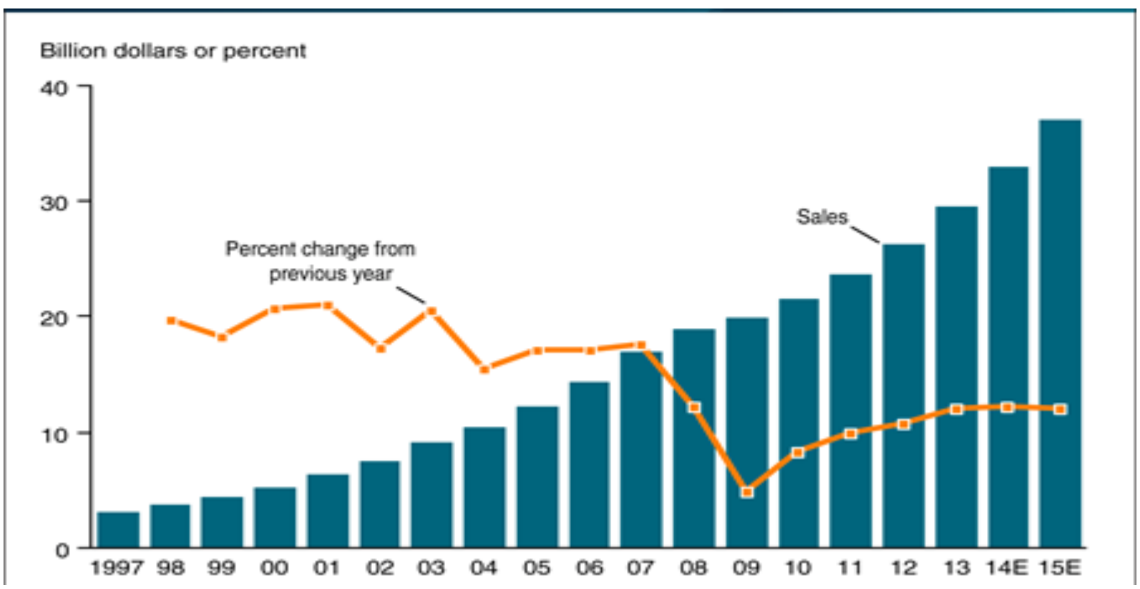
Organic farming is practiced worldwide and plays an increasingly important role in modern agriculture, as measured by the number of farmers turning to certified organic farming systems. Despite long and complicated processes and practices involved with moving toward organic agriculture production systems, its use has grown substantially since emerging in the 1940s (Dimitri and Greene 2000). Nevertheless, it is an open question whether organic agriculture will continue to expand in the future, and if so, what will drive its growth. Some researchers (e.g. Pinstrup-Anderson et al. 1999) contend organic agriculture does not provide a viable solution for improving food security because it occupies only one percent of global cropland, but others (e.g. Crowder and Reganold 2015) view organic agriculture as an important tool for achieving global food security. If the latter view is valid and organic agriculture can help enhance food security and food system sustainability, it is critical to identify which policies are effective, and which ones are impediments for encouraging agricultural producers to move toward organic production.

4.2 Global Organic Demand and Supply

Organic agriculture may have the potential to contribute to increasing the global food supply and reduce some of the negative environmental impacts of conventional agriculture. People throughout the world produce and consume organic food and beverages. According to the International Federation of Organic Agriculture Movement, in 2014 the United States ranked fourth in the world in terms of the production of organic products, with sales valued at 32.2 billion U.S. dollars, and corresponding to about four percent of total U.S. food sales. The United States is ranked as the country with the third largest organic crop area, and with

Australia as the first and Argentina the second largest combined, these three countries have 73% of the world's organic agricultural land (Niggli et al. 2016). The production of certified organic products continues to increase in response to surging consumer demand, even though organic food products as a share of all food products remains relatively small. Figure 4.1 shows that although the annual growth rate of organic food sales fell from the double-digit range in 2009-10 when the U.S. economy slowed, annual growth rates since 2011 have rebounded to 10-12 percent, and are more than double the annual growth rate forecast for all food sales (Jaenicke et al. 2015).

Figure 3: U.S. Organic Food Retail Sales



Source: Economic Issues in the Coexistence of Organic, Genetically Engineered (GE), and non-GE Crops

The growth in the organic food market did not come without challenges to the supply chain. U.S. producers struggle to keep pace with the growing consumer demand for organic products, both domestically and internationally, and face increased competition from foreign producers. In addition, increased global population growth and food supply pressures have led to concerns about putting too much of the arable land under sustainable production practices. Nevertheless, Halweil (2006) believes that a large-scale shift to organic farming would not only increase the world's food supply, but might be the only way to eradicate hunger. The author also expressed the belief that organic agriculture has the ability to restore the ecosystem because it does not deplete the soil of its nutrients, so the focus on organic agriculture as a sustainable approach to agricultural production is justified, as are research efforts to motivate farmers to adopt organic agriculture production methods. Whether or not this view is widely shared, there is broad agreement on the need to build a secure supply chain that can support demand, which goes hand-in-hand with securing additional organic acreage, by encouraging farmers to farm organically.

4.3 Trends in Organic Agriculture

U.S. crop acres under USDA-certified organic systems have grown rapidly since the implementation of the NOP in 2002. The number of organic acres was nearly 2.8 times greater in 2014 than in 2002, and increased from about 1.3 million to almost 3.7 million acres (Coleman-Jensen et al. 2014). Among the major field crops using organic production methods whose acreage increased substantially during the same period were corn, soybean and wheat. For instance, Table 3 shows that organic corn production increased the most in the United States, from about 96,000 acres in 2002 to 234,000 acres in 2011. Between 2011 and 2014 alone, acreage committed to the production of organic corn increased by 24%. Certified organic wheat made up the largest number of organic acres between 2002 and 2011; it increased from 225,000 acres in 2002 to a peak of about 345,000 acres in 2011. Certified organic soybean acres increased from 120,000 acres in 2002 to about 240,000 acres in 2011. In addition, between 2005 and 2013, the amount of certified organic pasture fluctuated from year to year but overall expanded by nearly 80% to 3.1 million acres in 2011. Much of the increase in organic crop production is associated with a rapidly growing demand for organic products, which increased at an average rate of 20% each year since 1990, with retail sales reaching $51.8 billion in 2014 (Spark, 2014).

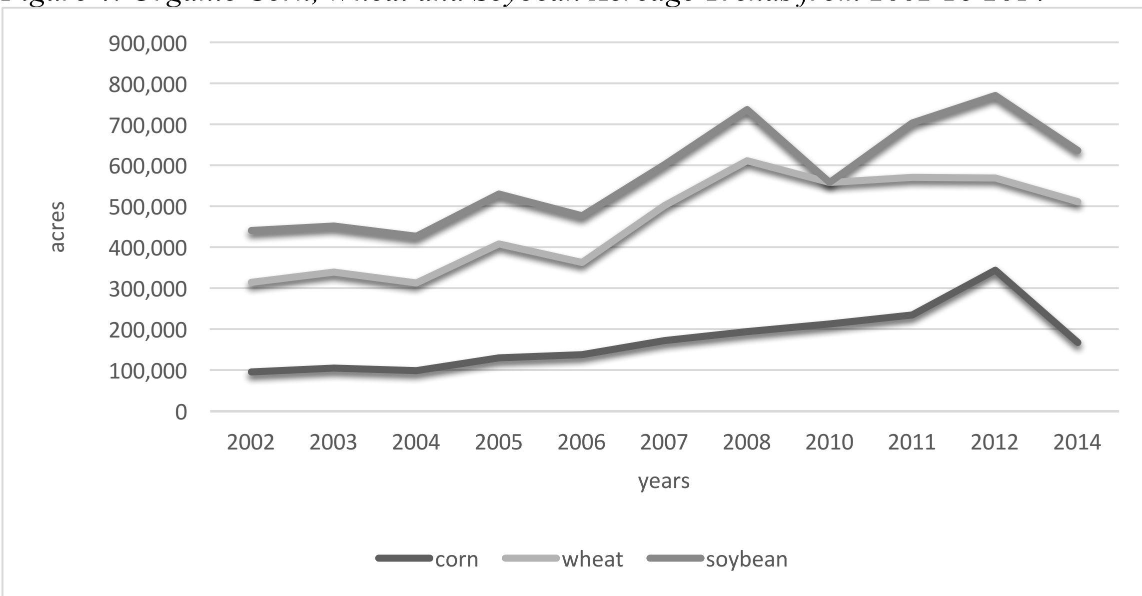
Table 3: Trends in U.S. Top Leading Organic Crops

Year	**Corn (acres)**	**Wheat (acres)**	**Soybean (acres)**
2002	96,270	217,611	126,540
2003	105,574	234,221	112,403
2004	99,111	214,244	114,239
2005	130,672	277,487	122,217
2006	137,522	224,762	114,581
2007	172,112	329,688	100,390
2008	194,637	415,902	125,621
2010	213,035	345,041	132,468
2011	234,470	335,829	132,411
2012	344,883	224,329	200,876
2014	167,702	343,793	125,000

Source: Census of organic survey by USDA/ERS.

Figure 4 depicts corn, wheat and soybean acreage trends from 2002 to 2014. The figure shows that soybean acreage committed to organic agriculture practices grew more than acreage dedicated to organic wheat and corn acres.

Figure 4: Organic Corn, Wheat and Soybean Acreage Trends from 2002 To 2014



Source: Census of organic survey by USDA/ERS.

4.4 Data

The quantitative methods used in this research include conducting an analysis of annual state-level data from 2002 to 2014. Based on the availability of data and the model described in Chapter 3, nine variables are utilized in testing the research hypothesis. Data on both independent and dependent data were collected from archived materials, and government and academic sources. To assess the extent to which organic production methods were adopted as a result of subsidies provided, only data pertaining to certified organic agriculture were used to allow for drawing proper inferences and conclusions.

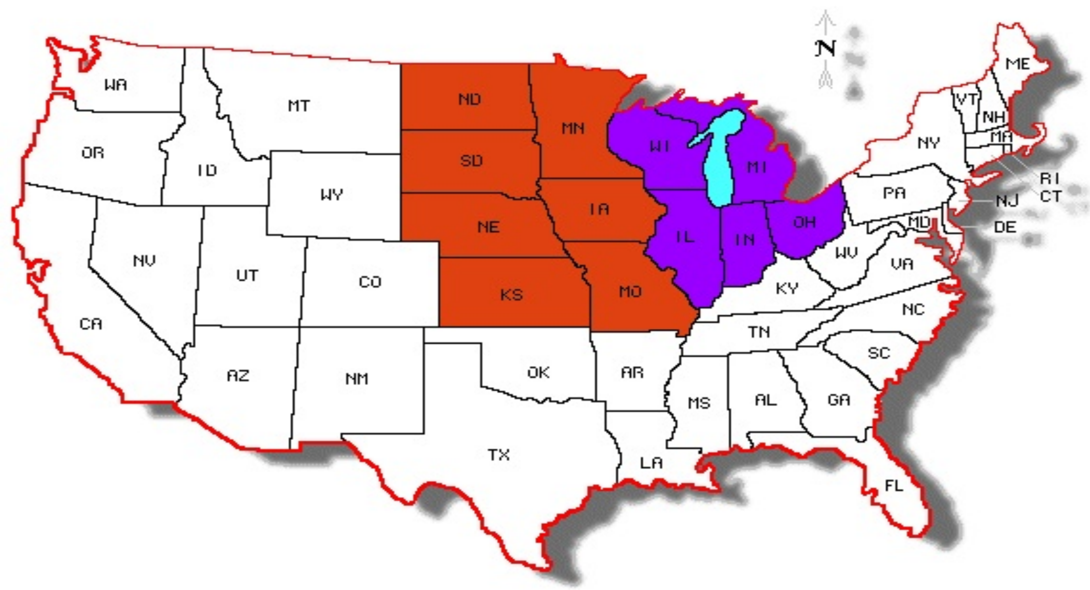
4.5 Main Sources of Data

Our analysis uses secondary data from two key sources. First, the USDA Organic Agriculture database from the Agricultural Resource Management Survey (ARMS) over the 2000-2014 period provided data on organic acreage, cost of production and subsidies. It is part of a larger ARMS database, which provides information on financial conditions, production practices, resource use, and economic well-being of America's farm households. These data provide an opportunity to study farmers' responses to policies. The second data source is the USDA's National Agricultural Statistics Service (NASS), which conducts its Organic Production Survey in conjunction with USDA's Risk Management Agency (RMA)-Collaborative Organic Censuses. Data from this source include marketing practices, organic sales and production expenses.

4.6 Geographical Area Considered

Consistent with the objectives of the study and in accordance with the literature, our analysis is based on data collected in North-Central U.S. States (IA, IL, IN, KS, MI, MN, MO, NE, ND, OH, SD, and WI); see Figure 4.3. Though farmers in other states are also involved in practicing organic production, these states have relatively high concentrations of certified organic farmers and experienced a relatively large increase in organic acreage over the past decade. For example, on average there are fewer than 500 certified operations per state in Southeastern states, compared to over 700 certified operations per states in the 12 North-Central states.

Figure 5: States in the Study Area –North Central States



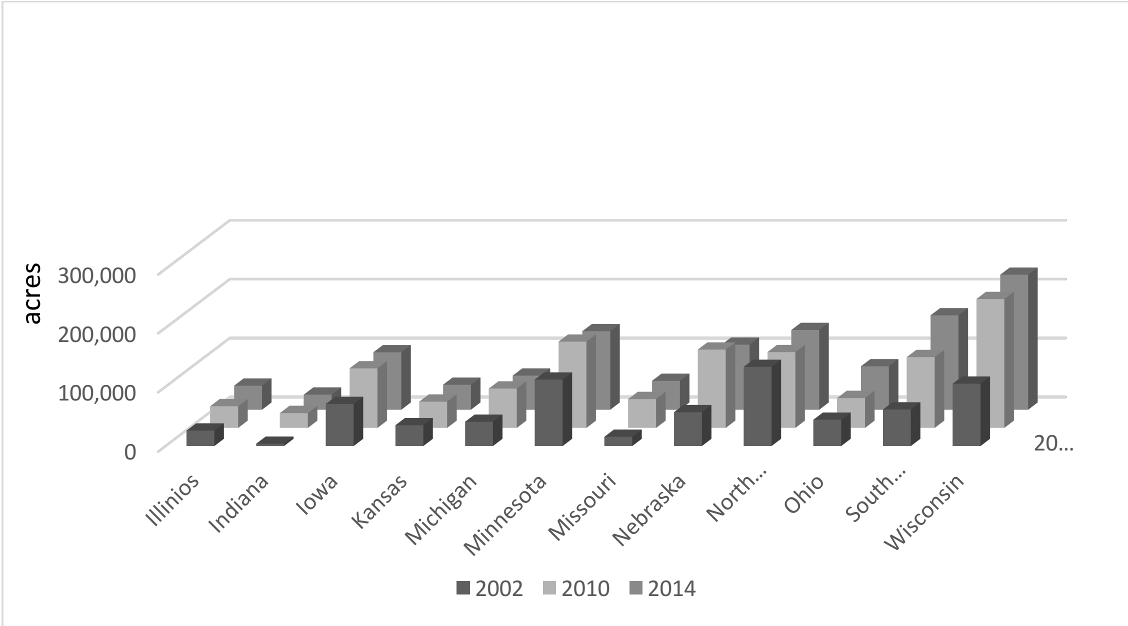
Sources: The geography of the Midwest.

4.7 Acreage Size

Acreage data from 2002 to 2014 were obtained from the Organic Production Survey conducted by NASS and RMA. This is the third organic production and practices survey NASS conducted at the national level; the previous data pertain to the 1997-2011 Certified Organic Production Survey.

U.S. organic acreage has increased rapidly since the establishment of the Organic Foods Production Act in 1990, which mandated the creation of the National Organic Program (NOP) and the passage of uniform organic standards. Figure 4.4 shows the increase in certified organic acreage. This increase is due in part to the growing federal spending on organic agriculture programs associated with the farm bill.

Figure 6: Study Area Acreage Size Analysis



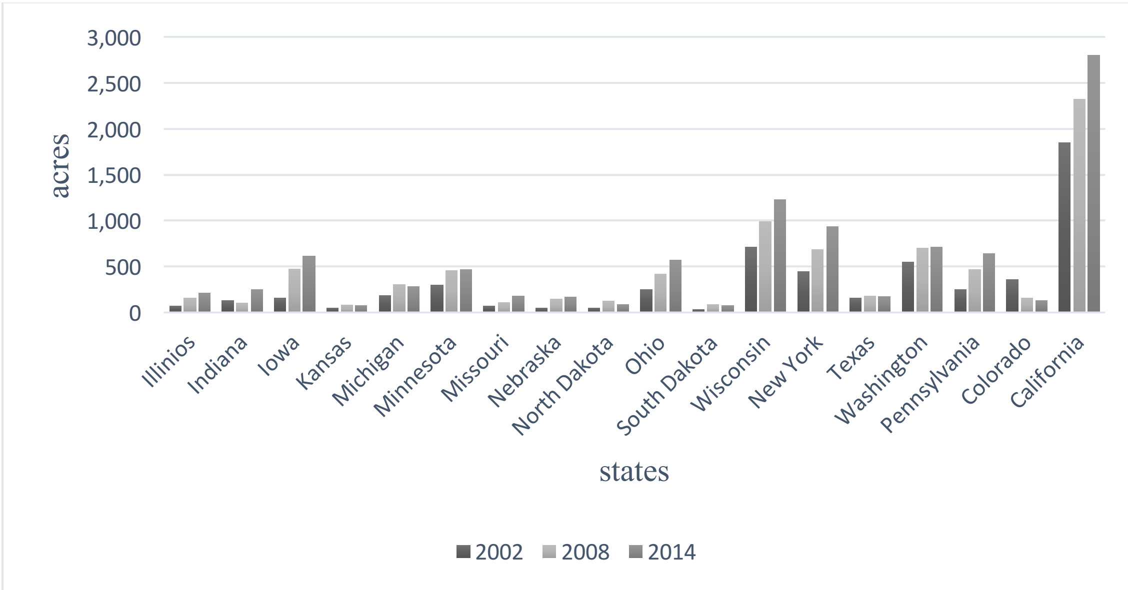
Source: Census of organic survey by USDA/ERS.

4.8 Farm Size

As stated earlier, the number of acres devoted to organic production has increased in recent decades. The organic conversion rate among producers who turned idle arable land into cropland between 2002 and 2014 was 22% for NC states, versus and 16.9% for the U.S. as a whole. When farmers convert land into organic production, they may also turn conventional cropland into organic production.

Granatstien (2003) suggest that the issue of scale has always been part of the organic discussion. According to the author, the most diligent organic farmers in America are unbothered by the size of farmland they convert initially, because innovations at one organic system often influence sustainability in the other. Figure 7 shows the increase in farm size operated by organic farmers for most of the 12 states.

Figure 7: Organic Farm Size



Source: Census of organic survey by USDA/ERS.

Table 4 lists the average farm size by state for the study area, taken from the 2002-2014 Census of Agriculture. In 2014, the North Central region had 22,877 farms that operated 7,815,730 organic acres, resulting in an average size of 342 acres of organic land per farm, which compares to an average size of about 5,300 acres for all farms in the region. The relatively small size of the organic operations is in part due to general characteristics associated with organic farming discussed earlier, particularly concerning labor intensity.

Table 4: Study Area Summary Statistics, 2014

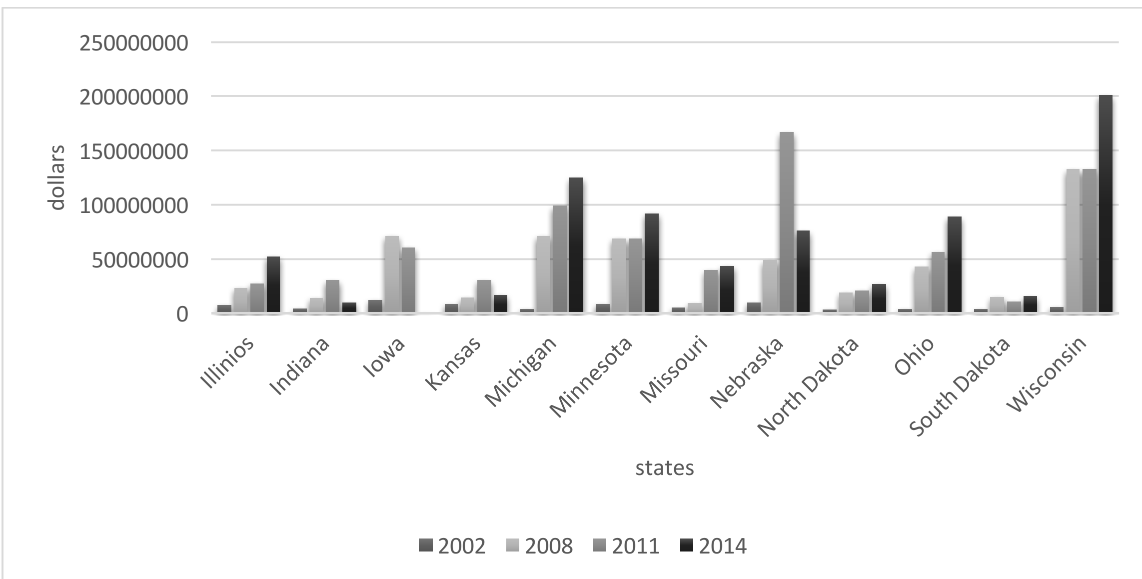
NC States	Organic cropland Operated in (1000 acres)	Farms (numbers)	Average Farm Size (acres)
Illinois	240,296	1,029	234
Indiana	157,671	1,170	135
Iowa	690,377	2,913	240
Kansas	293,219	488	601
Michigan	416,515	1,851	225
Minnesota	985,608	2,955	352
Missouri	294,938	837	1,008
Nebraska	856,911	850	1,658
North Dakota	1,117,353	674	145
Ohio	399,420	2,756	1,909
South Dakota	971,623	509	203
Wisconsin	1,391,799	6,845	342
Totals	7,815,730	22,877	342

Source: Census of organic survey by USDA/ERS.

4.9 U.S. Organic Market Forces

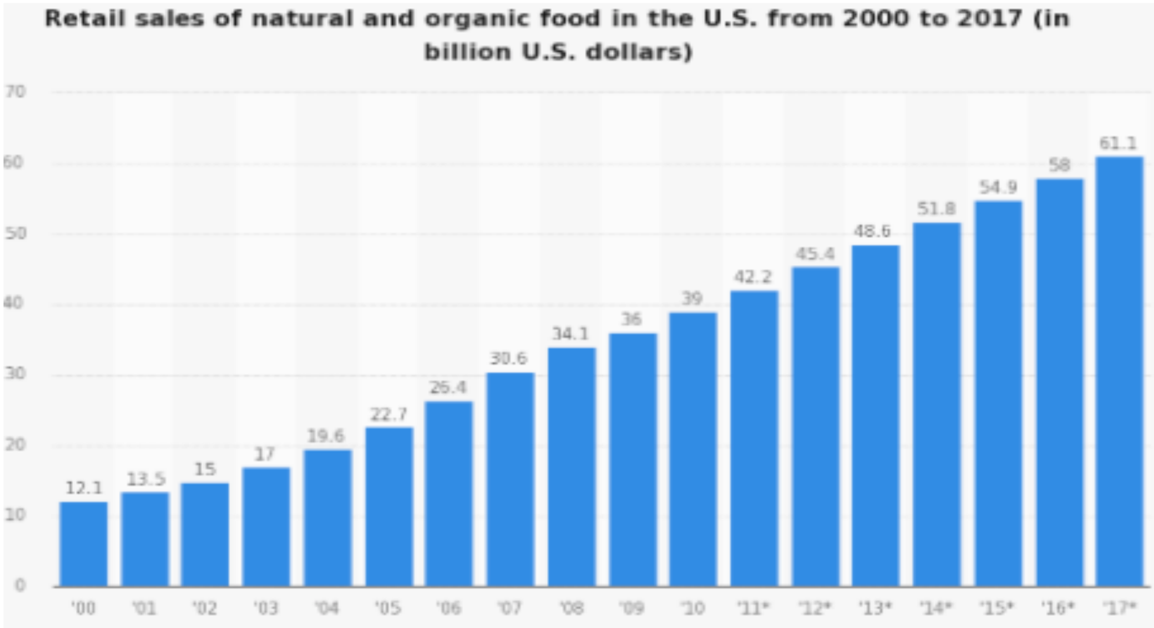
Figure 8 shows the market demand for organic products for the selected years. Market demand increased in the North-Central states between 2002 and 2014. Kroger and Walmart, two of the top food retailers in the United States in 2014, announced organic initiatives including to expand the number of organic products they sell. This could further incentivize conventional farmers to transition to organic agriculture. While profit-driven factors continue to induce the organic industry to grow, recent years have seen an increase in the number of health-conscious, informed, and demanding consumers, which has led to an increase in the demand for healthy, safe and environmentally-friendly food products. The food industry has responded to this increased demand by offering a wider range of quality-differentiated products, including organic food. The projected increase in sales of organic products in Figure 9 reflects an increasingly positive attitude among consumers toward the consumption of organic products in the United States.

Figure 8: Proportions of Sales by States, 2002-2014



Source: Census of organic survey by USDA/ERS.

Figure 9: Organic Food Sales in the United States from 2000 To 2014



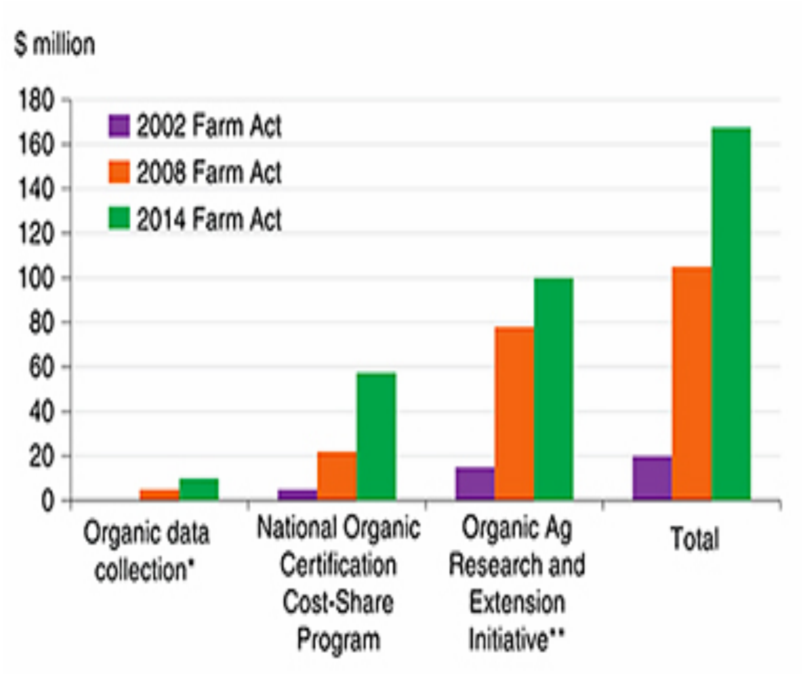
Source: fibl.org: Media release of FiBL and IFOAM - Organics International of February 2016.

4.10 Subsidies/ Cost of Production

Conventional farmers who wish to transition to organic methods often require funding to convert their production systems, because the transition process is quite expensive, in part due to high input costs. Both the government and private organizations provide support to transitioning farmers in the form of funding for organic research, financial assistance for conservation practices, certification cost-share assistance, and data collection. Funding for these and other policy instruments was increased in the 2014 farm bill, which continued the support for the organic sector that began in 2002 when the USDA implemented national organic standards. Funding was also expanded for USDA's National Organic Program, which regulates organic standards, labeling and certification.

In the late 1990s, as demand for organic products grew, a need arose for national organic standards. As a part of the 1990 farm bill, the Organic Foods Production Act that included the National Organic Program (NOP) was passed. The goal of the NOP was to set national standards for organic production. In 2002, the NOP rule was issued establishing uniform national standards for organic goods including production and handling standards, labeling standards, and a system of USDA accreditation for independent certifiers (Fetter et al. 2002). The 2014 Farm Bill reflects shifting priorities over the past decade in which issues such as local and organic food and healthy food access have become elevated, in accordance with growing consumer demand for agricultural products produced locally and strong growth in the development of local and regional food systems (Morath 2015). Figure 10 shows a notable increase in funding for the National Organic Certification Cost Share Program, which provides subsidies to farmers for the certification fee. In 2008, this subsidy increased to $750 per farm, up from $500 per farm in 2002 (Mercier 2016). A variety of stakeholders play a role in organic agriculture, including both national and state government agencies, as well as organic certification companies, interest groups, and a large variety of producers, suppliers, and consumers of organic goods. Organic subsidies provided by the federal government are intended to help organic agriculture producers manage risks associated with organic production and profitability from year to year. Usually these support funds help curb the effect of variations that weather, market prices and other factors have on farmers when adopting organic farming practices.

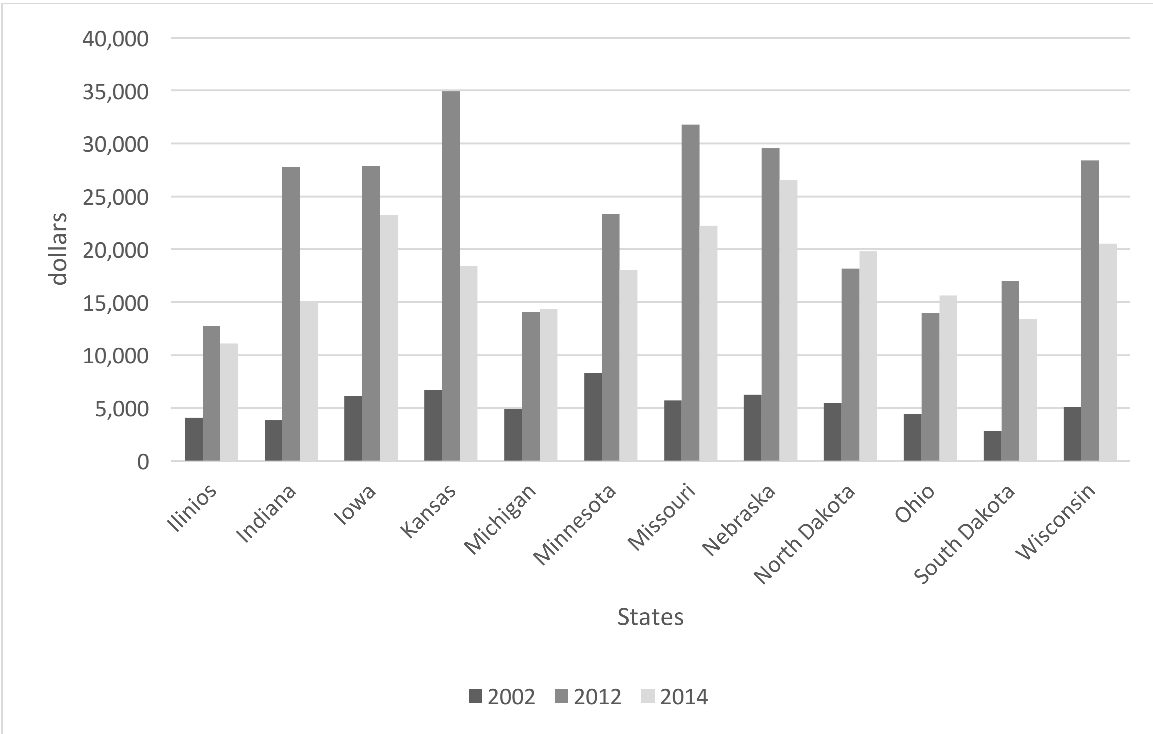
Figure 10: Mandatory Spending On Organic Agriculture, 2002-2014



Sources: McFadden et al 201.

The Environmental Quality Incentives Program (EQIP) is a voluntary program that provides financial and technical assistance to agricultural producers to plan and implement conservation practices that improve soil, water, plant, animal, air and related natural resources for agricultural production. U.S. agri-environmental programs such as EQIP seek to offset the cost of environmental regulation, so maximizing the extent to which these objectives can be achieved entails designing programs to be cost-effective. Environmental cost effectiveness has been an important criterion in the development of U.S. agri-environmental policy since the early 1990s (Santos et al. 2015). According to the authors, these financial assistance payments are provided to eligible producers to implement approved conservation practices on eligible land or to help them develop Conservation Activity Plans (CAPS) to address specific land uses. Figure 11 shows that between 2002 and 2014, all 12 North Central Region states received a considerable increase in the amount of assistance. In particular, Kansas, Missouri and Indiana saw increases of about 80 percent in 2014 relative to 2002.

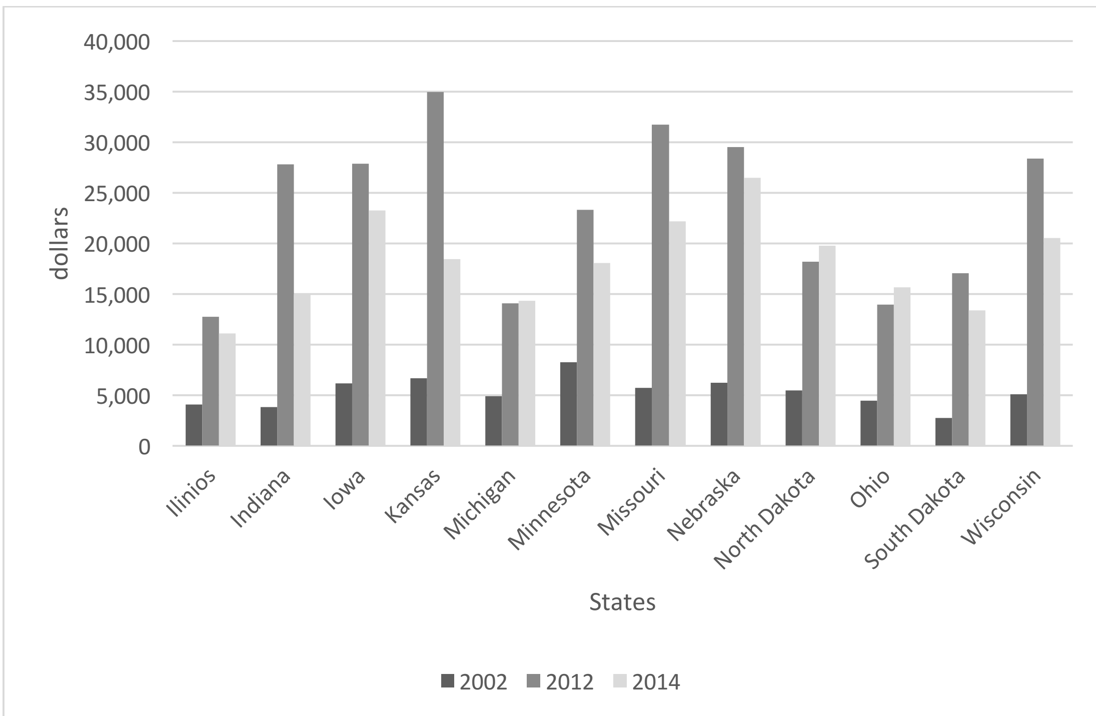
Figure 11: Trends in Environmental Quality Subsidies



Source: Census of organic survey by USDA/ARMS

Consumers want assurance that products labelled "organic" are indeed produced per organic production methods, and producers want to know that other producers also claiming to produce organic products are competing fairly. The "organicness" of a product cannot be established by looking at the harvested product or by testing it. Rather, it is ascertained through documentation and inspection of the whole production process. Federal subsidies provide the core source of funding to assist organic producers and handlers with covering the cost of organic certification. These subsidies exempt certified organic producers from having to pay for conventional commodity promotion programs, and instead allow them the option of reducing the cost involved in obtaining certification. In addition, subsidies require improvements in crop insurance for organic producers and strengthen enforcement of organic regulations. Figure 12 shows that certified organic farmers in Iowa appear to receive the largest amount of subsidies and have seen greater increases between 2002 and 2014 than other states.

Figure 12: Federal Subsidies

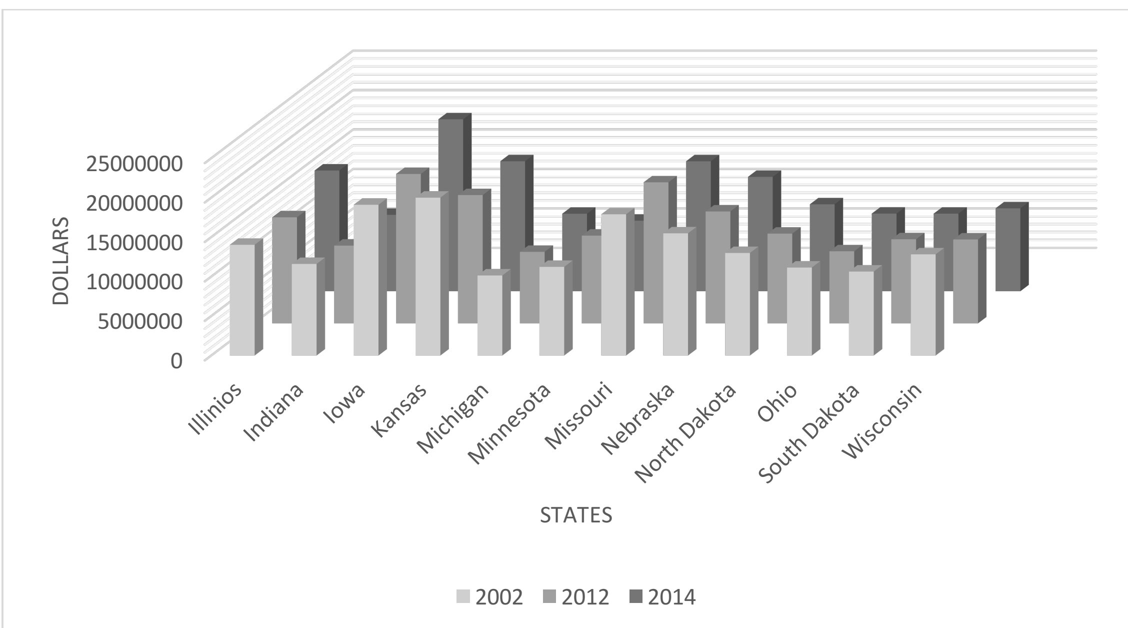


Source Census of organic survey by USDA/ARMS

As with sustainable agriculture, there is a variety of definitions of organic farming (Kennedy and Smith 1995). Kongolo (2014) refers to it as "a holistic view of agriculture that aims to reflect the profound interrelation that exist between farm biota, its production and the overall environment". The author stresses that much of the debate over agricultural sustainability includes issues of soil health and structure, the exhaustible nature of artificial fertilizers and human health, which organic agriculture addresses in its aims of production and processing.

In the United States, organic farming is considered a form of sustainable agricultural practice, so the USDA has thus far ensured that certified organic farmers continue to receive organic conservation assistance to help facilitate changes in land use as needed for natural resource protection and sustainability. These funds aid organic farmers to solve soil, water quality, water conservation, air quality, and agricultural waste management problems and reduce soil loss due to erosion. Figure 13 shows a consistent though slow increase in the distribution of these funds among the 12 states. The Organic Conservation Technical Assistance Program helps in providing soil information and interpretation to individual organic farmers and aids them in making sound decisions regarding the wise use and management of soil resources.

Figure 13: Organic Conservation Technical Assistance Program



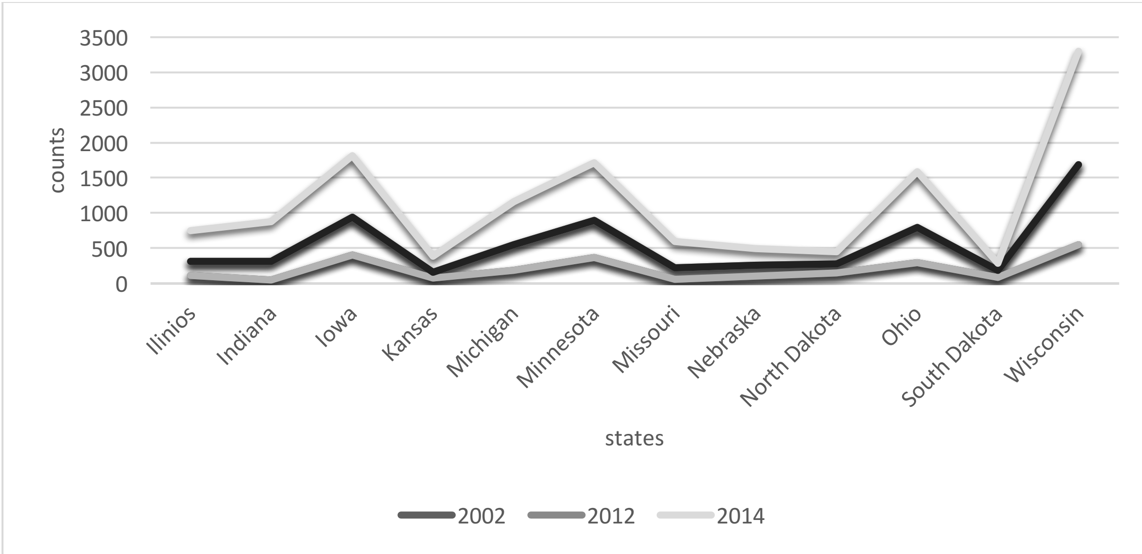
Source: Census of organic survey by USDA/ARMS.

4.11 Certified Organic Programs

To label products as being organic, farmers must obtain organic certification. Nationwide, a variety of USDA accredited independent certifying companies exist to grant such certification, which is based on a set of strict criteria about land use and agricultural practices. Certified organic operations must meet defined standards, so farms that are not USDA-certified are excluded from being recognized as organic and are not allowed to market their products as such. While it is crucial that these certified organic operations meet organic standards, a negative effect is that uncertified organic farms do not get included in research and statistical analyses of organic farms.

Organic agriculture has evolved in the United States from a small number of farmers who market locally and directly to consumers to a multi-billion-dollar agricultural sector that trades domestically and internationally. For the purpose of clarity and further development of organics in the market place, organic standards which keep evolving over the years are enforced in the United States. These standards represent an agricultural production system founded upon ecological principles that promote a whole-system approach to farming and impact on the environment. Figure 14 shows the increase in the number of organic programs between the 2002-2014 time periods. According to U.S. National Organic Program Standards (NOPS) these programs encourage practices that improve soil health, promote good sanitation measures, employ cultural practices that enhance crop diversity, and advance the control of pathogens through mechanical, physical and cultural methods. NOPS further confirms that these growing programs are expected to facilitate the development of research projects that can be applicable to a broader base of organic producers.

Figure 14: Certified Organic Program 2002-2014



Source: Census of organic survey by USDA/ARMS.

4.12 Conclusion

This chapter reviewed the variables potentially responsible for the adoption of organic agriculture practices in the United States, particularly in the North Central region. The chapter also discussed trends in the variables for the 2012-2014 period, such as the growth in the governmental and private support for the adoption of organic agriculture. There is agreement in the literature that organic subsidies and demand for organic products have been on the rise over the past several decades.

CHAPTER 5: ANALYSIS AND RESULTS

5.1 Introduction

This chapter seeks to answer the research questions stated in Chapter 1, which are, to what extent organic policies and subsidies affect the adoption of organic agriculture and which barriers farmers face in adopting organic agriculture production methods in the North-Central states. We report summary statistics, correlation coefficients between the dependent and independent variables, and regression results using STATA 14.1.

5.2 Results for Diagnostic Test

All three models show strong goodness-of-fit, as indicated by the relatively high R^2 and the χ^2 statistics, which are significant at the 5% level. The high R^2 indicates a strong relationship between our model and the response variable. In addition, the estimated coefficients are similar across different models and estimators, and they are in the expected directions. These findings indicate that the models explain a substantial proportion of the variation in the dependent variable and are well specified.

5.3 Results from Stationarity Test

The second issue concerns the results of key regression diagnostics and the performance of appropriate specification tests. To check for the data's stationarity, we conducted a unit-root test using the Philip-Peppron procedure, which provides an improvement over the Dickey-Fuller test. Once the data are identified as being stationary, OLS results are likely to be consistent.

5.4 Results from Residual Correlation Matrix

The third observation concerns the coefficients of the independent variable. The Breusch – Pagan test for independence was used to obtain the correlation matrix for the residuals in all three IUFS (Indirect Utility Function Regressions). The null hypothesis for the Breusch – Pagan test was that the equations under consideration are independent of each other and the alternative hypothesis was that the equations are not independent of each. A failure to reject the null hypothesis will mean that OLS can be used to obtain estimates for parameters without danger. A failure to reject the alternative hypothesis will permit the use of IUFS to obtain estimates for parameters.

5.5 Results for Multicollinearity

Reviewing concerns regarding multicollinearity reveals the extent to which the inclusion of one observed variable could inflate coefficients of the remaining independent variables. We test for multicollinearity correlation between predictors using the Variance Inflation Factor (VIF). The test shows that the number of organic programs (Oprogram) causes constant variance in the model. As a rule of thumb, variables with VIF values greater than 10 are excluded, as is case with the program variable. In addition, removing the variable from the model increased the goodness of fit of all models. This suggest that multicollinearity is problematic, because it can increase the variance of the regression coefficients, making them unstable and difficult to interpret. See Appendix I, II and III for test results.

5.6 Results for Heteroscedasticity

Due to the fact that a single model including all three subsidies resulted in perfect multicollinearity, we ran three separate models to analyze the effect of each subsidy on the adoption of organic agriculture. With respect to an FIML (asymptotically efficient estimator for simultaneous models with normally distributed errors) model, heteroscedasticity tests were significant at the 5% level.

The Breusch – Pagan test Statistics revealed that models were fairly homoscedastic. This indicates that the assumptions underpinning the FIML approach are not substantially violated, so these test estimates are preferred. Robust standard errors are used to address any remaining heteroscedasticity.

Finally, the most striking results are the consistently positive and significant effects of the subsidies observed in all three models, suggesting all three subsidy variables – Equipfund, Otcap and Fedsub correlate positively with the adoption of organic agriculture practices. The consistently negative coefficient of organic certification costs indicates that we can reject the null hypothesis that there is no significant difference in organic adoption between certified and non-certified farmers. This suggests there is a negative relationship between organic certification costs incurred and farmers' willingness to adopt organic agriculture. The results from getting adequate technical advice from enrolling in cost-share programs are also significant. This implies that there is a measureable gain from the adoption of organic farming when farmers enroll in cost-share programs, holding all other variables constant.

5.2 Empirical Findings

To conduct our statistical analyses, we applied inferences of three statistical model specifications, differing only by type of subsidy considered. Tables 6, 7 and 8 report the results of the three models, with each model containing the same set of explanatory variables except the subsidy variables. Before going through each model result, provided below is an overall statistical comparison of the three organic adoption models.

The relative performance of the three models is compared by examining their R^2 values. First, adoption of organic agriculture induced by the Environmental Quality

Incentive Fund (Equipfund) has the highest R^2 (78.15 percent), and indicates that the independent variables in Model 2 explain 78 percent of variation in the adoption of organic agriculture. All the explanatory variables are statistically significant at the 5 percent level in Model 2, except organic sales which is only significant at the 10 percent. Model 3 has the same set of statistical significant explanatory variables, with a maximum rescaled R^2 value of 76.59 percent, somewhat lower than in Model 2. Finally, Model 1 has a considerably lower R^2 value than the other two models. These results suggest that model 2 is the strongest and Model 1 is the weakest of the three models discussed in this section.

Summary statistics of subsidies (the main independent variables) are listed in Table 5. The table shows that the amount of funds associated with the federal subsidy, the Environmental Quality Incentive program, and the Organic Conservation Technical Assistance program received by the organic farmers in the North Central states were $11,780,580,000, $23,012,000 and $23,012,000, respectively. Over the thirteen-year period, the states with the largest percentage increase in federal subsidies received were Indiana, Iowa, Kansas and Michigan (Figure 12). These states experienced an increase of 35 percent while the states that received the largest amounts of funds of the Equipfund program were Iowa, Missouri and Nebraska (Figure 13), which experienced an increase of 29 percent. Kansas, Minnesota, Nebraska, Wisconsin and Illinois received an increase in Otcap over 32 percent in the thirteen-year period (Figure 13).

In addition to setting the standard for the U.S. organic industry, the USDA supports organic agriculture in the adoption process, so the subsidies are a means of supporting organic agriculture. Both government and private institutions provide a wide variety of funding opportunities, including conservation grants, organic crop insurance and simplified microloans. Comparing the various kinds of subsidies from government and private organizations provides (indirect) evidence that coupled subsidies indeed induce farmers' behavior, and may lead them to switch from conventional to organic agriculture.

Table 5: Summary Statistics of Independent Variables

Independent Variables	*Obs.*	*Mean*	*Std. Dev.*	*Min*	*Max*
Fedsub	126	117,806	65,327	4,384	309,606
Equipfund	126	23,012	20,389	2,776	100,187
Otcap	126	13,891	5,929	7,336	36,460

*Units of all the variables are in thousands of U.S. dollars.

Table 6 shows the regression results of organic agriculture adoption and the six behavioral characteristics and institutional factors over the 2012-2014 period for the North Central states with federal subsidies as the determining subsidy. In appendix IV all the three subsidies were run together in one model, there was the issue of multicollinearity where one subsidy was correlated with one other variable and that was the reason we chose to run the models separately with each subsidy. The Table shows a positive coefficient for each of the independent variables, except for the certification cost variable. All coefficients are statistically significant at the 0.05-probability level, except the NOSCP coefficient which is not statistically significant. The parameter estimates of the organic certification cost variable is negative and statistically significant at the 0.05 confidence level.

Organic food products are typically more expensive than conventional food products, possibly making the cost of organic products prohibitive for some consumers.

Federal subsidies help reduce organic farm input costs. The regression results indicate that the subsidies are positively associated with the increase in the number of organic acreage.

The number of farms enrolled in organic cost-share programs shows a strongly positive association with the number of organic acres suggesting that the practical knowledge of organic agriculture passed on to farmers in their decision-making process is important in their transition phase. It is often difficult to quantify the benefits of organic knowledge to farmers because the benefits are often intangible, however, it is important to ensure environmental costs are considered, such as proper production of healthy food without insecticides and pesticides for the organic market. Farmers enrolled in cost-share programs receive knowledge on opportunities in maximizing the use of their resources.

Organic agriculture is complex and the conversion to organic management affects the entire farming system. The 36-month transitioning period affects the farming infrastructure and approach, such as maintaining soil fertility, as well as controlling weeds and pests. The process of adopting organic agriculture systems causes unusual changes to the land, input costs and yields, leading to excessive costs that many farmers are unable to bear. This explains the negative parameter estimate of the organic certification cost variable. The results in Table 6 also show that average farm size, as measured by organic product sales, is positively associated with organic agriculture adoption. Based on Model 1, the increasing number of organically certified farmers over the last 13 years indicate that farmers are increasingly converting conventional/arable lands into organic agriculture

Table 6. Model 1: Regressing the Adoption of Organic Agriculture on Fedsub as Main Subsidy

Explanatory Variable	***coefficient***	***Standard errors***	***P-value***
Subsidy to farmers (Fedsub)	.3456	.1344	(0.011)**
Organic certification cost (Orgcertcost)	-64.5349	18.6072	(0.001)**
Sales of organic products (orgsales)	.2391	.0620	(0.000)**
Number of organic certified farmers (Orgcertfm)	160.6888	29.1954	(0.000)**
Number of farms enrolled in organic cost-share program (Nocsp)	91.8957	91.9529	(0.320)
Intercept	17850.25	20540.81	(0.387)
Observation	126		
R^2	.7084		
Adj-R^2	0.6960		

*Notes: the dependent variable is Orgacrge. Asymptotic t-values for the OLS model are in parenthesis, Standard errors are robust and asterisks indicate significance at a specific confidence level. *Significant at 1% level, **significant at 5% level, and ***significant at 10% level.*

Table 7 shows the results of regressing the adoption of organic agriculture on Equipfund as the desired subsidy and the remaining independent variables. The results show that subsidies as part of EQIP given to organic farmers motivate them to adopt organic agriculture and are statistically significant. The positive and statistically significant

Nocsp coefficient indicates that farmers find the availability of organic information and education important in the conversion to organic agriculture decision making process.

The statistically significant and negative coefficient of -34.03 for organic certification cost indicates that a $1,000 increase in organic certification costs per farm is associated with a decrease in the number of organic cropland by 34,000 acres. Dimitri and Greene (2000) found that market development and increased sales (consumer demand for organic products) substitute for conversion subsidy payments. They explained that aid in the form of the establishment of market infrastructure for organic products has a more permanent impact on conversion than subsidizing production costs. We confirm these findings, so that a $1,000 increase in organic sales is associated with a 0.2% increase in organic agriculture acres. This may explain why the USDA in 1999 awarded the Organic Trade Association a cost-share under the Market Access Program (MAP) to explore foreign markets for organic food products.

The statistically significant and positive coefficient of organic farms gives an idea of scale effects. In particular, if organic certified farmers increase in size by one unit, the probability of farmers adopting organic agricultural practices increases by a greater percentage. The more motivated organic farmers are, the more likely they are to convert additional land to organic production and adopt its practices thereafter. Thus when farmers expect improved financial returns, it is easier to increase organic farmlands.

Table 7. Model II: Regressing the Adoption of Organic Agriculture on Equipfund as Main Subsidy

Explanatory Variable	***coefficient***	***Standard errors***	***P-value***
Subsidy to farmers (Equipfund)	3.2129	.4583	(0.000)**
Organic certification cost (Orgcertcost)	-34.0272	16.6633	(0.043)**
Sales for organic product (orgsales)	.0020	.0632	(0.097)***
Number of organic certified farmers (Orgcertfm)	124.096	25.9073	(0.000)**
Number of farms enrolled in organic cost-share program (Nocsp)	213.2414	73.5352	(0.004)**
Intercept	-5878.662	13822.91	(0.671)
Observation	126		
R^2	0.7815		
Adj-R^2	0.7724		

*Notes: the dependent variable is Orgacrge. Asymptotic t-values for the OLS model are in parenthesis. Standard errors are robust and asterisks indicate significance at a specific confidence level. *Significant at 1% level, **significant at 5% level, and ***significant at 10% level.*

Table 8 lists the results of regressing the adoption of organic agriculture on Otcap as the main subsidy payment. Compared to the first two regression model specifications, all independent variables are statistically significant and have the same direction of association with the adoption of organic agriculture. The relationship between the cost of organic certification and the adoption of organic agriculture is not surprising and is consistent with the work of Constance and Choi (2010), who found that the relationship between organic agriculture growth and the cost of transitioning was negative and statistically significant. This makes intuitive sense, because a reduction in cost of transitioning might motivate farmers to adopt organic agricultural practices.

As far as the financial situation of organic agriculture is concerned, the period of converting to organic farming is costly and does not always lead to improved profits afterwards. In this case, organic agriculture differs from conventional agriculture, which might be more commercially beneficial. However, with all that mentioned, the available evidence from the results of Models 1, 2 and 3 indicates that well-established markets, conversion aid payments and ongoing support for organic farming that may be available each contribute to the adoption of organic agriculture, hence the positive coefficients of Orgsales, Nocsp, and Otcap. However, for some farmers, conversion to organic farming may be associated with an economic penalty due to cost of conversion and a potential loss of revenue thereafter. It is likely that the perception of relatively low profits and high risks may be important barriers to the conversion.

The results presented in Tables 6, 7 and 8 suggest the independent variables in all three models explain the adoption of organic agriculture in similar ways. Organic subsidies, organic sales, and organic farms enrolled in cost-share program are all positively related to the adoption of organic agriculture and are statistically significant. The analysis shows that while federal policies strongly support organic agriculture, private conversion incentives also strongly motivate farmers to convert to organic agriculture.

Table 8. Model III: Regressing Adoption of Organic Agriculture on Otcap as Main Subsidy

Explanatory Variable	***coefficient***	***Standard errors***	***P-value***
Subsidy to farmers (Otcap)	7.4462	1.2102	(0.000)**
Organic certification cost (Orgcertcost)	-50.1021	16.8203	(0.043)**
Sales for organic product (orgsales)	.1353	.0578	(0.097)***
Number of organic certified farmers (Orgcertfms)	136.5331	27.0822	(0.000)**
Number of farms enrolled in organic cost-share program (Nocsp)	239.4452	76.5373	(0.004)**
Intercept	-54718.46	21522.73	(0.012)**
Observation	126		
R^2	0.7659		
Adj-R^2	0.7562		

*Notes: the dependent variable is Orgacrge. Asymptotic t-values for the OLS model are in parenthesis, Standard errors are robust and asterisks indicate significance at a specific confidence level. *Significant at 1% level, **significant at 5% level, and ***significant at 10% level.*

In the final chapter, we present a summary of key findings of this study, conclusions, limitations, and recommendations for future research related to this thesis.

CHAPTER 6: SUMMARY OF FINDINGS AND CONCLUSION

This final chapter summarizes and concludes the study. It also contains a description of the limitations of the study and recommendations for future study.

6.1 Summary of Key Findings and Conclusions

This research attempts to accomplish four main objectives. One is to examine to what degree conversion subsidies are positively related to farmers' decisions to switch to organic production. Second, to investigate various persistent barriers that may keep farmers from switching to organic agricultural production. Third, to study market demand forces that incentivize farmers to transition to organic production; and fourth, to analyze environmental sustainability challenges of organic production practices.

To achieve these objectives, data on organic agriculture were collected for twelve North-Central states namely: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. Specifically, the data pertaining to organic cropland acreage, the number of organic farms, the organic operations, number of farms enrolled in cost share programs, federal organic subsidies, environmental quality incentive subsidies, organic certification cost, and organic conservation technical assistance. The data were analyzed using descriptive statistics and multiple linear regression. STATA was the statistical package employed in the analysis. Major findings of this study are as follows.

Table 9 shows the descriptive statistics of trade-offs between organic acres and other variables while holding the probability of subsidy requirements constant in that the increased market for organic products explains about 60 percent of the variation in farmers' willingness to adopt organic agriculture practices, thereby enhancing farmers in their decision making process when transitioning. This finding confirms the work of Thilmany et al. (2008) who found that farmers' markets and specialty markets carrying organic produce are increasingly becoming prevalent, particularly in larger cities. We also estimate that each additional certified organic farmer operated and cost-share program enrolled in, explained 58% variation in farmer's willingness to adopt organic agriculture. This provides evidence that the positive adoption effect arises not only from subsidy payment to farmers. The degree of importance of these variables may change in the future as additional variables are included and effective farming techniques are adopted.

Table 10. Trade-Offs Between Adoption Level and Other Variables to Hold Probability of Subsidy Requirement Constant

Change in variables	***Willingness to adopt organic agriculture (%)***
One thousand dollar (increase) in organic sales	60.78 (acres)
One acre (increase) in arable farms	58.35 (acres)
One thousand (decrease) in organic certification cost	25.90 (acres)
One unit (increase) adequacy of technical advice from enrolling in cost-share program	58.44 (acres)

The study confirms that absence of organic subsidies, the presence of sales, and increased number of farms enrolled in cost-share program are relevant for the adoption of organic agriculture in the North Central states of the U.S. In addition, the presence of high transitioning cost is detrimental in farmers' decision-making process when converting to organic agriculture. Finally, to confirm the robustness of the results, Table 10 lists the results of testing the three hypotheses. Hypothesis II, the expectation of no effect in sales on the adoption of organic agriculture is strongly rejected. We also reject Hypothesis I, but more cautiously – farmers acquiring knowledge because of enrolling in cost-share programs generates a relatively small positive effect, but this is only observable when it is the only independent variable explaining the adoption of organic agriculture. Finally, we reject the null hypothesis that organic certification cost has no effect on the adoption of organic agriculture. The results in Table 10 confirm the importance of including all these variables in the study though studies reviewed show that there is a wide variety of motives for the conversion to organic agriculture.

Table 11. Results of Hypothesis Testing

Null and Alternative Hypothesis	***Ha mean <0*** ***Ha mean >0***	***Findings*** ***Ha: mean !=0***
H_O: Sales =0 H_A: Sales ≠ 0	Pr(T < t) = 1.0000 Pr(T > t) = 0.0000 t = 5.0343	Pr(|T| > |t|) = 0.0000
H_O: Nocsp =0 H_A: Nocsp ≠ 0	Pr(T < t) = 1.0000 Pr(T > t) = 0.0000 t = 8.2392	Pr(|T| > |t|) = 0.0000
H_O: Ocertcost =0 H_A: Ocertcost ≠ 0	Pr(T < t) = 1.0000 Pr(T > t) = 0.0000	Pr(|T| > |t|) = 0.0000

6.2 Conclusions

This study was motivated by the evolution of organic agriculture. We have analyzed the effects of subsidies on the adoption of organic agriculture in 12 North-Central U.S. states, and the implications of the existence of barriers to moving to organic farming. Controlling for a range of factors including organic sales and cost-share programs, we find a positive individual effect on organic agriculture adoption with the organic sales variables. Our results suggest that the increase in organic acreage is due in part to the availability of conversion subsidies. Without government assistance, most small-scale farmers are not sufficiently motivated to switch to organic production due to the high initial costs involved in transitioning. Further, increased institutional support could facilitate organic adoption and its absence is detrimental to increasing the rate of adopting organic production methods.

Based on the three models, we find clear evidence that the link between subsidies and the level of organic adoption during the transitioning phase is positive, though the magnitude of the regression coefficients varies substantially across subsidy type. While the coefficients are relatively small, they are highly statistically significant. In terms of organic adoption, the relationship is negative for the cost of certification, but not statistically significant. These results are consistent with findings in the literature.

Finally, we found potential barriers to the adoption of organic farming and identified problems with access to information, access to markets, farm structure and availability of necessary organic inputs. Most importantly, the non-adoption of organic practices may be due to its complexity and the need for an entire system change, higher risks and possibly lower yields. In addition, organic agriculture might not be immediately financially rewarding but could results in positive effects regarding soil fertility, animal health or human health or general benefit to the environment.

6.3 Limitations of the Study

This study has some notable limitations. First, the results differ slightly from previous studies, which are largely based on primary survey data. In contrast, our analysis uses secondary data, and does not account for important factors such as knowledge and access to appropriate technology, as well as favorable organic trade policies that could motivate farmers to transition toward organic farming. The difference in results may also be attributable to the use of proxies and adjustments to shortcomings in the collection of primary data. Another limitation of this work includes the limited unavailability of published data on organic agriculture.

6.4 Recommendations

While this study is focused on policies and subsidies associated with the adoption of organic agriculture, possible future work could investigate relationships that may exist between infrastructure for transport, handling, packaging and marketing, and the growth of organic agriculture. This could help identify policies in the area of organic agriculture that need attention and support. Future research could also consider testing whether there are barriers that might prevent organic-transitioning farmers in acquiring organic subsidies.

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APPENDIX

Appendix I: Model 1 test for multicollinearity

Dependent Variable	*Model 1* VIF	*Adjusted Model* VIF
Fedsub	1.36	1.32
Orgsales	7.79	6.00
Orgcertfms	19.40	5.63
Ocertcost	3.61	2.61
Oprgram	21.07	removed
R-squared	0.70	0.71
Adj-R-squared	0.69	0.69
Obs	126	126
Mean VIF	11.43	4.18

Appendix II: Model 2 test for multicollinearity

Dependent Variable	*Model 2* VIF	*Adjusted model* VIF
Equipfund	2.00	2.00
Orgsales	10.02	8.22
Orgcertfms	16.85	4.66
Ocertcost	2.77	2.81
Oprgram	20.19	removed
R-squared	0.72	0.78
Adj-R-squared	0.77	0.77
Obs	126	126
Mean VIF	11.25	4.47

Appendix III: Model 3 test for multicollinearity

Dependent Variable	***Model 3*** VIF	***Adjusted Model*** VIF
Otcap	1.10	1.10
Orgsales	8.24	6.52
Orgcertfms	16.92	4.76
Ocertcost	3.63	2.67
Oprgram	30.19	removed
R-squared	0.77	0.77
Adj-R-squared	0.75	0.76
Obs	126	126
Mean VIF	10.73	3.93

Appendix IV: Correlation Matrix

	OAcreage	*Octap*	*Equifund*	*Febsub*	*Ocertcost*	*Osales*	*Ofarm*	*Nocsp*
OAcreage	1.000							
Octap	0.2461	1.000						
Equifund	0.7378	0.5869	1.000					
fedsub	0.0163	0.6698	0.3372	1.000				
Ocertcost	0.5147	-0.0967	0.3661	-0.1614	1.000			
Osales	0.7816	0.0333	0.6683	-0.1016	0.7589	1.000		
Ofarm	0.7660	-0.1039	0.5004	-0.2519	0.7477	0.8540	1.000	
Nocsp	0.7686	-0.0615	0.5463	0.0306	0.6533	0.8649	0.8270	1.000

Appendix V: *Table 9. Model IV: Regressing Adoption of Organic Agriculture On all subsidies*

Explanatory Variable	***coefficient***	***Standard errors***	***P-value***
Subsidy to farmers (Otcap)	7.4462	1.2102	(0.000)**
Organic certification cost (Orgcertcost)	-50.1021	16.8203	(0.043)**
Sales for organic product (orgsales)	.1353	.0578	(0.097)***
Number of organic certified farmers (Orgcertfms)	136.5331	27.0822	(0.000)**
Number of farms enrolled in organic cost-share program (Nocsp)	239.4452	76.5373	(0.004)**
Intercept	-54718.46	21522.73	(0.012)**
Observation	126		
R^2	0.7659		
Adj-R^2	0.7562		