ORGANIC TRANSITION SCHEMES FOR A MORRIS COUNTY KANSAS GRAIN FARM

By

RUSSELL T. MOORE

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Major Professor
Hikaru Hanawa Peterson

ABSTRACT

Profitability is a primary economic motivator for a farm to remain in business. As conventional crop farming endures rising fertilizer and chemical costs, small farmers that raise grains must look towards innovative cropping practices that are economically affordable or depart the business. As small farmers evaluate other cropping prospects, organic cropping systems and the availability of organic price premiums should be considered as an alternative in meeting farm profitability goals.

This study compared the economic return per acre of converting to an organic cropping system from a conventional system against the conventional crop enterprise of the same crop mix. A simulation model was created using assumed organic yield data, actual organic prices, historical conventional yield data and historical conventional prices to determine the economic return.

An initial simulation was run, ignoring the three-year transitional period that farms must undergo with no synthetic inputs to become certified organic, to determine if organic cropping systems using organic price premiums on the 600-acre farm would be competitive with conventional production. The simulation showed that organic production is economically competitive with conventional production. Previous studies and personal interviews indicated that the three-year transitional period could easily cause the farm economic loss, since conventional inputs cannot be used and organic premiums cannot be obtained for crops sold. Therefore, three different conversion schemes were simulated to find which one would cause the farm the least economic damage: converting the entire farm to organic production at once, converting 20% of the farm’s tillable acres to organic

production annually and converting 10% of the farm's tillable acres to organic production annually.

All three of the proposed transition schedules revealed economic loss to the farm at some point during their transition periods. The only scheme that showed no average loss was the existing conventional system. However, after complete transition, the three transition schemes showed higher profitability than the conventional cropping system. The downside was that this took a minimum of 13 years to accomplish. The only scheme that did not cause the farm's cumulative present value to drop into negative numbers was the 10% per year transition rate.

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CHAPTER 1: INTRODUCTION

1.1. Problem Statement

Many smaller farmers today are wondering how or if they are going to stay in business. With profit margins of traditional crops becoming increasingly smaller, it is becoming more challenging for a smaller producer to remain in business without supporting their businesses with outside income. The traditional answer has been to gain more land and equipment to achieve economies of scale and make that dwindling margin enough to survive. Unfortunately, many smaller farmers today do not have the means to obtain more land or equipment. Moore Farms, in east-central Kansas, is such a farm, with 600 total tillable acres, that faces the above dilemma. What if they could produce a product that commands a premium price such as organic crops?

The organic movement began in Europe in the 1920's (Tate, 1994). A period from the 1920's to 1970 was a time of struggle and financial difficulty for the organic movement in a hostile environment. In the early 1970's, private organizations began to develop organic standards to support organic farming, and some key organic labeling schemes for identification of organic products were set up as consumer demand increased. Since 1980, organic agriculture has gained more widespread acceptance. By the late 1980's, many states began to offer organic certification. The standards often differed from state to state and between organizations, leading the U.S. Congress to pass the Organic Foods Production Act of 1990 to establish national standards. At an April 1995 meeting in Orlando, Florida, the National Organic Standards Board defined organic agriculture as "an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony." The standards were fully implemented in 2002, and the U.S. Department of Agriculture (USDA) is currently responsible for implementing all organic regulations.

The growth of the organic food market since 1990 has been about 20 percent annually (Dimitri and Greene, 2002). Greene (2004) reported that between 1992 and 2003 organic production in the U.S. grew tremendously with some sectors quadrupling during that time. The total number of organic cattle grew from 9,061 animals in 1992 to 113,221 animals in 2003, and the total crop and pastureland acres grew from 935,450 certified acres to 2,196,873 during that same time period. Government efforts to boost production in the form of developing national standards for certification as well as some USDA programs to subsidize the transition process were explained as partial reasons for the organic acreage expansion. However, the percentage of land and cattle in organic production is still small when compared to the total 95.5 million head of cattle and 938 million acres of available farmland and pastureland in the United States (USDA-NASS, 2002).

Moore Farms is a small farm in Morris County Kansas that is interested in exploring the economic feasibility of transitioning to organic production. They would like to continue growing the traditional crops that grow well in the geographic area but investigate the effects that growing and marketing them organically would have on whole-farm profitability.

Many smaller farmers like Moore Farms would like to determine if an organic cropping system will be more profitable on their farm than a conventional cropping system. They have many other questions. For example, what adjustments need to be made to incorporate the system and what types of potential hazards or pitfalls may need to be considered during the transition from conventional to organic? How much risk is involved in organic agriculture during and after the transition? Do tools exist to mitigate transitional risks?

Some studies in the reviewed literature were conducted on research farms. Others were conducted using the results of actual operating farms while still others simulated results. Many websites were surveyed, as well as university studies. There has been substantial research conducted and several articles written dealing with the subject of crop budgets and energy prices. However, none compared the economic costs or benefits of conventional versus organic production or the economic cost of the organic transition period for a whole farm.

Most comprehensive and relevant research findings have been based on the Rodale Institute Farming System Trial (FST). There have been multiple articles written about this FST, many of which deal with the economics of organic production, organic crops budgets, or the effects on the environment. However, these articles do not indicate whether it is economically feasible for a small farm to transition to organic production.

The primary objective of this thesis is to determine if an organic cropping system would supply a farm with higher profit levels than a conventional cropping system. A second objective of the thesis is to determine how many acres could be transitioned to organic each year without sustaining an economic loss from which the farm could not recover.

Moore Farms is a 600-acre farm in east-central Kansas. A model was created to simulate profitability of Moore farms over 17 years. One thousand realizations of whole farm net income based on randomly drawn conventional crop prices and yields and actual conventional crop input costs were simulated in the model. The model also drew random organic crop prices and yields and simulated farm net income from organic crops using estimates of organic crop input costs. These two net incomes were then compared to see which cropping system was more beneficial economically.

The model was used to determine how quickly the 600-acre farm could be transitioned to organic production while remaining economically viable. Organic production costs and yields were combined with conventional prices to simulate the reduced income received for the three-year transition period. Different transition rates to organic production were used for the transition simulation.

The remainder of this thesis is organized as follows. Chapter 2 is a summary of the other research that has been done on this topic. Chapter 3 is an explanation of the way the model was constructed and composed for this project. Chapter 4 analyzes the results of Chapter 3's model simulations. Chapter 5 summarizes the conclusions drawn from the simulation as well as describes limitations of the model.

CHAPTER 2: RELATED RESEARCH

Several studies have been conducted regarding different types of organic cropping systems and their impact on the environment and farm economies. The studies have varied in their methods but they include, among others, research plot studies, actual farm studies, studies on simulated farms, studies on economic impacts, studies on the transition from conventional to organic and even studies on non-grain organic crops. Descriptions of the studies follow.

2.1. Research Plot Studies

Helmers, Langemeier, and Atwood (1986) estimated the net return of 13 different cropping systems in East Central Nebraska from 1978 to 1985. The tests were based on experimental trials run at the University of Nebraska and analyzed with regard to profit and risk. Only two of the systems were completely organic and price premiums were not considered. However, the authors reported that the organic alternatives performed well with comparable profitability and relatively fewer incidents of low net returns..

Hanson et al. (1990), Hanson, Lichtenberg, and Peters (1997), and Pimentel et al. (2005a and 2005b) analyzed the environmental issues, profitability, risk and other economic issues encountered by the FST from its beginning in 1981. In most cases it was found that, due to the necessity of using crop rotation in the absence of synthetic fertilizers, the organic systems grew high value crops less frequently than organic systems. Also the organic systems required more labor and management than did the conventional. Lotter, Seidel, and Liebhardt (2003) studied the economic benefits that the FST's organic cropping systems had during years of climate extremes such as drought and excess rainfall. They found that organically grown crop yields were higher than conventional yields in climate extremes.

Chase and Duffy (1991) of Iowa State University compared actual results of conventional and reduced chemical farming systems in Floyd County, Iowa. They evaluated the production costs, yields, and returns of both systems from 1978 to 1989. While the reduced-chemical system was not organic, it showed some cost reduction and increased returns in terms of reduced pest control costs.

Karlen, Duffy, and Colvin (1995) evaluated the economics of a conventional and an alternative cropping system in Boone County, Iowa. The alternative system primarily used swine and beef manure and municipal sewage to supply nutrients to crops. Some additional nitrogen was applied as necessary. It was found that the alternative system had higher returns to management than the conventional systems using commercial fertilizers and herbicides.

Rodale Institute's Farming Systems Trial™, in Kutztown, Pennsylvania, began in 1981 and is one of the longest running experiments designed specifically to study leguminous and animal manure organic cropping systems in comparison with conventional systems. The project focuses on corn and soybean production and studies the transition process, both biological and economic, that occurs when converting from conventional to organic farming. It also studies the long-term implications of organic agriculture after the transition. Due to this trial being one of the longest running, there have been numerous studies done on it. Peterson, Drinkwater, and Wagoner (1999) provide a survey of the studies conducted during the first fifteen years.

Delate and Cambardella (1999, 2000, 2001) examined the agronomic and economic performance of organic and conventional grain crops on 160 acres in Adair County, Iowa, from 1998 to 2001. Their conclusion was that the organic cropping system's returns, both with and without price premiums for organic crops, could remain competitive with conventional cropping systems.

A similar farming system trial in Piatt County, Illinois, from 1996 to 2001 compared the economic returns of conventional, no-till, three-crop, and organic cropping systems (Glasgow, 2002). It was found that, on average, the organic system netted $56 per acre more than the no-till system, $67 per acre more than the conventional system and $83 per acre more than the three-crop system. The trial took advantage of price premiums for organic specialty crops such as popcorn and blue corn, which were factored into the production budgets.

2.2. Actual Farm Studies

Berardi (1978) studied ten conventional and ten certified organic wheat farms in New York and Pennsylvania from 1975 to 1977. It was found that the conventional farms averaged 48% higher energy inputs but only 29% higher yields per hectare than wheat produced by organic farming methods. The economic cost averaged 29% less per hectare for the conventional wheat production than for the organic wheat producers. However, it was reported that the organic producers were compensated for this by receiving price premiums for their crop. Berardi concluded that more research and a longer sampling period were needed in this area of study.

Lockeretz et al. (1978) compared the economic performance of 14 organic farms and 14 conventional farms in the Midwest from 1974 to 1976. The study was initiated shortly after a sharp increase in fertilizer and oil prices when farmers were looking for a way to cut costs. It was reported that the value of crops per acre was 11% less on the organic farms but the net income per acre was indistinguishable. This study was done using only conventional crop prices.

Shearer et al. (1981) studied 23 alternative farms in the western Corn Belt. None of the farms used commercial fertilizers or chemicals. These were then compared to conventional farms in the same geographic areas. It was reported that the conventional farms had much higher gross returns in almost every situation. However, net returns for both types of farms were nearly the same. During times of unfavorable growing conditions the organic crops were more profitable. However, it was reported that under favorable growing conditions, the conventional system would outperform the organic. Price premiums were not considered in this study.

Lockeretz et al. (1984) again reported on the 14 farms studied previously (Lockeretz, 1978) but added an additional 23 organic farms that were studied from 1977 to 1978. It was reported that gross production per hectare was between 6% and 17% lower for the organic farms. However, the organic farms consistently had lower production costs. It was concluded in both studies that net incomes for both cropping systems were about equal. Again, these studies did not incorporate organic price premiums.

Lockeretz and Madden (1987) did a 10-year follow up on the farms in the Lockeretz et al. (1984) study to determine if the farms were still in business, and if so, were they still using organic practices. It was found that 55% of the farms were still farming organically, 21% were no longer farming, and 23% of them did not return the questionnaire, and therefore could not be accounted for. Of those that responded, it was asked if their financial situations overall had improved or declined in the last 10 years. The majority of the farms reported an improvement in financial situation and increased ability to pay off debts. Most perceived an improvement in soil and personal health. However, there was a major increase in weeds and labor requirements.

Cavigelli, Kois, and Ebbert (1988) studied five organic farms in Kansas from 1983 to 1987. The authors interviewed these farmers to understand the organic practices they used as well as the financials of each one. Most of the farms in the sample incorporated some form of livestock into their system. They showed that, for the most part, the farms in the sample increased their return over costs with production costs averaging only about 60% of the Kansas Farm Management Association averages. Price premiums were not considered in this study. This article is likely the most relevant to this thesis, since it uses actual farms in the same geographic area as Moore Farms.

Henning (1994) reported on the economics of organic farming in Canada. Canadian census data, Canadian Organic Growers data, and a 1992 BFB Consulting report were used to determine the number of organic producers in the country, as well as prices they had received and relative profitability of their operations. It was reported that Canadian organic grain yields were only 6% below conventional yields on average. Some farmers reported price premiums of as much as 30% higher than conventional, but also reported that prices were highly variable. The one common thread among Canadian organic farmers was that their production costs averaged 18% lower on organic farms than conventional. Almost three out of every four survey respondents concluded that organic farming in Canada was 'as profitable as conventional.' The study cautioned however, that the sample size of organic farmers in Canada was very small and that additional research was needed.

Dobbs and Smolik (1996) compared an "alternative" farm and a conventional farm located on the western edge of the Corn Belt from 1985 through 1992. It was found that when organic price premiums for the alternative farm were excluded, the conventional farm was more profitable. This was determined to be due to higher corn and soybean yields and higher Federal farm support programs for the conventional farm. However it was reported that when price premiums were included, it added $11 per acre to the net returns. This study also concluded that reduction in government policies and programs that promote high chemical use and only a few crops would benefit the alternative farm.

2.3. Simulated Studies

Diebel, Llewelyn, and Williams (1993a and 1993b) and Diebel, Williams, and Llewelyn (1995) compared the economics of several alternative-cropping systems and conventional systems, in northeast Kansas. The data for budgets used in these systems were gathered from the Kansas Farm Management Association, as well as from expert opinion to form a typical northeast Kansas farm for simulation purposes. The systems compared were simulated both with and without government programs. However, of note is that only one of the alternative systems in the study was totally organic and organic price premiums were not considered. It was concluded that the organic system has potential to improve net returns when compared to the conventional system.

Hewitt and Lohr (1995) simulated six different conventional and no-till cropping systems in Michigan. None of the cropping systems were 100% organic and therefore there was no consideration of organic price premiums. Two of the alternative systems used some practices similar to organic farms in that they used hairy vetch as a nitrogen source.

However, in the simulation these two systems ranked 5th and 6th in terms of profitability out of the six simulated systems.

2.4. Transitioning from Conventional to Organic

The Rodale Institute's Farming Systems Trial™ in Kutztown, Pennsylvania explored long-term agronomic and economic impacts of organic agriculture for the farm and showed that an established organic farm can be as profitable as a conventional farm under certain circumstances. However, there was first a transitional period before the organic systems came to be competitive with the conventional system. Dabbert and Madden (1986) developed a simulation using different assumptions about yield reduction to predict economic decline of the Kutztown farm during the transition from conventional agriculture to organic. Their findings indicated a 43% income reduction during the first year of transition. After stabilization of organic yields, income was only 7% lower than conventional not considering organic price premiums.

Liebardt et al. (1989) studied the actual transition period of the Kutztown farm from 1981 to 1985 in order to determine the best crops and crop rotation to grow to minimize transitional financial risks. The study determined that crops such as corn that have a high nitrogen demand were not the best choice for a transition crop. The best crops choices were ones with low nitrogen demand such as soybeans and a rotation that shifted between warm and cool-season crops like small grains and/or legume hay.

Peters (1991) explained the concerns and risks associated with the conversion of the Kutztown farm of Rodale Institute. Also given were "during" and "after" conversion yields of the crops in the system. The "after" yields were about 15% higher than transitional yields. Peters also gave recommendations for avoiding some of the problems encountered during the Kutztown trials, including avoidance of high nitrogen use crops, use of green manures, gradual reduction of external inputs, and performing field operations in a timely manner. Additional information was given on future improvements to the Kutztown farm such as: reduced tillage, increased diversity of crops, growing and harvesting their own cover crop seed, composting with urban wastes and altering size and types of livestock.

Jaenicke and Drinkwater (1999) also studied the Kutztown farm with the Rodale Institute. They stated that traditional measures of productivity growth might not fully account for all sources of transitional growth. This article treated soil quality as part of the production process and incorporated it directly into rotational measures of productivity growth. It concluded that both experimental learning and soil quality improvements were important sources of growth during the agricultural system's transition.

Smolik and Dobbs (1991) reported on crop yields and whole farm economic performance associated with a 5-year transition to organic in the Brookings, South Dakota Agricultural Experiment Station. Labor requirements, effects of organic and protein premiums, changes in federal farm program target prices and increases in the prices of inputs were also reported. The analysis seemed to be consistent with others in that organic systems reportedly fared better under drought conditions. Also, it was noted that overall net return to the organic system was less variable than conventional systems.

The transition to organic production is often a time of low profits to the farm. MacRae et al. (1993) described agronomic changes and soil changes that take place during this time. They also summarized the different agronomic factors and soil management tools to consider while making the transition. In addition, it was suggested that there are possible opportunities in marketing the transitional product of the farm at a higher price than are available in conventional markets. The financial risks of the transitional period can be minimized if the farmer plans ahead, identifies markets for products, converts the farm in stages and gradually cuts expenditures in off-farm inputs. They also stated that farmers find the benefits of conversion to organic beyond the purely economic.

Padel and Lampkin (1994) pointed out that the transition period is much different from either conventional systems or established organic systems. Attention was focused on the different things that need to be considered if transitioning to organic, such as farm size, farmer education, motivation of transition, farmer marketing skills, investment in capital, technical requirements, and conversion planning. Barriers to transition were also considered. It was concluded that the transition will likely have a steep learning curve, but if the variables were considered and a conversion was planned out in advance, some of the risk of the transition can be minimized.

Altieri and Nicholls (2003) studied the worldwide effect of transitioning to organic agriculture. They stated that some farmers in more industrialized nations have adopted organic practices that amount to simply substituting organic inputs into conventional agricultural practices of their corporate farms. It was pointed out that there was more to consider in managing organic farms. The article was anti-corporate farm and advocated changes in policies, institutions and research to advance more local organic agriculture and to do away with subsidies that support conventional farming.

2.5. Organic Agriculture and the Community

There have a been a few studies done to try to determine what effect a widespread change to organic agriculture may have on the community and world economy. Olson, Langley and Heady (1982) modeled the effect a large-scale adoption of organic farming methods in the United States would have on the local and national economy. It was concluded that adoption of organic farming by more than 1/3 of the farms in the U.S. would increase annual farm income about $26 billion nationally and satisfy domestic demand for agricultural crops, but consumer food cost would increase about three times, and exports of agricultural products would decrease by about 800 million bushels annually.

Cacek and Langner (1986) studied the economic effects organic agriculture would have on farmers as well as the macroeconomic effects that organic agriculture would have on the United States. It was stated that actual crop trials showed that organic farming could equal or surpass conventional economic performance, whereas simulations seemed to show an economic disadvantage. The study questioned whether simulations failed to incorporate valid assumptions on conservation, and efficiency of the practices. Based on the actual trials, it was concluded that large-scale organic farming would have a positive economic effect on the farmers and a positive effect on a national level by reducing support programs and using fewer fossil fuels.

Lockertez (1989) compared the effects of both alternative and conventional cropping systems on the local economy in which a given farm operated. The goal was to find which system contributed more to the local economy in order for it to operate. Previous studies were reviewed to determine their contribution and it was determined that the conventional systems actually contributed more to the local economy than did the alternative system. It was mentioned, however, that this should be combined with currently unavailable quantitative information on the sustainability of the two systems to give a better picture of their comparative economic benefits, present and future.

Dimitri and Oberholtzer (2005) compared the very different agricultural policies in the United States and the European Union (EU) with regards to organic agriculture. The EU has several different government payments to farmers who produce organically in order to encourage the growth of organic agriculture. On the other hand, the U.S. has provided very few incentives for transition, preferring instead to let the demand of the consumer drive the supply and grow the organic industry. Europe has more organic production than does the U.S., but the demand in the U.S. continues to grow and therefore producers continue to try to meet the demand. The only policy both the EU and the U.S. have in common is a government-defined organic standard.

2.6. Risk and Risk Management for Organic Farmers

In a series of focus groups, Hanson et al. (2003) gathered a wide range of risks identified by organic farmers from different regions of the United States. The risks identified fit into three categories depending on their similarity to conventional agriculture: (1) risks similar to ones in conventional farming such as access to management tools like federally subsidized crop insurance, (2) risks that are different from those in conventional but temporary such as the transition period from conventional to organic, and (3) risks that are very different from those encountered in conventional farming like possible cross contamination by conventional GMO crops. The data gathered identified marketplace, policy, and contamination risks that may need attention as the organic market continues to expand.

2.7. Economic Impacts of Reduced Chemicals

Lee (1992) compiled the results of several previous organic cropping studies to determine the effects that a reduction in chemical use, such as those in organic agriculture, would have on human health risks, as well as the economic effects of such a change. Regarding health risks, it was decided that there was incomplete evidence on the risks of chemicals, but it was generally agreed that if chemicals posed a risk, these risks and environmental damage could be decreased through a reduction in chemical use. It was also concluded that without changes in governmental programs to gain widespread adoption of reduced chemical use, it is unlikely that many farmers will voluntarily switch to low-input systems. However, if it were to happen, it would likely increase farm income and consumer food prices, and decrease yield and food supply.

Pimentel et al. (1993) conducted a similar study with more quantitative results than the study by Lee. It was determined that a 50% reduction in chemical use would address many concerns. The authors argued that chemical usage could be reduced without a reduction in crop yield and that less chemical use would give the public peace of mind that their food would have fewer chemical residues. They also pointed out that with reduced chemical use, governments would not have to spend so much on prevention of chemical poisonings and groundwater monitoring, and on other related expenses. It was also concluded, however, that there would be an increase in food price to the consumer which could be countered by the consumer’s willingness to pay for chemical-free food.

2.8. Comparison of Past Studies

Duffy (1991) summarized three different studies on organic systems: two in Iowa conducted by Iowa State University and one in Kutztown, Pennsylvania. Two of these, one of the Iowa State studies and the Kutztown study, have been written about elsewhere in this literature review. Duffy’s conclusion was that organic systems showed much potential in terms of profitability. The conclusion was that as knowledge, and available tools increase, production practices and profitability will improve.

Anderson (1994) evaluated several studies by other authors on organic versus conventional systems across the United States. Some of the studies found organic and alternative systems to have higher net return than conventional while others did not. A few studies concluded that there would be no major differences in the profitability of the two systems. The study concluded that, on average, across the U.S., organic agriculture yields less but this is not necessarily offset by lower production costs. Therefore, organic farming is slightly less profitable than conventional systems. Of special note is that this article evaluated some of the same studies as Dobbs (1995). The data included in both evaluations showed that organic small grains farms could possibly be more competitive than other types of organic systems.

Dobbs (1995) reviewed studies by other authors on the subject of organic and conventional systems comparisons. Some of the studies found organic and alternative systems to be profitable while others did not. Still others found there to be no significant differences in the profitability of the two systems. The pattern that seemed to emerge from all the studies was that alternative systems appear to be very competitive with conventional systems in areas that were dominantly small grains or in transition areas.

Roberts and Swinton (1996) studied the methods and different criteria that several other authors had used to compare organic and conventional cropping systems. It was found that most of the economic studies focused on farm profitability without incorporating environmental criteria and the dynamic soil characteristics common in organic systems. It was concluded that there was still not enough research done to evaluate both economic and environmental attributes of alternative cropping systems accurately. If there were quality data available, simulation models have the potential to evaluate the trade-offs among expected profitability, environmental impacts and stability.

Welsh (1999) wrote probably the most comprehensive comparison of organic and conventional cropping systems. Several different studies were evaluated and discussed. Also reviewed was the increasing demand for organic products domestically and in the EU, which helps drive the organic price premiums. It was concluded, however, that even in the absence of price premiums, the previous studies demonstrated that an organic farm could remain profitable. Some guidelines were offered as to which aspects of an organic operation may wish to address as well as what factors may affect profitability. Current governmental policies supporting conventional agriculture were also pointed out as something that may have to change to promote alternative cropping systems.

2.9. Prices and Costs

Streff and Dobbs (2004) compared conventional and organic grain and soybean prices in the northern Great Plains and Midwest from 1995 through 2003. The increases and declines of conventional and organic prices were compared relative to one another. They were also comparatively graphed over time for each crop. Historic target prices for organic crops were retrieved from the Organic Farmers' Agency for Relationship Marketing (OFARM, 2006) from 2003 to 2006. Organic and conventional prices moved together to a point. However, organic prices are less variable over time. The prices were a minimum of 35% higher than conventional and went as high as 217% above conventional.

Lazarus and Selley (2005) prepared an economic engineering approach to provide a representative farming industry cost for specified machines and field operations. Several charts were included for several different operations, which can be multiplied by the cost of fuel to obtain a cost per acre for petroleum use. Also included was information on machine depreciation, owning and operating costs, overhead costs of machinery. These are all important costs in both conventional and organic agriculture. Hanna (2001) published a reference for fuel usage per field operation that was adapted from the above work by Lazarus and Selley.

2.10. Non-grain Agricultural Studies

Clark et al. (1999) conducted whole farm profit comparisons of organic and conventional vegetable farms in California using a two-year rotation with tomato and wheat. It was determined that the organic crop system with price premiums was the most profitable. However, they warned that this system's dependence on price premiums led to concern over its long-term economic viability as more growers begin transitioning to organic methods, especially if demand did not continue to increase at its current pace. It was mentioned that green beans appeared to be a reliable crop to grow during and following the transition to organic because of its low nitrogen demands.

Brumfield, Rimal and Reiners (2000) performed a comparative cost analysis of conventional and organic vegetable production methods. Data were collected from field studies conducted at Rutgers University. Time and motion study techniques were used to record machinery use and labor quantities. Records of production inputs and yields were also collected. It was determined that the organic practices had the lowest net returns but because of organic price premiums, net was just slightly short of conventional. The study concluded that as more producers start to grow organic vegetables this price premium may be reduced, and that organic producers will have to find a way to decrease costs and/or increase yields.

CHAPTER 3: SIMULATION MODEL

3.1. Modeling Framework

In this project, one objective is to determine if an organic cropping system would provide a farm with higher profit levels than a conventional cropping system. A second objective is to determine how many acres could be transitioned to organic each year without incurring an unrecoverable economic loss.

Crop production decisions include choices of crop varieties to plant as well as production practices to follow. In this analysis, farmers of tillable land are assumed to choose production practices to follow, given a mix of crop varieties in order to maximize earnings. Alternative production practices include an organic cropping system. Using acreage allocation as the decision variable will allow the farmer to arrive at a decision based on maximizing expected return over time. It is assumed that the producer is interested in maximizing profit, i.e., net of associated costs. It is further assumed that crop producers are price-takers. The variation in crop input prices over time are the result of total supply and demand and are therefore out of the farmer's hands. This is also true for commodity market prices, which are a function of the crop market that would account for customers' willingness to pay.

Farm profitability is a function of both revenues and expenses. Profit can remain unchanged even if expenses increase. Alternatively, profit can decrease, if expenses increase more than revenues. On the other hand, revenues can decrease, but as long as expenses decrease more than revenues do, overall profit will increase. Revenues are a function of quantity and price. Moore Farms in east-central Kansas deal with quantities of bushels, hundred weights, or pounds per acre, and dollars per unit of measure. Expenses are also a function of quantity and price, but farmers normally have more control over the quantity and type of inputs used for each crop. Other factors impacting profitability—crop price, crop yield, and input prices—are less predictable.

It is assumed that the farmer is concerned with a whole-farm profitability measure and would base his decision on whichever option earns the greatest amount of return. The study compares two different cropping systems on a whole farm basis over time to determine if an organic cropping system will be more profitable than a conventional Kansas cropping system using Moore Farms as a case farm. A point of critical consideration is the transition period before organic certification, which involves higher risk and much lower profits unless properly managed.

A model was created to simulate profitability of Moore Farms, a 600-acre farm in east-central Kansas, over a 17-year period. This time horizon was used because it was found that it would take at least this long to completely transition the farm acres to stabilized organic production using the slowest transition rate considered (see table 4.1). The model was designed to estimate 1,000 realizations of whole farm net income based on randomly drawn conventional crop prices and yields and actual conventional crop input costs. The model also drew random organic crop prices and yields and, using estimates of organic crop input costs, estimated farm net income from organic crops. These two net incomes were then compared to see which cropping system is more economically beneficial.

The model was used to determine how quickly the 600-acre farm could be transitioned to organic production and still survive economically. For the three-year transition period, organic production costs and yields were combined with conventional prices to simulate the reduced income received. The transition was simulated using different transition rates to organic production.

3.1.1. Model Assumptions

The model consisted of a series of assumptions:

1. Farm size was assumed to be 600 tillable acres for both conventional and organic cropping practices.
2. Based on interviews with local organic farmers (Keating, 2006; Parks, 2006; McGranahan, 2006) and other literature, average organic yields of corn, wheat and milo in the first year of transition were assumed to drop to about 60% those of their conventional counterparts as the synthetic nitrogen application was withdrawn. Soybean and alfalfa yields dropped to only 65% of conventional yields, as they rely less upon applied nitrogen. The yields were assumed to increase linearly to within 90% of conventional levels for corn, wheat and milo by year 7 because of the farm manager learning curve and natural fertility build-up. Yields of soybeans and alfalfa reach 95% of their conventional equivalents by year 7. Maximum possible organic yields were assumed to be no higher than 97% of their conventional equivalents in any given year.
3. Each crop was expected to be replanted each year except for alfalfa, which has an expected life of 3 years and therefore has seed and tillage costs amortized over that 3-year period.
4. The first three years of organic production corresponded to the "transition period," where organic production practices must be followed but the producer cannot take

advantage of certified organic prices and therefore will receive conventional crop prices.

5. Organic conversion is assumed to be made with the same crop distribution over the total acres despite the transition rate.
6. Conventional yields for soybeans, milo, wheat, and alfalfa were correlated to the yield of conventional corn, based on historical levels of correlation.
7. Organic yields were correlated to their conventionally grown counterparts with a correlation coefficient of 0.95.
8. Conventional prices were assumed to follow similar patterns as the previous 10-years' historical prices.
9. Organic prices were assumed to be the same as the previous 10-years' historical prices as reported by Kansas Organic Producers (KOP).
10. Organic crop yields were assumed to be less variable than their conventional counterparts. This accounted for by the coefficients of variation that were between 1.5% (alfalfa) and 7.1% (milo) smaller than those of the conventional equivalents.

3.1.2. Model Parameters

The model incorporated a series of parameters to represent conditions similar to those faced by Moore Farms:

1. Conventional crop yields in bushels per acre were estimated for corn, soybeans, milo, wheat, and alfalfa (alfalfa yields are in tons per acre) based upon the recorded average historical yields on Moore Farms from 1991 to 2005.
2. Average conventional crop price per bushel was estimated for corn, soybeans, milo, wheat, and alfalfa (per ton) based on U.S. Department of Agriculture (USDA)

National Agricultural Statistical Service (NASS) data for Kansas over a 10-year period from 1995 to 2005.

3. Historic organic commodity price data, obtained from Kansas Organic Producers, were used to estimate price ranges for organic crops.
4. Per acre conventional fertility and herbicide costs were based upon actual invoices of costs incurred by Moore Farms and were specified as levels considered typical for the farm.
5. Per acre land rental rates were an average of rental prices paid to landlords by Moore Farms.
6. Per acre organic fertility and pest control costs were estimated based upon interviews with local organic farmers (Keating 2006; Parks 2006; McGranahan 2006) and other literature.
7. Per acre equipment usage costs were based on University of Minnesota Extension Service publication for equipment costs, as was a per bushel auger use cost (Lazarus and Selley, 2005).
8. Per acre weed hand rogue costs were assumed based on a labor rate of $15.00 per hour and a person covering one acre per hour.
9. A changeover cost was assumed based on the above labor rate and an estimate of nine hours of equipment changeover/cleanup per crop. This was assumed to be 50% higher for organic crops since equipment has to be cleaned before entering an organic field.
10. A management cost per acre was assumed based on the above labor rate and an estimate of 15 hours of management time per crop. This was assumed to be 50%

higher for organic crops since many more records must be kept to record management activities to verify the crops are organic and had no conventional inputs.

11. Trucking costs per bushel were assumed based upon averages given by Kansas Custom Rates for 2005 (Habets et al., 2005).
12. An on-farm storage cost of $.45 per bushel was assumed based upon Kansas State University Extension publication MF-2474 (Dhuyvetter et al., 2007).
13. A discount rate of 8.5 % is assumed to account for an 8.5% bank interest rate (Farmers State Bank, 2006).

3.2. Conventional Crop Yields

Conventional yields were estimated using the mean and maximum of actual recorded historic yield data for Moore Farms from 1991 to 2005. The Moore Farms data for this time period were not contiguous with little variability. Therefore, standard deviations from the USDA NASS data for Morris County Kansas from 1995 to 2005 were used to compute the coefficients of variation for yields. A random number was used to account for factors such as weather, insects, weeds and disease.

3.2.1. Random Numbers for All Yields

In a separate Excel worksheet, one random number was generated for use in each of the 1,000 yield calculations for each crop, including organic crops. The equation used in Excel to generate 1,000 random values (Σ) is:

(1)

$$\Sigma = \text{NORMINV (RAND (), 0, 1)}.$$

This returns the inverse of the normal cumulative distribution with a random probability between 0 and 1 inclusive, a mean of 0 and a standard deviation of 1. The combination of the random probability and the inverse of the normal distribution enables the equation to return a negative random number 50% of the time, which more accurately represents market fluctuations or weather changes or weed pressures in the case of yield calculations (Kastens, 2006).

3.2.2. Conventional Corn

The maximum yield, minimum yield, mean yield, and coefficient of variation (CV) of yield of conventionally grown corn for Moore Farms between 1991 and 2005 are shown in table 3.1. A simulated yield for conventional corn ($\hat{Y}_{cc}$) was calculated based upon the numbers in table 3.1 using Equation 2 in Excel:

(2)

$$\hat{Y}_{cc} = \text{MIN}(\text{max\_}Y_{cc}, \text{MAX}(0, \bar{Y}_{cc} + \Sigma * \sigma_{cc}))$$

This equation first multiplies the simulated yield standard deviation (σ, calculated as a product of the mean yield and CV in table 3.1) by the random number (Σ) and adds it to the mean yield ($\bar{Y}_{cc}$). It then determines if the value returned from that calculation is greater than the minimum yield of 0. The larger value of the two is then compared to the historical maximum yield ($\text{max\_}Y_{cc}$) to select the smaller of those two numbers. This calculation is repeated for another 999 simulations to provide 1,000 total observations of simulated corn yields. All other conventional crop yields were correlated to these corn yields.

3.2.3. Conventional Soybean, Wheat, Milo, and Alfalfa Yields

The other four conventional crop yields were estimated from the conventional corn yield given the calculated correlation between historic corn yield and the other crop yields. The maximum, minimum, and mean yields, and coefficients of variation for soybeans, wheat, milo and alfalfa from Moore Farms between 1991 and 2005 are reported in table 3.1.

The simulated conventional yields for soybeans ($\hat{Y}_{cs}$), wheat ($\hat{Y}_{cw}$), milo ($\hat{Y}_{cm}$), and alfalfa ($\hat{Y}_{ca}$) were calculated from the simulated conventional corn yield ($\hat{Y}_{cc}$) using the Ordinary Least Squares (OLS) regression. OLS minimizes mean squared error or the average squared differences between an actual crop yield and estimated crop yields. The calculation involves root mean squared error (γ), a slope coefficient (B_1) and an intercept term (B_0) for each crop.

The root mean squared error for the *i*th crop yield (γ_i) is calculated by equation:

(3)

$$\gamma_i = (1-\rho_i^2)^{1/2} * \sigma_i$$

i= *cs, cw, cm* and *ca*

where ρ_i is the correlation between historic corn yields and the *i*th crop yields, and σ_i is the standard deviation of the *i*th crop yield. The notation *i* represents the crops: *cs* is conventional soybeans, *cw* is conventional wheat, *cm* is conventional milo, and *ca* is conventional alfalfa.

The slope coefficient (B_1) indicates how much the crop's yield will change when corn yield changes by one bushel per acre. This is calculated through equation 4:

(4)

$$B_{1\ i} = ((\sigma_i^2 - \gamma_i^2)/\sigma_{cc}^2)^{1/2} * \text{sign}\ (\rho_i)$$

i= *cs, cw, cm* and *ca*

where σ_i is the standard deviation of the other crop yields, γ_i is the root mean squared error of the *i*th crop, σ_{cc} is the standard deviation of the corn crop yields and ρ_i is the yield correlation between corn and the *i*th crop. If the yield correlation is negative, the slope coefficient is negative, and vice versa.

The constant or intercept term (B_0) determines the level of the other crop yields when the level of the corn yield equals zero. This is found through the equation:

(5)

$$B_{0\ i} = \overline{Y}_i - B_{1_i} * \overline{Y}_{cc}$$

i= *cs, cw, cm* and *ca*

where $\overline{Y}_{cc}$ is the mean yield of corn, B_{1_i} is the other crop's slope coefficient, and $\overline{Y}_i$ is the other crop's mean yield.

A simulated yield for the *i*th crop was then calculated based upon the above numbers using equation 6 in Excel:

(6)

$$\hat{Y}_i = \text{MIN}(\max\_Y_i, \text{MAX}(\min\_Y_i, B_{0_i} + B_{1_i} * \hat{Y}_{cc} + \gamma_i * \Sigma))$$

i= *cs, cw, cm* and *ca.*

The equation first multiplies the RMSE (γ_i, equation 3) by the random number (Σ, equation 1). It then multiplies the calculated corn yield ($\hat{Y}_{cc}$, equation 2) by the dependent crop slope coefficient (B_1, equation 4). The resulting two numbers are added together and then added to the dependent crop intercept (B_0, equation 5). It then determines if the value returned from that calculation is greater than the minimum yield ($\min\_Y_i$) of 0. Whichever value is larger, it then compares to the maximum yield ($\max\_Y_i$) and finally returns the lesser of those two numbers.

Table 3.1: Conventional Yield Calculation Parameters

	$\bar{Y}$	CV_Y	Max_Y	Min_Y	ρ	σ_i	γ_i	B_1	B_0
C Corn	106.20	0.28	135.00	0.00		29.24			
C Beans	32.40	0.35	52.00	0.00	0.73	11.47	7.82	0.29	1.92
C Wheat	47.40	0.25	80.00	0.00	0.09	11.91	11.86	0.04	43.31
C Milo	91.50	0.27	112.00	0.00	0.95	24.82	7.91	0.80	6.06
C Alfalfa	3.14	0.16	5.00	0.00	0.91	0.51	0.21	0.02	1.43

3.3. Organic Crop Yields

Organic crop yields were calculated in much the same manner as conventional yields using equations 3-6. However, a different random number as calculated in Equation 1 was used to calculate new random numbers for the organic yields. A key difference between organic and conventional yields is that each organic crop yield was assumed to be correlated to its conventional equivalent rather than the yield of conventional corn. This correlation was assumed based upon research and interviews with local farmers (Keating, 2006; Parks, 2006; McGranahan, 2006). Another major difference is that seven different yield columns were calculated, with average yields that increased linearly over the years to simulate the number of years it takes for crop yields to return to conventional levels according to the experience of local organic farmers (Keating, 2006; Parks, 2006; McGranahan, 2006). In the interviews, the farmers indicated that yields of the organic crops were less variable than their conventional yields. This is accounted for by using the coefficients of variation in each year that were lower than those of the conventional counterparts. Parameters for organic yield calculations for the first seven years are reported in table 3.2.

Table 3.2: Organic Yield Calculation Parameters

	$\bar{Y}$	*CV_Y*	*Max_Y*	*Min_Y*	ρ	σ_i	γ_i	B_1	B_0
O Corn 1	63.72	0.22	130.95	0.00	0.95	14.02	4.38	0.46	15.35
O Corn 2	69.03	0.22	130.95	0.00	0.95	15.19	4.74	0.49	16.63
O Corn 3	74.34	0.22	130.95	0.00	0.95	16.35	5.11	0.53	17.91
O Corn 4	79.65	0.22	130.95	0.00	0.95	17.52	5.47	0.57	19.19
O Corn 5	84.96	0.22	130.95	0.00	0.95	18.69	5.84	0.61	20.47
O Corn 6	90.27	0.22	130.95	0.00	0.95	19.86	6.20	0.65	21.75
O Corn 7	95.58	0.22	130.95	0.00	0.95	21.03	6.57	0.68	23.03
O Bean 1	21.06	0.30	50.44	0.00	0.95	6.32	1.97	0.52	4.11
O Bean 2	22.68	0.30	50.44	0.00	0.95	6.80	2.12	0.56	4.43
O Bean 3	24.30	0.30	50.44	0.00	0.95	7.29	2.28	0.60	4.74
O Bean 4	25.92	0.30	50.44	0.00	0.95	7.78	2.43	0.64	5.06
O Bean 5	27.54	0.30	50.44	0.00	0.95	8.26	2.58	0.68	5.38
O Bean 6	29.16	0.30	50.44	0.00	0.95	8.75	2.73	0.72	5.69
O Bean 7	30.78	0.30	50.44	0.00	0.95	9.23	2.88	0.76	6.01
O Wheat 1	28.44	0.20	77.60	0.00	0.95	5.69	1.78	0.45	6.93
O Wheat 2	28.44	0.20	77.60	0.00	0.95	5.69	1.78	0.45	6.93
O Wheat 3	30.81	0.20	77.60	0.00	0.95	6.16	1.92	0.49	7.51
O Wheat 4	33.18	0.20	77.60	0.00	0.95	6.64	2.07	0.53	8.09
O Wheat 5	35.55	0.20	77.60	0.00	0.95	7.11	2.22	0.57	8.67
O Wheat 6	37.92	0.20	77.60	0.00	0.95	7.58	2.37	0.60	9.25
O Wheat 7	40.29	0.20	77.60	0.00	0.95	8.06	2.52	0.64	9.82
O Milo 1	82.35	0.20	108.64	0.00	0.95	16.47	5.14	0.63	24.67
O Milo 2	54.90	0.20	108.64	0.00	0.95	10.98	3.43	0.42	16.45
O Milo 3	59.48	0.20	108.64	0.00	0.95	11.90	3.71	0.46	17.82
O Milo 4	64.05	0.20	108.64	0.00	0.95	12.81	4.00	0.49	19.19
O Milo 5	68.63	0.20	108.64	0.00	0.95	13.73	4.29	0.53	20.56
O Milo 6	73.20	0.20	108.64	0.00	0.95	14.64	4.57	0.56	21.93
O Milo 7	77.78	0.20	108.64	0.00	0.95	15.56	4.86	0.60	23.30
O Alfalfa 1	2.83	0.15	4.85	0.00	0.95	0.42	0.13	0.78	0.37
O Alfalfa 2	2.04	0.15	4.85	0.00	0.95	0.31	0.10	0.57	0.26
O Alfalfa 3	2.20	0.15	4.85	0.00	0.95	0.33	0.10	0.61	0.28
O Alfalfa 4	2.36	0.15	4.85	0.00	0.95	0.35	0.11	0.65	0.31
O Alfalfa 5	2.51	0.15	4.85	0.00	0.95	0.38	0.12	0.70	0.33
O Alfalfa 6	2.67	0.15	4.85	0.00	0.95	0.40	0.13	0.74	0.35
O Alfalfa 7	2.83	0.15	4.85	0.00	0.95	0.42	0.13	0.78	0.37

3.4. Crop Prices

3.4.1. Random Numbers for All Prices

In a separate Excel worksheet, 1,000 random numbers, independent of those for yield, were generated for use in each of the 1,000 price calculations for each crop, including organic crops, using equation 1.

Prices of conventional grains for this simulation were based on USDA NASS data. Monthly average prices for each commodity were collected from years 2003 through 2005 for the state of Kansas because that is the time period that organic premium prices were available. This yielded a total of 36 prices for each grain commodity. The maximum price, minimum price, average price, standard deviation (σ), correlation to conventional corn prices (ρ), and the coefficient of variation (CV) of these prices were calculated for each grain commodity based on these data. Conventional corn price was generated using equation 2 the same way conventional corn yield was generated. The parameters for the price generation are included in table 3.3. Prices of the rest of the conventional crops were generated in the same way as the yields using equations 3-6 and the parameters in table 3.3.

Table 3.3: Conventional price calculation parameters

	$\bar{P}$	CV_P	Max_P	Min_P	ρ	σ_i	γ_i	B_1	B_0
C Corn $	$2.36	14.2%	$3.04	$1.85		0.33			
C Beans $	$6.49	21.3%	$9.82	$5.04	0.69	1.38	1.00	2.85	-0.23
C Wheat $	$3.32	7.3%	$3.79	$2.80	0.87	0.24	0.12	0.63	1.83
C Milo $	$2.00	18.2%	$2.80	$1.53	0.96	0.37	0.10	1.05	-0.48
C Alfalfa $	$76.06	9.4%	$120.00	$63.00	0.09	7.13	7.10	1.89	71.59

3.5. Organic Prices

Prices of organically grown commodities for this simulation were gathered from the Kansas Organic Producers (KOP). The KOP provided a list of prices paid to producers for several different grains, including corn, soybeans, hard red winter wheat and alfalfa hay from the last few months of 2003 until the end of 2005. Heiman (2006) used these same data for price analysis. Table 3.4 shows the number of organic prices that were sampled. Of note in table 3.4 is that the premium of organic milo was based on only 5 samples gathered from KOP all in one year with the latest price samples being much higher than the earlier samples. The maximum price, minimum price, average price, standard deviation (σ), correlation to its conventional equivalent (ρ), and coefficient of variation (CV) of these prices were calculated for each organic grain based on these data. The parameters for the price generation are included in table 3.5. Note that prices for the organic crops largely have negative correlations to their conventional equivalents for the time period chosen. Prices of the organic crops were generated in the same way as the organic yields using equations 3-6 and the parameters in table 3.5.

Table 3.4: Organic price samples

	Number of Samples
O Corn	213
O Beans	109
O Wheat	63
O Milo	5
O Alfalfa	59

Table 3.5: Organic price calculation parameters

	$\overline{P}$	CV_P	Max_P	Min_P	ρ	σ_i	γ_i	B_1	B_0
O Corn $	$4.81	13.9%	$6.30	$3.67	-0.29	0.67	0.64	-0.59	6.19
O Beans $	$12.20	4.1%	$14.57	$11.51	-0.44	0.50	0.45	-0.16	13.23
O Wheat $	$4.29	7.2%	$5.61	$3.95	-0.14	0.31	0.31	-0.18	4.88
O Milo $	$2.88	2.1%	$2.94	$2.60	-0.95	0.06	0.02	-0.16	3.19
O Alfalfa $	$100.82	14.8%	$148.00	$50.00	0.08	14.96	14.91	0.18	87.31

3.6. Gross Revenue Per Acre

After prices and yields of each crop were simulated, they were multiplied together in another worksheet to determine gross revenue per acre generated by each of the 1,000 observations for each crop. The calculations are shown in equations 7-9 below, where Y_c is conventional yield, P_c is conventional price, Y_o is organic yield, P_o is organic price, CG$ is conventional gross revenue per acre, TG$ is transitional gross revenue per acre, and OG$ is organic gross revenue per acre.

(7)

$$CG\$ = Y_c * P_c$$

(8)

$$TG\$ = Y_o * P_c$$

(9)

$$OG\$ = Y_o * P_o$$

3.7. Input Costs Per Acre

In a separate worksheet, all input costs were estimated for growing each crop raised both conventionally and organically. Table 3.6 shows an example of the costs associated with growing corn with both per acres costs as well as costs that are yield dependant. It was determined that there were 33 potential inputs associated with growing a given crop that could be calculated on a per acre basis, and there were 3 potential inputs that depended on the yield of that crop. These are listed in the first column, and their associated costs are listed in the second column.

Inputs in the "Fertility / Herbicide etc." section were derived from actual invoices of expenses paid by Moore Farms in 2006 for the inputs applied and are considered typical for the farm. Inputs in the "Equipment" section were based on University of Minnesota extension economic cost estimates (Lazarus and Selley, 2005). These costs include: fuel, lubrication, use-related repairs and labor, depreciation, interest, insurance, personal property taxes, housing, as well as labor for downtime for equipment adjustments, and planter/ drill filling. Rent was the average of land rent paid to landlords by the farm from 1991 to 2006.

Inputs in the "Labor" section were based upon a labor rate of $15.00 per hour. Per acre weed hand rogue costs assumed one person covering one acre in an hour. A "Changeover" cost was estimated assuming 6 hours were spent for each crop on equipment changeover, cleanup, transport and handling, divided by the number of acres of each crop. This was assumed to be 50% higher for organic crops since each piece of equipment has to be cleaned before performing an operation in an organic field.

Similarly, a "Management" cost assumed 12 hours of management time per crop, divided by the number of acres of each crop. This was assumed to be 50% higher for organic crops, since more documentation must be kept to record management activities and to verify the crops are organic with no conventional inputs and also was intended to account for additional logistics of the grain.

As for yield-dependent inputs, trucking costs per bushel were assumed based upon rates given by Kansas Custom Rates for 2005 (Habets et al., 2005). This is an average of trucking rates paid by Kansas farmers in 2005. With commercial elevators and outlets for conventionally grown crops, on-farm storage is usually not necessary. Since organic crops do not have the infrastructure yet to have nearby handling facilities, on-farm, temporary storage is needed. If on-farm storage were already utilized for conventional crops, a second facility would be necessary since the two cannot be intermingled. An on-farm storage cost of $.45 per bushel was assumed based upon Kansas State University Extension publication MF-2474 (Dhuyvetter et al., 2007). This cost includes the cost of purchasing a 10,000-bushel bin, conveyance equipment, depreciation, interest, taxes, insurance, utilities, repairs, auger use and grain shrinkage, but excludes bin insecticide. In the simulation, the extra storage was not applied to organic crops grown through the 3-year transition period, since they were assumed to be sold through conventional channels.

The "Conventional" and the "Organic" columns have sub-columns called "P", which stands for passes. This is the number of times a particular input is applied for growing a crop. For the conventional crops the numbers of passes in table 3.6 were taken from the actual numbers of passes applied by Moore Farms for the year 2006. The numbers of passes for the organic crops were determined through interviews with local organic farmers (Keating, 2006; Parks, 2006; McGranahan, 2006). The passes associated with each crop were considered typical for the geographic area. Two inputs, trucking, and storage were multiplied by the simulated yield to convert them to a per acre basis and then added to the rest of the associated input costs. This yielded one column of 1,000 annual costs for each associated conventional crop and each of the 7 years of organic crops, for a total of 40,000 simulated input costs (= 5 conventional crops × 1,000 simulations + 5 organic crops × 7 years × 1,000 simulations).

Table 3.6: Input cost example (Corn)

	CORN	Cost	Conventional		Organic	
		$/Acre	P	Grain	P	Grain
Fertility / Herbicide etc.	Seed	$34.70	1.0	$34.70	1.0	$34.70
	Innoculant	$0.97		$0.00		$0.00
	Seed treatment	$1.17	1.0	$1.17	1.0	$1.17
	Starter 10-34-0	$6.53	1.0	$6.53		$0.00
	Starter 32-0-0	$5.55	1.0	$5.55		$0.00
	Later Fert	$23.11	1.0	$23.11		$0.00
	Pre-emerge herb.	$4.34	1.0	$4.34		$0.00
	Application	$3.75	1.0	$3.75		$0.00
	Post-emerge herb.	$5.04	1.0	$5.04		$0.00
	Application	$4.75	1.0	$4.75		$0.00
Equipment	Disk 1	$9.87	1.0	$9.87	1.0	$9.87
	Disk 2	$7.88	1.0	$7.88	1.0	$7.88
	Field cultivate	$4.07	1.0	$4.07	2.0	$8.14
	Seed drill	$9.78		$0.00		$0.00
	Row planter	$11.47	1.0	$11.47	1.0	$11.47
	Row cultivate 1	$4.44		$0.00	3.0	$13.32
	Combine (corn)	$33.64	1.0	$33.64	1.0	$33.64
	Combine (flex)	$19.60		$0.00		$0.00
	Combine (row)	$22.12		$0.00		$0.00
	Swather	$9.40		$0.00		$0.00
	Rake	$7.04		$0.00		$0.00
	Plow	$16.23		$0.00		$0.00
	Chisel	$7.58		$0.00		$0.00
	Baler w/ wrap	$19.21		$0.00		$0.00
	Frg harv (row)	$46.89		$0.00		$0.00
	Frg harv (pickup)	$19.54		$0.00		$0.00
	Rotary Mower	$6.53		$0.00		$0.00
	Load Manure	$9.00		$0.00	1.0	$9.00
	Spread Manure	$11.52		$0.00	1.0	$11.52
	Rent	$40.00	1.0	$40.00	1.0	$40.00
Labor	Hand Rogue	$15.00		$0.00	2.0	$30.00
	Changeover	$2.40	1.0	$2.40	1.5	$3.60
	Management	$4.20	1.0	$4.20	1.5	$6.30
	Total $/Acre/yr			**$202.47**		**$220.61**

	Yield dependant	Cost	Conventional		Organic	
		$/bu	P	Grain	P	Grain
$/bu	Trucking	$0.12	1.0	$0.12	1.0	$0.12
	Added storage	$0.45		$0.00	1.0	$0.45
	Input $/bu/yr			**$0.12**		**$0.57**

3.8. Net Revenue Acre

Simulated net revenue for the five conventional crops and the seven years of their organic equivalents were calculated by subtracting their input costs (I_c, I_o) from their corresponding calculated gross revenue (CG$, OG$) from the results of equations 7-9. Conventional net revenue (CN$) is shown in equation 10, where CG$ is conventional gross revenue and I_c is conventional input costs. Organic (ON$) and transitional (TN$) net revenues are shown in equations 11a and 11b, respectively.

(10)

$$\text{CN\$} = \text{CG\$} - I_c$$

(11a)

$$\text{TN\$} = \text{TG\$} - I_o$$

(11b)

$$\text{ON\$} = \text{OG\$} - I_o$$

Each of the 1,000 calculated values for input costs for each of the five conventional crops were subtracted from the same 1,000 calculated values for gross revenue for each of the five conventional crops to give 1,000 simulated values for net revenue per acre for each conventional crop. This same calculation was repeated for each of the seven years of organic production in each of the five crops for a total of 40,000 simulated net revenue values per acre.

3.9. Net Revenue Per Crop

Percentages of the farm's 600 tillable acres were assigned to the five different crops to represent a typical distribution of the crop mix on the Morris County, Kansas farm. Table 3.7 shows the acreage distribution.

Table 3.7: Acreage distribution

Crop	Percent	Acres
Corn %	8.33%	50
Bean %	33.33%	200
Wheat %	16.67%	100
Milo %	33.33%	200
Alfalfa %	8.33%	50

The per acre net revenues (CN$) that were calculated in equation 10 for the five conventionally grown crops were multiplied by the number of acres (A) on which they were grown, shown in table 3.7, resulting in how much annual net income the farm gained or lost on each crop (CCrop $) according to equation 12.

(12)

$$CN\$ * A = CCrop\ \$$$

The per acre net revenues (ON$) that were calculated in equation 11 for the seven years of organically grown crops were also multiplied by the number of acres (A) in table 3.7 resulting in the annual net income the farm gained or lost on the transitional and organic crops (TCrop $ and OCrop $) as shown in equations 13a and 13b, respectively.

(13a)

$$TN\$ * A = TCrop\ \$$$

(13b)

$$ON\$ * A = OCrop\ \$$$

This was executed 1,000 times for each conventional crop and 1,000 times for each year of each organic crop. The same crop acre distribution was maintained throughout.

CHAPTER 4: RESULTS

4.1. Whole Farm Net Revenue

The calculated values for yields, prices, gross revenue per acre, inputs per acre, net revenue per acre and net revenue per crop were incorporated into the farm-level analysis to find out if a fully certified organic cropping system can be profitable on the 600-acre farm for a given crop mix. If it is found profitable, the next step is to find out how much revenue will be diminished in the three-year transitional period of each crop. The last two points of interest are what transition rate will pose the least risk to the farm and how long will it take for organic conversion to pay for itself.

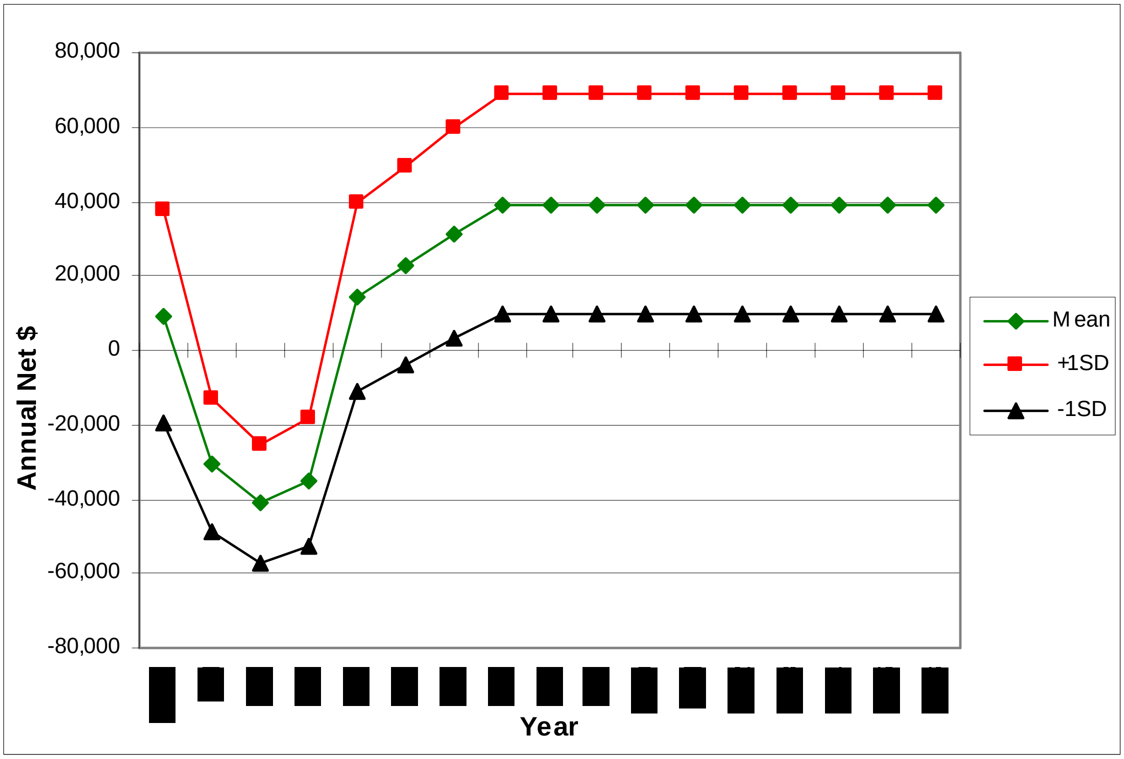
Adding together simulated net revenues for conventional corn, beans, wheat, milo, and alfalfa crops resulted in 1,000 possible annual net revenues for the entire farm. Annual net revenues for years 1-7 for the organically grown crops were computed as well. The mean value for these 1,000 samples was calculated to find what the whole farm average annual income over 1,000 random samples might be. The standard deviation of these annual whole farm income values was then calculated to determine how much up or down the annual income could vary from the mean on average. This was repeated for each of the seven years of each of the five organic crops as well to determine mean farm income over 1,000 random samples as well as the variability over time.

The analysis was completed assuming three transition schemes as discussed below.

4.1.1. 100% Conversion

If all acres were converted to organic at one time, the whole farm annual income will switch from the income dependent on conventional crops to that dependent on organic groups for the subsequent years. Figure 4.1 shows such average annual profit plus and minus one standard deviation for the farm if 100% of the 600 acres is converted to organic production at one time. Thus, the range represents about 68% of realizations if the annual profit is distributed normally. The first data point, labeled 'Conv', is the net profit for conventional production under status quo and is considered the benchmark. The next three data points, labeled 'Yr 1' through 'Yr 3' are the transitional years of organic production. The data points 'Yr 4' through 'Yr 7' are profit levels when the farm is able to take advantage of organic price premiums. Year 7 is when yield levels of the organic crops are assumed to reach their peak of 90%-95% those of conventional (Keating, 2006; Parks, 2006; McGranahan, 2006). Observably, organic production with organic price premiums can bring whole farm profit levels that easily exceed those of conventional production practices in about four years. However, as can be seen, there is a very high likelihood to incur a substantial economic loss for the initial three transitional years, which ranges from losing as much as $57,000 in year 2 to losing as little as $13,000 in year 1. The data used in the figures are reported in the Appendix. The question is, can this economic loss be minimized?

Figure 4.1: Annual profit with 100% land conversion



4.1.2. 20% Conversion

Obviously, an average annual loss of nearly $36,000 for the first three years is undesirable for both a farm operator and a banker. However, 100% of the farm does not have to be transitioned into organic at once. An alternative would be to transition 20% of the total acreage every year to spread the loss over a longer time period and allow part of the conventional profits and some of the certified organic profits to cover the transitional losses.

Transitioning 20% of the total acres per year requires a schedule to keep track of how many acres are in each stage of transition in a given year. Table 4.1 shows the 20% per year transition schedule. The highlighted rows indicate the transitional years. As can be seen, it takes 11 years for 100% of the tillable acres to reach full yield organic production.

Table 4.1: 20% per year land transition schedule

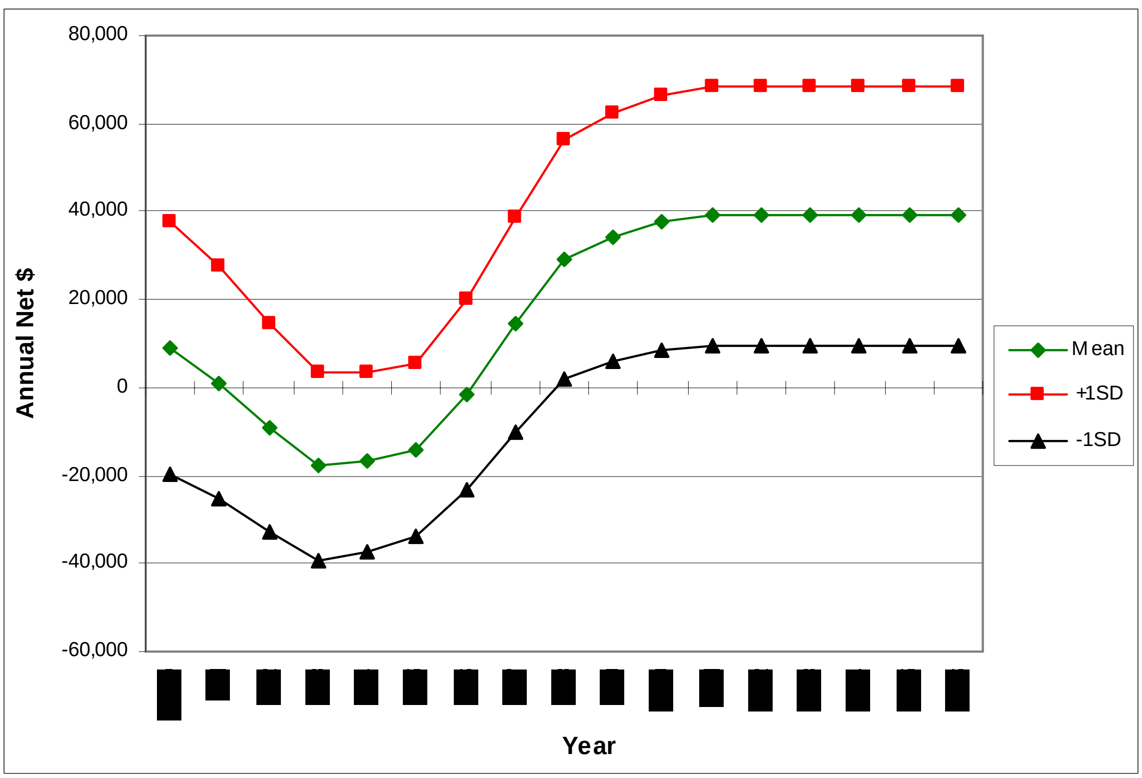
20%	Conv	yr 1	yr 2	yr 3	yr 4	yr 5	yr 6	yr 7	yr 8	yr 9	yr 10	yr 11
Conv	100%	80%	60%	40%	20%							
T yr 1		20%	20%	20%	20%	20%						
T yr 2			20%	20%	20%	20%	20%					
T yr 3				20%	20%	20%	20%	20%				
O yr 4					20%	20%	20%	20%	20%			
O yr 5						20%	20%	20%	20%	20%		
O yr 6							20%	20%	20%	20%	20%	
O yr 7								20%	40%	60%	80%	100%
Total acres	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Figure 4.2 shows average annual profit plus and minus one standard deviation for the farm if 20% of the 600 acres is converted to organic production per year. The dollar values from figure 4.1 were multiplied by the percentages given in table 4.1 and added together to produce the data for figure 4.2. Again, 'Conv' is the benchmark. The data points labeled 'Yr 1' through 'Yr 11' reflect 20% of the land per year being moved through the transitional years of organic production according to the schedule in table 4.1. It can be seen that year 8 is the first year that all acres can take advantage of organic price premiums (table 3.5), but year 7 is when the average whole farm profit level rises above the conventional average (figure 4.2). Also note that net farm profits in years 1 through 7 were less variable than conventional profits due to the assumption of lower variability of both organic prices and organic yields. However, the variation becomes greater after year 10 due largely to the higher standard deviation of the organic crop prices simulated from the sample from KOP. Though the coefficient of variation is lower for the organic prices, in several cases it may only be slightly lower and when it is multiplied by the higher organic price it produces a higher standard deviation. In addition, it is coupled with the increasing yield variability as the organic yield reaches its maturity while the acres go through

transition and 4 years beyond. However, the annual net revenue remains much higher than conventional.

At 20% acreage conversion per year, organic production with organic price premiums can bring whole farm profit levels that exceed those of conventional production practices in about 7 years. However, as shown in figure 4.2, there is still likely to be considerable economic loss in years 3-6, with the annual net income for these years averaging about -$13,000, ranging from as high as $27,000 in year 2 to as low as -$39,000 in year 3.

Figure 4.2: Annual profit with 20% conversion per year



4.1.3. 10% Conversion

Again, five consecutive years of loss does not sound good to farmers or their bankers. Perhaps transitioning fewer acres per year would help. Thus, a scenario of transitioning 10% of the total acreage every year to spread the loss over even more years and manage transitional losses was considered.

Transitioning 10% of the total acres per year also requires a schedule to keep track of how many acres are in each stage of transition in a given year. Table 4.2 shows the 10% per year transition schedule. As can be seen, it takes 16 years for 100% of the tillable acres to get to full yield organic production. It can also be seen that year 13 is the first year that all acres can take advantage of organic price premiums.

Table 4.2: 10% per Year Land Transition Schedule

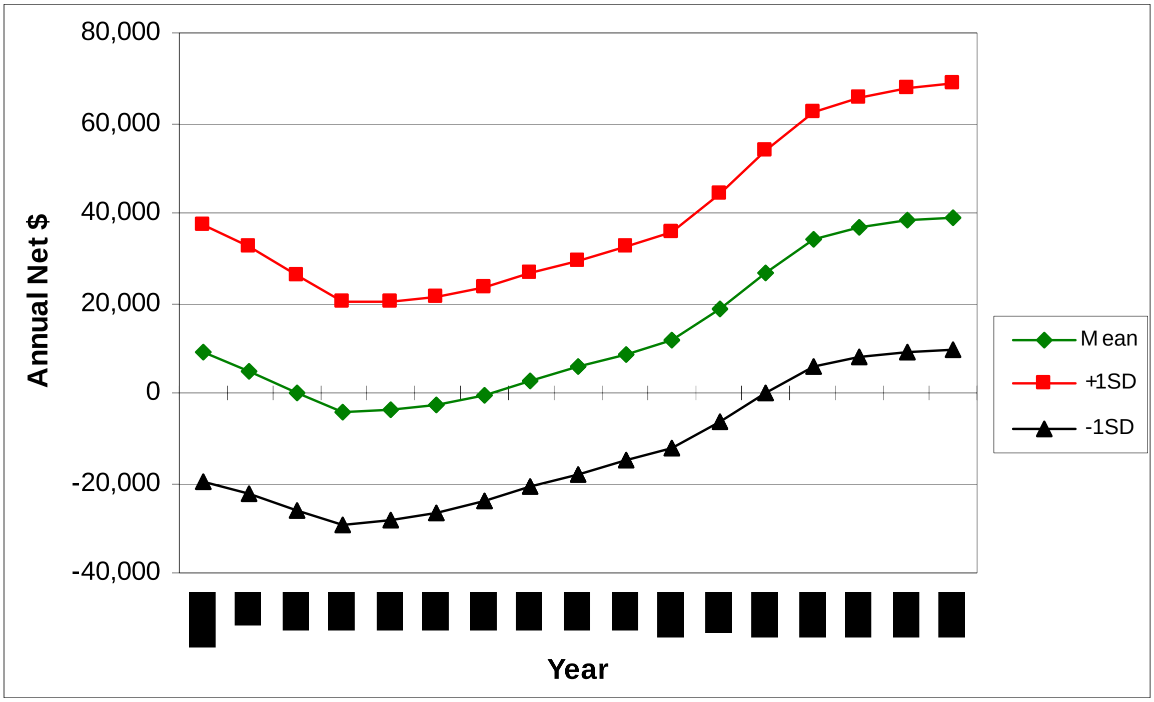
10%	Conv	yr1	yr2	yr3	yr4	yr5	yr6	yr7	yr8	yr9	yr10	yr11	yr12	yr13	yr14	yr15	yr16
Conv	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%							
T yr 1		10%	10%	10%	10%	10%	10%	10%	10%	10%	10%						
T yr 2			10%	10%	10%	10%	10%	10%	10%	10%	10%	10%					
T yr 3				10%	10%	10%	10%	10%	10%	10%	10%	10%	10%				
O yr 4					10%	10%	10%	10%	10%	10%	10%	10%	10%	10%			
O yr 5						10%	10%	10%	10%	10%	10%	10%	10%	10%	10%		
O yr 6							10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	
O yr 7								10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Total acres	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Figure 4.3 shows average annual profit plus and minus one standard deviation for the farm if 10% of the 600 acres are converted to organic production per year, generated in the same manner as figure 4.2. See the benchmark ‘Conv’ at the far left. The data points labeled ‘Yr 1’ through ‘Yr 16’ reflect 10% of the land per year being moved through the transitional years of organic production according to the schedule in table 4.2. Figure 4.3 shows that year 10 is when average whole farm profit levels rise above the conventional

average. They are less variable than conventional potential profits with conventional potential profits ranging from -$19,500 to $37,500, and organic potential profits in year 10 only ranging from -$11,500 to $34,500. However, notice that at year 15 the range of potential profits becomes greater, but the potential for loss is less. This increased range of potential profits is due largely to the higher standard deviation of the organic crop prices simulated from the sample from KOP once again.

At 10% acreage conversion per year, organic production with organic price premiums can bring whole farm profit levels that match those of conventional production practices in about 9 years. Also, according to figure 4.3, in the likelihood of economic loss to the farm peaks in year 3 with an average loss of around $4,400 with a potential low of about -$29,000 or a potential high of about $20,500. Even though loss is less than the other two conversion schemes, there would be several pretty lean years for the farm, which may be enough to discourage farmers from transitioning to the organic production system.

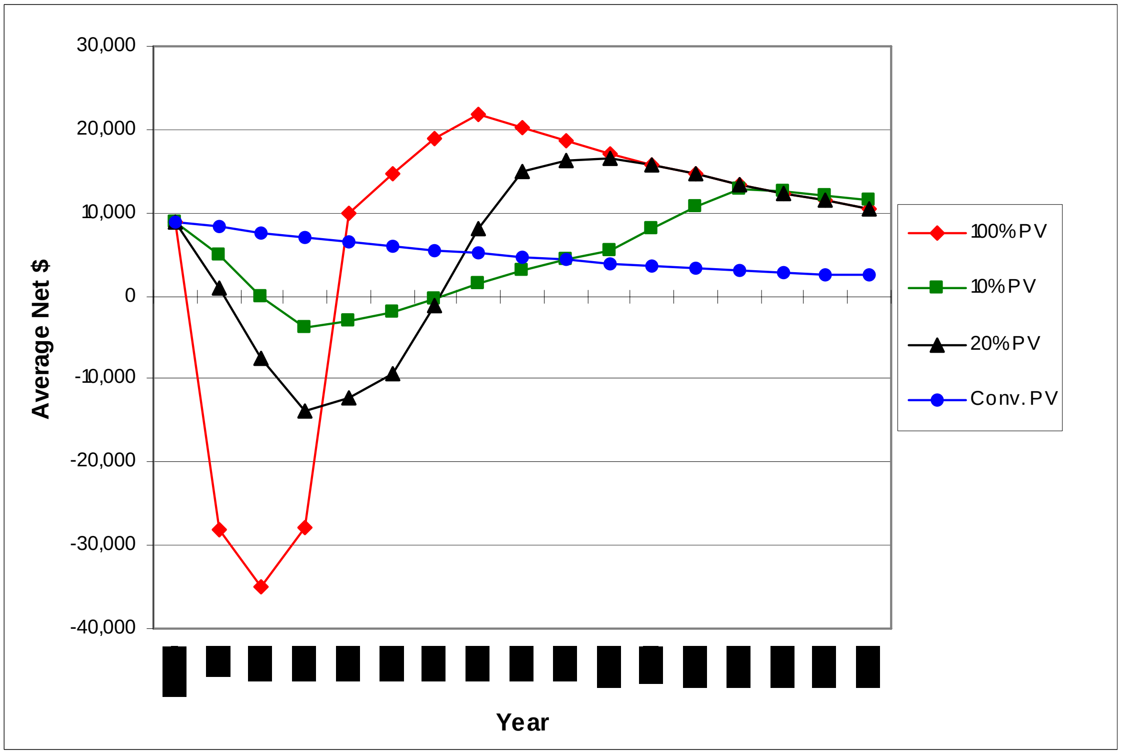
Figure 4.3: Annual profit with 10% conversion per year



4.2. Present Values of Whole Farm Average Net Revenue

Annual net revenue is important to the farm but now that it appears that organic production can be profitable for the farm, it is important to take into account the time value of that profit to determine if organic production is economically sustainable for the farm. The present value of the average whole farm annual net income was calculated to determine the value of future farm income in today's dollars, using a discount rate of 8.50% (model assumptions, Ch 3.2). Figure 4.4 shows a "snapshot" of annual profit for the three different conversion rates in today's dollars with 'Conv' being today, where all crops are grown conventionally.

Figure 4.4: PV of annual whole farm net income under various conversion schemes



Even accounting for time value of money, the loss in year 1 under the 100% conversion scheme is more than $28,000 and nearly $35,000 in year 2. The loss begins to improve in subsequent years but it is not until organic price premiums are introduced at year 4 that the PV jumps above $0 and above that of the conventional system's PV.

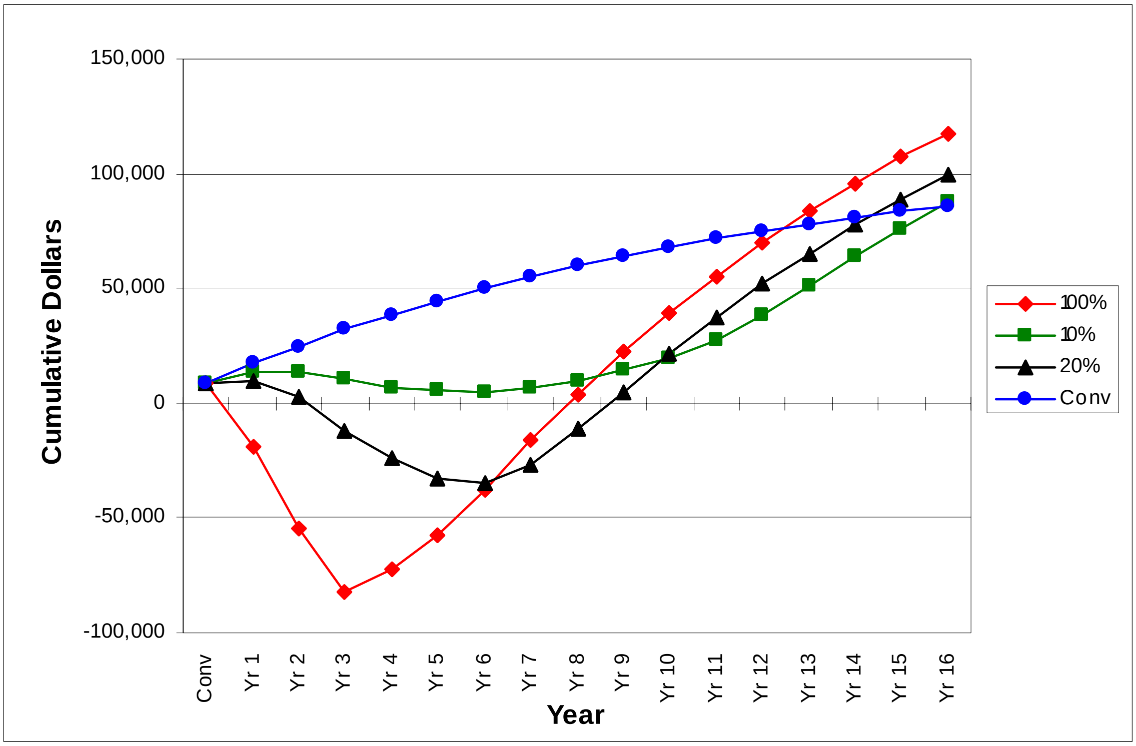
The 20% conversion rate has a positive PV of around $1,000 after the first year of transition but proceeds to have negative PV for the next five years and finally exceeds the conventional net farm income in year 7.

The 10% per year conversion rate yields a positive annual net income in average PV terms in years 1 and 2 but then shows negative net income for the next four years. After that, the present value continues to be positive and is only slightly lower than that of the conventional system in year 8. It finally comes close to matching the PV of both the 100% and 20% acreage conversions in year 13. Note that after year 13 the PV is higher for the 10% conversion rate. At any conversion rate, however, the PV is higher than that of the conventional cropping system no later than by year 9.

4.3. Cumulative Present Values of Whole Farm Average Net Revenue

Important questions most farmers are going to ask if they are considering a transition are: 1. Is there a way to get through the transition if losses are highly likely? 2. Is the transition worth it economically in the long run? The cumulative present values (CPV) of the whole farm average net revenues in each conversion scheme over time can help answer these questions. The present values of annual net revenues from a given conversion scheme are added to its PV's from previous years. For example: 'Conv' CPV is simply the PV of profit made in the benchmark year of the conventional system. 'Yr 1' CPV is 'Conv' PV added to 'Yr 1' PV. Yr 2 CPV is the PV's of 'Conv', 'Yr 1' and 'Yr 2'. This continues through 'Yr 16'. The computed CPV's represent the net present values of converting the farm into organic for the given conversion schemes over a given number of years. The CPV's are calculated for the three conversion schemes as well as the conventional cropping system. Figure 4.5 below shows these different scenarios.

Figure 4.5: Cumulative PV by year per conversion rate



4.3.1. 100% Conversion Average Cumulative PV

If all available acres were converted to organic production at once and the net profits or losses were added together beginning with 'Conv' (totally conventional production) using today's dollars, the 100% conversion rate would be the result. As can be seen in figure 4.5, the first three years would be cumulative losses for the whole farm with some recovery in years 4, 5, 6 and 7 due to the advantage of organic price premiums. However, it is not until year 8 that the cumulative present value creeps above $0, and it is not until year 13 that CPV exceeds that of the existing conventional cropping system. That is, the farm can be better off by converting to organic only if they intend to stay farming for at least 13 years after converting the farm 100% in the first year. But, cumulative PV remains higher than that of conventional cropping after year 13 as shown by the steeper curve in figure 4.5. However, it is not likely that many small farms would be able to survive a cumulative loss of nearly $82,000 in the first 3 years.

4.3.2. 20% Conversion Average Cumulative PV

If 20% of the available acres were converted to organic production per year (refer to table 4.1) and the net profits or losses were added together beginning with ‘Conv’ (totally conventional production) using today’s dollars, the 20% conversion rate would be the result. For the first 14 years after beginning the transition, the farm is worse off than if it had stayed with the conventional cropping system. The cumulative loss is not incurred in the first two years but in years 3 through 8, the loss becomes apparent. However, the loss is not nearly as severe as those losses incurred under the 100% conversion scheme. Nonetheless, it is not until the 15th year that CPV finally climbs above that of the conventional system.

4.3.3. 10% Conversion Average Cumulative PV

If 10% of the available acres were converted to organic production per year (refer to table 4.2) and the net profits or losses were added together beginning with ‘Conv’ (totally conventional production) using today’s dollars, the 10% conversion rate would be the result. The curve is fairly flat in years 1 and 2 with cumulative PV hovering around $14,000 for the farm. In years 4 through 8 cumulative PV dips down below $10,000 bottoming out at $5,000 in year 6. Cumulative PV begins to increase after that. It can be noticed that in year 12 the cumulative present value of the 10% conversion rate rises to just under half that of the conventional system. Note also that the 10% per year conversion rate did not climb above the cumulative PV value of the conventional cropping system until year 16 but was increasing at a faster rate than that of the conventional system. This appears to be a possible option for small farmers wishing to transition to organic cropping systems without incurring substantial loss since the cumulative PV on average never drops below zero and after 16 years, the farm is expected to be more profitable.

CHAPTER 5: CONCLUSIONS

Profitability is a principal economic motivator for a farm to continue to conduct business. As conventional crop farming suffers from rising fertilizer, herbicide and pesticide costs, small farmers that raise grains look in the direction of new cropping practices that are not economically prohibitive or get out of the business. As these small farmers evaluate other cropping alternatives, organic cropping systems and the availability of premium organic prices should be examined as an option in achieving farm profitability objectives.

This study evaluated the economic return per acre of three different organic cropping system transition rates against the conventional crop program of the same crop mix. A simulation model was created using assumed organic yield data, actual organic prices, historical conventional yield data and historical conventional prices to determine the economic return. The model was based on an actual farm located in east-central Kansas of 600 tillable acres, with a fixed crop-acre distribution of 8.33% corn, 33.33% soybeans, 16.67% wheat, 33.33% milo, and 8.33% alfalfa. All known costs per acre were allocated to each enterprise under the conventional and organic farming systems, specific for that system and crop. These costs included land rental rates that were an average of actual rates paid to landlords by the farm, actual fertilizer and herbicide costs, assumed labor rate for crop production and management, assumed storage costs, and assumed field preparation costs spread over the crop's life of production, which is one year for all crops except alfalfa, which is three years.

A farm has to undergo a three-year transitional period with no conventional inputs before it can be considered fully organic. Three schemes for transition to organic production were analyzed: Converting the entire farm to organic production at once, converting 20% of the farm's tillable acres to organic production per year and converting 10% of the farm's tillable acres to organic production per year.

First the simulation was run to determine if organic cropping systems using organic price premiums on the 600-acre farm would be profitable at all. The simulation showed that this would most likely hold true, where organic crop production is more profitable than conventional when the transition period is ignored. However, research and personal interviews indicated that the three-year transitional period could well cause economic loss to the farm. Therefore, three different conversion schemes were simulated to find which one would be the least economically damaging to the farm.

The results of most interest to farmers are likely the cumulative present values (CPV). If a farmer wishes to transition to organic production but is afraid transitioning will cause excessive economic loss, they should consider the CPV across several years. The 100% conversion would certainly cause an acute negative CPV initially and remain negative for several years. The 20% conversion would still cause a significant CPV loss to the farm after a few years but not as severe. The average CPV of the 10% per year conversion rate never drops below $0, meaning the farm may have several lean years since it will have an economic loss, but overall, it is not likely that the farm will go completely into debt during transition with this conversion scheme.

Obviously, the transition period from conventional cropping to organic cropping is going to be the most difficult and costly. All three of the proposed transition schedules revealed economic loss to the farm at some point during their transition periods. The only system that showed no loss was the existing conventional system. However, after complete transition, the other three schemes showed much higher profitability in the long term than the conventional cropping system. The down side was that this took a minimum of 13 years to accomplish in the 100% conversion scheme, or as many as 16 years in the 10% per year conversion scheme.

The results of this study generally agree with the results of other studies on the subject. Many studies showed or assumed a reduced income in the transitional years with some recovery in the years after transition. This study finds that average income reduction from the conventional cropping system can be as much as $50,000 or 558% at its lowest point in year 2, under the 100% per year conversion scheme and as little as $13,400 or 150% in the 10% per year conversion scheme in year 3. This is supported by MacRae et al. (1993), who described that financial risks of transition could be minimized if the farm was converted in stages. Dabbert and Madden (1986) reported a 43% economic reduction during the first year with recovery in subsequent years based on their simulation. Peters (1991) observed a reduction in income in the first years of transition to organic with recovery in later years. The major differences were that Dabbert and Madden assumed to maximize income in the first year while Peters was concerned with minimizing transitional biological problems without as much regard to costs. Also in the Dabbert and Madden (1986) simulation as well as the Peters (1991) study, livestock was included, which was shown in both studies to improve economic gain. Nonetheless, the reduced transitional income is common to Dabbert and Madden (1986) and Peters (1991) as well as this study's findings.

5.1. Limitations

There were things that were not addressed in this study, most of which would affect all three-conversion schemes but not the conventional system. One consideration that would affect all cropping systems was the crop rotation. For instance, growing a legume such as soybeans or alfalfa in the year previous to milo or corn would reduce the cost of synthetic fertilizer inputs for the conventional system and reduce the need for manure application in the organic systems. This would reduce total input costs in certain years for each of the crops produced, likely making the results of the conventional figures in this study look slightly worse than they might be in reality and overestimating the economic appeal of the organic farming system.

The assumption that organic crop yields are highly correlated to their conventionally grown equivalents was another limitation. Neither interviews with local organic farmers nor research revealed any correlation of organic crop yields to conventional yields. This is where it was assumed that if the conditions were favorable to conventional crops they would be favorable to organic crops as well, and vice versa.

Also, further research is required on yield variability. The research studied and the interviews with local organic farmers suggested that the yield variability for organically grown crops was lower than that of conventionally grown. However, there have been no quantitative studies that suggest how much lower the variability is. This is the reason for the assumed variability figures. Also, it can be seen in this study that whole farm net revenue actually becomes more variable after conversion to organic production as evidenced by the higher standard deviations. However, this can again be largely attributed to the higher standard deviation of the organic crop prices simulated from the KOP price sample.

The acreage distribution across all the crops was inflexible as well. In reality, a farm is not going to keep the crop acre percentage distributions as rigid as they were assumed in this simulation. This rigidity facilitates the simulation but may also make the simulation's transitional net revenues lower than they might be in reality. As a common organic practice, farmers will typically only plant one crop for a transition crop, normally alfalfa, and allow it to grow for the entire transition period. In addition, a conventional farmer may wish to plant only the single-most profitable crop several years in a row as well, which would also change the results of the simulation.

Input costs used in this study were also assumed to remain constant throughout. In reality these input cost would likely fluctuate throughout the years. As history has shown, it is more than likely the input costs would largely climb as time progresses. One major input for organic production, labor, was possibly underestimated in this study. This is one input whose cost has consistently risen over time but was held constant for this simulation. Rising input costs such as those for fuel, and equipment would affect both organic and conventional systems adversely. Costs of other inputs such as fertilizers and herbicides have been rising over the years too, which might make conventional cropping systems appear worse.

Another limitation that would affect all conversion schemes as well as the conventional crops is crop insurance. While this is a normal farm expense for growing a crop, it was not considered at the time the study took place because the insurance company that was in use by Moore Farms would not cover organically grown crops. However, if it had been considered assuming that it was only available for conventional crops, it may have made the conventional cropping system look more profitable.

The prices of organic crops were assumed to remain at a premium above those of their conventional equivalents throughout this study. This made the years after transition look more attractive. It is a basic economic principle that if a venture is economically attractive, more entities will enter the market, creating more competition, slowly eroding the previously wide profit margin, until it is much more difficult to make a profit in that venture. With the growth of the organic movement recently and more producers, including some large retailers who have the advantage of economies of size, getting into the organic market, there is a risk that the organic premiums seen in the last few years will slowly dwindle until organic production is no longer as economically lucrative to a smaller farm. As a side note however, at the time of publication of this study, some conventional grain prices had jumped to all-time highs. Preliminary research suggests that organic commodities have maintained, and in some cases, widened their premium ratio above that of conventional in the face of those rising prices.

5.2. Suggestions for Future Research

It has been established that if an existing farm is going to transition to an organic cropping system that there will be reduced yields and therefore likely reduced profits for at least the three years of transition. Additional research needs to be conducted on the sensitivity of certain parameters in the transition simulation and also on the subject of risk management tools to reduce the economic loss of this transition.

There are certain parameters of this simulation that were held fairly rigid during every calculation and iteration of the model. During exploratory analysis, it was noticed that changing certain parameters such as milo yield averages and organic price premiums could change the net income figures significantly. In fact this particular simulation is highly dependant on milo and soybeans since over 66% of the farm's acres are in these two crops. Changing other parameters, such as the correlation of the organic crops to their conventional counterparts did not seem to have a great effect on net income. There was not much experimentation with parameter changes but it would be interesting to study how much effect they have on the net income and CPV in the simulation.

A risk management tool in organic conversion is raising specialty crops. In 2006 and 2007, Moore Farms contracted to grow identity-preserved soybean seed to be grown 'naturally' (without the use of herbicides or synthetic fertilizers but not certified organic) for a price premium above that of conventional soybeans but below that of certified organic soybeans. These soybeans were grown on acres that were in transition from conventional to organic production. Though there was a reduction in yield, net profit remained near to or slightly above that of the conventionally grown equivalent. However, finding risk management crops like this in the correct quantities can be compared to trying to thread a needle.

Another risk management tool would be to simply let the transitional land set idle for the 3-year transitional period. Economic loss would certainly be incurred, but it would be limited to the cost of rent, which in this study was only $40 per acre per year, with zero variability. The downside of this is that there is no benefit to the farmer for learning organic practices.

One last, previously noted risk management tool that seems to be the most popular among organic farms is to plant alfalfa and let it grow for the 3 years of transition. The input costs are lower since they are spread out over the three-year life of the crop and yields are not as drastically reduced as they are with corn, milo, or wheat since there is less dependence on synthetic nitrogen.

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APPENDIX A: DATA USED FOR FIGURE 4.1

100%/yr Conversion rate net $				
Year	**Mean**	**SD**	**Max**	**Min**
Conv	$8,993	$28,514	$37,508	-$19,521
Yr 1	-$30,622	$17,903	-$12,719	-$48,525
Yr 2	-$41,150	$15,919	-$25,231	-$57,070
Yr 3	-$35,438	$17,331	-$18,107	-$52,770
Yr 4	$13,907	$24,866	$38,773	-$10,959
Yr 5	$22,252	$26,320	$48,572	-$4,069
Yr 6	$30,981	$28,109	$59,090	$2,872
Yr 7	$38,770	$29,130	$67,900	$9,640
Yr 8	$38,770	$29,130	$67,900	$9,640
Yr 9	$38,770	$29,130	$67,900	$9,640
Yr 10	$38,770	$29,130	$67,900	$9,640
Yr 11	$38,770	$29,130	$67,900	$9,640
Yr 12	$38,770	$29,130	$67,900	$9,640
Yr 13	$38,770	$29,130	$67,900	$9,640
Yr 14	$38,770	$29,130	$67,900	$9,640
Yr 15	$38,770	$29,130	$67,900	$9,640
Yr 16	$38,770	$29,130	$67,900	$9,640

APPENDIX B: DATA USED FOR FIGURE 4.2

20%/yr Conversion rate net $				
Year	**Mean**	**SD**	**Max**	**Min**
Conv	$8,993	28,514	$37,508	-$19,521
Yr 1	$1,070	26,306	$27,377	-$25,236
Yr 2	-$8,958	23,717	$14,759	-$32,675
Yr 3	-$17,845	21,417	$3,572	-$39,262
Yr 4	-$16,862	19,616	$2,754	-$36,478
Yr 5	-$14,210	18,596	$4,385	-$32,806
Yr 6	-$1,890	20,683	$18,793	-$22,573
Yr 7	$14,094	23,732	$37,826	-$9,638
Yr 8	$28,936	26,907	$55,843	$2,029
Yr 9	$33,908	27,891	$61,799	$6,018
Yr 10	$37,212	28,652	$65,864	$8,560
Yr 11	$38,770	29,130	$67,900	$9,640
Yr 12	$38,770	29,130	$67,900	$9,640
Yr 13	$38,770	29,130	$67,900	$9,640
Yr 14	$38,770	29,130	$67,900	$9,640
Yr 15	$38,770	29,130	$67,900	$9,640
Yr 16	$38,770	29,130	$67,900	$9,640

APPENDIX C: DATA USED FOR FIGURE 4.3

10% /yr Conversion rate net $				
Year	**Mean**	**SD**	**Max**	**Min**
Conv	$8,993	28,514	$37,508	-$19,521
Yr 1	$5,032	27,407	$32,439	-$22,375
Yr 2	$18	26,107	$26,124	-$26,089
Yr 3	-$4,426	24,947	$20,521	-$29,372
Yr 4	-$3,934	24,012	$20,077	-$27,946
Yr 5	-$2,608	23,297	$20,688	-$25,905
Yr 6	-$410	22,833	$22,423	-$23,243
Yr 7	$2,568	22,631	$25,199	-$20,063
Yr 8	$5,545	22,601	$28,146	-$17,055
Yr 9	$8,523	22,742	$31,266	-$14,219
Yr 10	$11,501	23,053	$34,554	-$11,552
Yr 11	$18,440	24,553	$42,992	-$6,113
Yr 12	$26,432	26,263	$52,695	$169
Yr 13	$33,853	27,929	$61,782	$5,923
Yr 14	$36,339	28,465	$64,804	$7,874
Yr 15	$37,991	28,875	$66,865	$9,116
Yr 16	$38,770	29,130	$67,900	$9,640

APPENDIX D: DATA USED FOR FIGURE 4.4

Conversion Net Present Values					
Year	**Disc. Factor**	**Conv. PV**	**100% PV**	**20% PV**	**10% PV**
Conv	1.00	$8,993	$8,993	$8,993	$8,993
Yr 1	0.92	$8,289	-$28,223	$987	$5,032
Yr 2	0.85	$7,640	-$34,955	-$7,610	$16
Yr 3	0.78	$7,041	-$27,745	-$13,971	-$3,759
Yr 4	0.72	$6,489	$10,035	-$12,167	-$3,080
Yr 5	0.67	$5,981	$14,798	-$9,451	-$1,882
Yr 6	0.61	$5,513	$18,989	-$1,158	-$272
Yr 7	0.56	$5,081	$21,902	$7,962	$1,574
Yr 8	0.52	$4,683	$20,186	$15,066	$3,133
Yr 9	0.48	$4,316	$18,605	$16,272	$4,438
Yr 10	0.44	$3,978	$17,147	$16,458	$5,519
Yr 11	0.41	$3,666	$15,804	$15,804	$8,156
Yr 12	0.38	$3,379	$14,566	$14,566	$10,775
Yr 13	0.35	$3,114	$13,425	$13,425	$12,719
Yr 14	0.32	$2,870	$12,373	$12,373	$12,583
Yr 15	0.29	$2,645	$11,404	$11,404	$12,124
Yr 16	0.27	$2,438	$10,510	$10,510	$11,404
	Discount Rate	8.50%			

APPENDIX E: DATA USED FOR FIGURE 4.5

Cumulative Present Value by Year				
Year	**Conv**	**100%**	**20%**	**10%**
Conv	$8,993	$8,993	$8,993	$8,993
Yr 1	$17,282	-$19,229	$9,980	$14,025
Yr 2	$24,922	-$54,185	$2,370	$14,042
Yr 3	$31,963	-$81,930	-$11,600	$10,282
Yr 4	$38,452	-$71,895	-$23,768	$7,202
Yr 5	$44,433	-$57,096	-$33,218	$5,320
Yr 6	$49,946	-$38,107	-$34,377	$5,047
Yr 7	$55,027	-$16,205	-$26,414	$6,621
Yr 8	$59,709	$3,981	-$11,349	$9,754
Yr 9	$64,025	$22,586	$4,923	$14,192
Yr 10	$68,003	$39,733	$21,382	$19,711
Yr 11	$71,669	$55,537	$37,186	$27,867
Yr 12	$75,048	$70,103	$51,751	$38,641
Yr 13	$78,162	$83,528	$65,176	$51,360
Yr 14	$81,032	$95,901	$77,549	$63,943
Yr 15	$83,677	$107,304	$88,953	$76,067
Yr 16	$86,115	$117,815	$99,463	$87,471

APPENDIX F: SOYBEAN PRODUCTION COSTS

	SOYBEANS	Cost	Conventional		Organic	
		$/Acre	P	Grain	P	Grain
Fertility / Herbicide etc.	Seed	$14.11	1.0	$14.11	1.0	$14.11
	Treatment	$1.17	1.0	$1.17	1.0	$1.17
	Innoculant	$0.97	1.0	$0.97	1.0	$0.97
	Starter 10-34-0	$5.86	1.0	$5.86		$0.00
	Starter 32-0-0	$0.00		$0.00		$0.00
	Later Fert	$0.00		$0.00		$0.00
	Pre-emerge herbici	$12.58	1.0	$12.58		$0.00
	Application	$3.75	1.0	$3.75		$0.00
	Post-emerge herbic	$11.00	1.0	$11.00		$0.00
	Application	$4.75	1.0	$4.75		$0.00
Equipment*	Disk 1	$9.87	1.0	$9.87	1.0	$9.87
	Disk 2	$7.88	1.0	$7.88	1.0	$7.88
	Field cultivate	$4.07	1.0	$4.07	2.0	$8.14
	Seed drill	$9.78		$0.00		$0.00
	Row planter	$11.47	1.0	$11.47	1.0	$11.47
	Row cultivate 1	$4.44		$0.00	3.0	$13.32
	Combine (corn)	$33.64		$0.00		$0.00
	Combine (flex)	$19.60		$0.00		$0.00
	Combine (row)	$22.12	1.0	$22.12	1.0	$22.12
	Swather	$9.40		$0.00		$0.00
	Rake	$7.04		$0.00		$0.00
	Plow	$16.23		$0.00		$0.00
	Chisel	$7.58		$0.00		$0.00
	Baler w/ wrap	$19.21		$0.00		$0.00
	Frg harv (row)	$46.89		$0.00		$0.00
	Frg harv (pickup)	$19.54		$0.00		$0.00
	Rotary Mower	$6.53		$0.00		$0.00
	Load Manure	$9.00		$0.00		$0.00
	Spread Manure	$11.52		$0.00		$0.00
	Rent	$40.00	1.0	$40.00	1.0	$40.00
Labor	Hand Rogue	$15.00		$0.00	3.0	$45.00
	Changeover	$0.60	1.0	$0.60	1.5	$0.90
	Management	$1.05	1.0	$1.05	1.5	$1.58
	Total $/Acre/yr			**$151.25**		**$176.53**

	Yield dependant	Cost	Conventional		Organic	
		$/bu	P	Grain	P	Grain
$/bu	Trucking	$0.13	1.0	$0.13	1.0	$0.13
	Added storage	$0.45		$0.00	1.0	$0.45
	Input $/bu/yr			**$0.13**		**$0.58**

APPENDIX G: WHEAT PRODUCTION COSTS

	WHEAT	Cost	Conventional		Organic	
		$/Acre	P	Grain	P	Grain
Fertility / Herbicide etc.	Seed	$14.22	1.0	$14.22	1.0	$14.22
	Treatment	$1.17	1.0	$1.17	1.0	$1.17
	Innoculant	$0.97	1.0	$5.86	1.0	$5.86
	Starter 10-34-0	$0.00		$0.00		$0.00
	Starter 30-20-0	$17.90	1.0	$17.90		$0.00
	Urea	$21.87	1.0	$21.87		$0.00
	Pre-emerge herbici	$2.70	1.0	$2.70		$0.00
	Application	$4.00	1.0	$4.00		$0.00
	Post-emerge herbic	$4.55	1.0	$4.55		$0.00
	Application	$3.75	1.0	$3.75		$0.00
Equipment*	Disk 1	$9.87	1.0	$9.87	1.0	$9.87
	Disk 2	$7.88	1.0	$7.88	1.0	$7.88
	Field cultivate	$4.07	1.0	$4.07	2.0	$8.14
	Seed drill	$9.78	1.0	$9.78	1.0	$9.78
	Row planter	$11.47		$0.00		$0.00
	Row cultivate 1	$4.44		$0.00		$0.00
	Combine (corn)	$33.64		$0.00		$0.00
	Combine (flex)	$19.60	1.0	$19.60	1.0	$19.60
	Combine (row)	$22.12		$0.00		$0.00
	Swather	$9.40		$0.00		$0.00
	Rake	$7.04		$0.00		$0.00
	Plow	$16.23		$0.00		$0.00
	Chisel	$7.58		$0.00		$0.00
	Baler w/ wrap	$19.21		$0.00		$0.00
	Frg harv (row)	$46.89		$0.00		$0.00
	Frg harv (pickup)	$19.54		$0.00		$0.00
	Rotary Mower	$6.53		$0.00		$0.00
	Load Manure	$9.00		$0.00	1.0	$9.00
	Spread Manure	$11.52		$0.00	1.0	$11.52
	Rent	$40.00	1.0	$40.00	1.0	$40.00
Labor	Hand Rogue	$15.00		$0.00	1.0	$15.00
	Changeover	$1.20	1.0	$1.20	1.5	$1.80
	Management	$2.10	1.0	$2.10	1.5	$3.15
	Total $/Acre/yr			**$170.52**		**$156.99**

	Yield dependant	Cost	Conventional		Organic	
		$/bu	P	Grain	P	Grain
$/bu	Trucking	$0.13	1.0	$0.13	1.0	$0.13
	Added storage	$0.45		$0.00	1.0	$0.45
	Input $/bu/yr			**$0.13**		**$0.58**

APPENDIX H: MILO PRODUCTION COSTS

	MILO	Cost	Conventional		Organic	
		$/Acre	P	Grain	P	Grain
Fertility / Herbicide etc.	Seed	$10.04	1.0	$10.04	1.0	$10.04
	Treatment	$1.17	1.0	$1.17	1.0	$1.17
	Innoculant	$0.97	1.0	$0.00	1.0	$0.00
	Starter 10-34-0	$3.88	1.0	$3.88		$0.00
	Starter 32-0-0	$5.93	1.0	$5.93		$0.00
	Later Fert	$22.60	1.0	$22.60		$0.00
	Pre-emerge herbici	$13.74	1.0	$13.74		$0.00
	Application	$3.75	1.0	$3.75		$0.00
	Post-emerge herbic	5.04		$0.00		$0.00
	Application	$4.75		$0.00		$0.00
Equipment*	Disk 1	$9.87	1.0	$9.87	1.0	$9.87
	Disk 2	$7.88	1.0	$7.88	1.0	$7.88
	Field cultivate	$4.07	1.0	$4.07	2.0	$8.14
	Seed drill	$9.78		$0.00		$0.00
	Row planter	$11.47	1.0	$11.47	1.0	$11.47
	Row cultivate 1	$4.44		$0.00	3.0	$13.32
	Combine (corn)	$33.64	1.0	$33.64	1.0	$33.64
	Combine (flex)	$19.60		$0.00		$0.00
	Combine (row)	$22.12		$0.00		$0.00
	Swather	$9.40		$0.00		$0.00
	Rake	$7.04		$0.00		$0.00
	Plow	$16.23		$0.00		$0.00
	Chisel	$7.58		$0.00		$0.00
	Baler w/ wrap	$19.21		$0.00		$0.00
	Frg harv (row)	$46.89		$0.00		$0.00
	Frg harv (pickup)	$19.54		$0.00		$0.00
	Rotary Mower	$6.53		$0.00		$0.00
	Load Manure	$9.00		$0.00	1.0	$9.00
	Spread Manure	$11.52		$0.00	1.0	$11.52
	Rent	$40.00	1.0	$40.00	1.0	$40.00
Labor	Hand Rogue	$15.00		$0.00	3.0	$45.00
	Changeover	$0.60	1.0	$0.60	1.5	$0.90
	Management	$1.05	1.0	$1.05	1.5	$1.58
	Total $/Acre/yr			**$169.68**		**$203.52**

	Yield dependant	Cost	Conventional		Organic	
		$/bu	P	Grain	P	Grain
$/bu	Trucking	$0.13	1.0	$0.13	1.0	$0.13
	Added storage	$0.45		$0.00	1.0	$0.45
	Input $/bu/yr			**$0.13**		**$0.58**

APPENDIX I: ALFALFA PRODUCTION COSTS

	ALFALFA	Cost	Conventional		Organic	
		$/Acre	P	Forage	P	Forage
Fertility / Herbicide etc.	Seed	$36.00	0.3	$11.88	0.3	$11.88
	Treatment	$1.17	0.3	$0.39	0.3	$0.39
	Innoculant	$0.97	1.0	$0.00	1.0	$0.00
	Starter 10-34-0	$3.96	0.3	$1.31		$0.00
	Starter 32-0-0	$17.82		$0.00		$0.00
	Later Fert	$22.60		$0.00		$0.00
	Pre-emerge herbicid	$13.74		$0.00		$0.00
	Application	$3.75		$0.00		$0.00
	Post-emerge pestici	7.48	1.0	$7.48		$0.00
	Application	$4.75	1.0	$4.75		$0.00
Equipment*	Disk 1	$9.87	0.3	$3.26	0.3	$3.26
	Disk 2	$7.88	0.3	$2.60	0.3	$2.60
	Field cultivate	$4.07	0.3	$1.34	0.7	$2.69
	Seed drill	$9.78	0.3	$3.23	0.3	$3.23
	Row planter	$11.47		$0.00		$0.00
	Row cultivate 1	$4.44		$0.00		$0.00
	Combine (corn)	$33.64		$0.00		$0.00
	Combine (flex)	$19.60		$0.00		$0.00
	Combine (row)	$22.12		$0.00		$0.00
	Swather	$9.40	4.0	$37.60	3.0	$28.20
	Rake	$7.04	4.0	$28.16	3.0	$21.12
	Plow	$16.23		$0.00		$0.00
	Chisel	$7.58		$0.00		$0.00
	Baler w/ wrap	$19.21	1.0	$19.21		$0.00
	Frg harv (row)	$46.89		$0.00		$0.00
	Frg harv (pickup)	$19.54	3.0	$58.62	3.0	$58.62
	Rotary Mower	$6.53		$0.00		$0.00
	Load Manure	$9.00		$0.00	1.0	$9.00
	Spread Manure	$11.52		$0.00	1.0	$11.52
	Rent	$40.00	1.0	$40.00	1.0	$40.00
Labor	Hand Rogue	$15.00		$0.00	1.0	$15.00
	Changeover	$2.40	1.0	$2.40	1.5	$3.60
	Management	$4.20	1.0	$4.20	1.5	$6.30
	Total $/Acre/yr			**$226.42**		**$217.40**

	Yield dependant	Cost	Conventional		Organic	
		$/ton	P	Forage	P	Forage
$/bu	Trucking	$5.52	1.0	$5.52	1.0	$5.52
	Added storage	$0.45		$0.00		$0.00
	Input $/ton/yr			**$5.52**		**$5.52**