An Analysis of Industrialized Agriculture from the Local Perspective:

Possibilities and Constraints to Sustainable Farming in Grundy County, Illinois

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Abstract

Literature suggests that industrialized agriculture in the United States is unsustainable because of, among other things, its reliance on non-renewable resources and lack of emphasis on the needs of individual farmers, the environment, or the market it depends on. Mass production and economic advancement are out-competing the sense of community and stewardship towards the land. To address this issue an analysis of the local perception of grain farming was performed in Grundy County, Illinois (USA).

The U.S. provides a large amount of the foodstuffs in the world and is a global leader in technological development. Despite all of the advancements in agriculture since the Green Revolution in the late 1950s, the world grain supply- when compared to demand- shows signs of levelling off or decreasing, a decrease which coincides with an increase of world population by nearly 85 million people per year. Therefore an analysis of farming techniques from a holistic perspective, designed to determine overall system sustainability is relevant for the sake of securing the food needs of future generations. Relevance also lies in the local perspective where farming communities are succumbing to large corporate control, which draws power and benefits away from the farm where impacts of economic, social and environmental changes are felt.

It was chosen to approach individual farmers for this research because it is they who experience the changes associated with agricultural development and who help steer the future of agricultural development. My objective was to obtain a clear picture of the current practices being used in grain farming and why certain choices are being made. I have attempted to look at how this type of production system functions; observing the social and cultural as well as environmental and economic aspects surrounding grain farming in Grundy County.

By integrating knowledge from interviews and personal observations as well as from a literature review, it is concluded that industrialized agricultural practices are unsustainable in accordance to the current trajectory that is being followed. However, it is also noted that there is not one clear cut method to achieve sustainable agriculture, as there are a number of practices that have both positive and negative implications to an aspect of sustainability. What is important is that a practice be supported and accepted locally, integrating all three aspects of sustainability in equal proportions and viewing them from a global perspective. Suggestions for achieving this include increased government support for and focus on sustainable agriculture such as: promotions and rewards for adopting stewardship-based practices; subsidy reductions; provision of non-biased information; and the set up of interactive examples of sustainable practices where farmers will be able to observe viable, sustainable operations.

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List of Acronyms and Abbreviations

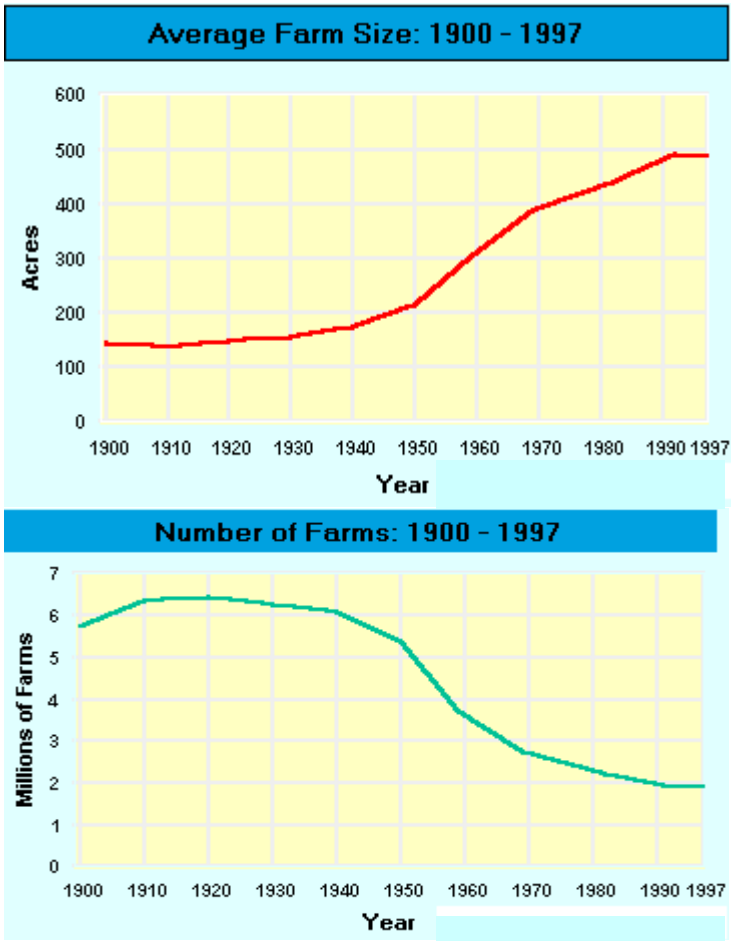
ADM – Archer Daniels Midland
CAP – Common Agricultural Policy
CLD – causal loop diagram
CO_2 – carbon dioxide
CRP – Conservation Reserve Program
DNA – deoxiribonucleic acid
EC – electrical conductivity
ECB – European corn borer
EPA – Environmental Protection Agency
ERS – Economic Research Service
EWG – Environmental Working Group
FAO – Food and Agriculture Organization
GDP – gross domestic product
GIS – geographical information system
GM – genetically modified
GPS – global positioning systems
IATP – Institute for Agriculture and Trade Policy
IFOAM – International Federation for Organic Agriculture Movements
MCDM – Multiple Criteria Decision Making
N_2O – nitrous oxide
NASS – National Agricultural Statistics Services
NCDC – National Climate Data Center
NPG – Negative Population Growth
NRCS – National Resource Conservation Service
OECD – Organization for Economic Co-operation and Development
PA – precision agriculture
PF – precision farming
PRONAF – Programa para apoio a agricultura familiar
PT – precision technology
SA – sustainable agriculture
SARE – Sustainable Agriculture Research and Education
SEHN – Science and Environmental Health Network
SSM – site-specific management
U.S. – United States
USDA – United States Department of Agriculture
WCED – World Commission on Environment and Development
WHO – World Health Organization
WTO – World Trade Organization

1.0 Introduction

1.1 Principle problem

This is a study of the current industrialized agricultural practices in Grundy County, a county situated in northern Illinois, USA, approximately 50 miles (~80 km) southwest of Chicago. Annually, the United States produces roughly 17% of the worlds total grain supply, and Grundy County is part of the nations' 'elite' producers of grains, ranked within the top third most productive counties in the country (National Agricultural Statistics Services, 1997b). However, some concerns arise when looking at this type of agricultural production. The industrialized agricultural system that is implemented in the United States, as well as other industrialized countries around the world, is highly dependent on the use of large machinery, fossil fuels, commercial fertilizers, pesticides, herbicides, and water for irrigation. While this has made it possible to more than double the crop production from the same amount of land over the past 60 years, thus keeping large areas of fragile land out of production (Miller, 2002), the intense and factory-like use of crop land will likely take its toll on the long term productivity of this environment.

It is claimed that the entire United States food production and distribution industry is in the midst of major structural changes (Boehlje, 1999), and this includes changes at the level of individual farmers. Agricultural trends in the United States have varied dramatically within the past 100 years, with the average farm size continually increasing and the number of farms decreasing (Figures 1a and 1b, respectively) (NASS, 1997a). Fewer and fewer farmers remain, and those who are staying are either largely expanding production in order to earn enough on-farm income or they are forced to compete with such large productions. With things such as new technologies and high input costs, farmers with small operations[1] cannot earn a living with an on-farm income alone. This trend of farm aggregation is thus eroding the rural community since more and more farmers need to either take on other off-farm jobs, or completely leave the farming occupation which in many cases means moving off of the farm and selling to bigger operations. Another part of this major structural change is the control heeded by a small number of huge corporations concerning types of seeds, equipment, and methods used. This reduction in production variability has put the agricultural sector in a more vulnerable situation in the case of economic or environmental hardships.



Figures 1a/b. Trends in U.S. agriculture. Modified from NASS, 1997a

[1] A small farm operation, as defined in 1999 by the Economic Research Service (ERS) of the United States Department of Agriculture (USDA), is an operation with sales less than $250,000 (Perry and Johnson, 1999).

1.2 Why this topic was chosen

The topic of industrialized agriculture was chosen for a number of reasons, ranging from global to local concerns. First and foremost, global population is expected to grow from the current 6.3 billion inhabitants to anywhere between 7.4 and 12.8 billion within the next 50 year (United Nations Population Division, 2003). Continuing to feed the Earth's people has been recognized as "the biggest challenge ever faced by mankind" (Freeman, 1990). The depth of this statement is made all the more alarming since this consistent increase in human population is occurring simultaneously to a steadying off and/or decrease in global grain production. Sources claim that there is evidence now that at the closing of the 2003 growing season, the world grain harvest will fall short of consumption for the fourth consecutive year, by an estimated 93 million tons (Brown, 2003). So despite the leaps and bounds that have occurred in agriculture production since the forthcoming of the Green Revolution in the 1950s and 60s, population growth is steadily outpacing production. Thus the world grain production *per capita* has been on a decline for nearly 2 decades (Miller, 2002). Trends also show that the solution to this dilemma cannot be sought by a continuation of current practices. China, the United States, and India- the world's top grain producing countries- are all facing in different degrees the effects of this type of production that relies heavily on machinery and irrigation. Water tables are falling each year in all three countries (Brown, 2003), and to a system that relies on heavy irrigation this is extremely problematic. To secure our food needs and those needs of the future generations, a sustainable method of production needs to be found now before the resources such as productive land, fresh water and ample fuels become depleted.

I chose to look at the United States because it is a hegemony, producing approximately one fifth of the world's grains and close to half of the world's grain exports (Miller, 2002). The agricultural sector is also responsible for providing 19% of all jobs in the private sector and generating 18% of the country's gross national income. (Miller, 2002) Industrialized agriculture relies heavily on fossil fuels – using almost one fifth of all commercial energy in the U.S. – and the continuous use of land without allowing it to 'rest' may jeopardize this vital sector of the country (Miller, 2002). My concern also arises from the outcomes of development in similar sectors in the United States and how this development has lead to the degradation of the local situation, creating extreme pressure on farmers to 'get big or get out' while the same act of getting bigger brings more risks (Schlosser, 2002). Large corporations can also corrode the rural setting by confiscating the freedoms that local producers once had. This is the case of pork production in northern Iowa for example, where agribusinesses have replaced corn fields with huge buildings where hogs are produced in mass quantities, and local family farms are forced to deal with the unpleasant sights, sounds and smells of this industry that has taken over the rural setting (Tyson, 1995).

Finally I chose to look locally at Grundy County because, as a former resident, I can use my advantage of familiarity with the area and with the families involved in farming. Figure 2 is an illustration of a farm operation near my former place of residence. I have seen the ever growing effects of urbanization on this rural areas, as well as the aggregation of farms, giving large companies more control over the local production and creating a gap between the decision-making level and where their decisions take effect, which plays a part in the erosion of the social aspects of rural life that defines a large part of the American culture.

Figure 2- A photo of a typical farm operation during harvest in Grundy County. Photo by S. Prindiville

1.3 Relevance

Taking on a research topic as this is very relevant for this stage of agriculture development. The development of farming is at a crucial stage in the grain farming sector with many farmers reaching the age of retirement and urbanization causing high land prices that make it difficult for someone new to start, therefore fewer individuals are having more power over more land area. More uniformity (less variability) often leads to susceptibility problems, including environmental as well as social problems. Besides the local relevance, sustainable development also deals with a world community, so actions taken locally have to also be viewed globally and temporally. Those of us living now need to do what we can to "ensure that… [development] meets the needs of the present without compromising the ability of future generations to meet their own needs." (WCED, 1987) In general this research deals with the concern for keeping this land inhabitable and productive for today's inhabitants as well as for generations to come.

1.4 Connection to Sustainable Development

Sustainable agriculture and the erosion of the rural area are worldwide issues surrounding the challenge of sustainable development. Looking more closely at the farming sector, there are some criteria that need to be met in order to include all three pillars of sustainability (i.e. economic, environmental, and social). In using the goals of the United States Department of Agriculture (USDA) sponsored program SARE (Sustainable Agriculture Research and Education), sustainable farming must strive to include these key aspects (SARE, n.d.(a)):

- ✓ Provide a more profitable farm income,
- ✓ Promote environmental stewardship, and
- ✓ Promote stable, prosperous farm families and communities.

Although change and development are inevitable in all facets of life, it seems that something should remain unchanged in the agricultural sector; that is the need for farmers to be stewards of the land, concerned and driven more with the health and well being of their land and products rather than market values, profit schemes, and cutting edge technology. Too often tradition is correlated with underdevelopment while innovation becomes the solver of this 'problem'. While innovation is indeed necessary it should not become the competitor of tradition, but rather its cofactor. In some cases, the ultimate purpose of growing food has become tainted by the shimmering possibilities of technological and economic advancements. Thus I will argue that current industrialized agricultural practices of grain farming in the United States are unsustainable and that too much effort is put towards securing short-term economic sustainability while long-term social, environmental and economic factors of sustainability are being degraded, thus degrading the whole system. The sustainability of grain farming needs to be viewed from a systems perspective, and only then will a balance between environmental, economic and social criteria of sustainability be achieved.

2.0 Research Objective and Scope

2.1 Objective

I have chosen to specifically look at grain farming and the rotational production of two grain types, corn (*Zea mays*) and soybeans (*Glycine max*) which when combined make up 97.5% of total grain output in Grundy County (National Agricultural Statistics Services, n.d.(a)). I have attempted to look at how this system functions, observing the social and cultural as well as environmental and economic aspects surrounding this type of farming. Initially, this thesis was designed to explore the farming practices in Grundy County and analyze how they could be more sustainable. Yet the word 'sustainable' can be viewed in many ways, and after performing interviews with farmers and analyzing different farming practices, it seems that the answer is not so straight forward, and that an analysis of sustainable farming in itself would need to be performed and then adapted to the local situation. Therefore my objectives are first to look at what sustainable farming is comprised of, and second to apply this idea to the real life situation in Grundy County, analyzing what the possibilities and the barriers are for adopting the most sustainable farming strategies.

More specific questions I will be addressing are:

What aspects of industrialized agriculture make it unsustainable?
What are the current issues facing farmers in this sector of agriculture?
What farming practices are available, and what are their pros and cons?

2.2 Scope

Some aspects surrounding grain farming in the U.S. have been omitted from this study. The ethics behind a more sustainable practice for intrinsic reasons was not included, although much research has been done involving this issue. (c.f. Elliot, 1992; Larrere, 2000)

This study includes social aspects of sustainability, but I have not gone into detail about some historical social issues that surround industrial agriculture in itself. For example, it has been argued by Wolf (2000) that contemporary (industrial) agriculture is simply a "consequence of the West's rejection to tradition", and only after the idealistic society (one that regards truth, right and goodness as standards and directive forces) was replaced with empiricism (a theory that all knowledge originates in experience) in the 14th century could industrialized agriculture take place. The fourteenth century was also when economics became a dominating force and according to Wolf (2000), was also the time when greed became socially acceptable. With this change from a barter economy to a monetary economy, the agrarian society shifted over to a commercial one, and it is argued that at that point the desire for material prosperity came about (Wolf, 2000). It can also be argued that the desire for prosperity lies deeper in human nature, and such deep rooted social issues are not incorporated in this work.

An issue deeply embedded in the debate of sustainable agriculture is the use of transgenic – or genetically modified (GM) crops. While some support the positive aspects that GM crops have provided, others feel resentment and distrust towards their use. This issue in itself could consume an entire research effort, and it is so strongly debated today that its omission seemed necessary at this time. The only references to be made to GM crops will be those related to their role (true or perceived) in increasing productivity, in corporate control and in effects on biodiversity.
Another omission from this research is the discussion about reducing the stress on agriculture by using food more efficiently as well as promoting a healthier diet that is reliant on foods lower on the food chain. However, the point must be made that the omission of these strategies from this research does not by any means reduce the potential I believe they render. According to a study done by the USDA, 27% of the food that has already been prepared is *thrown away* each year in the United States (Trivers and Bynum, 1997). This number does not include pre-harvest, on-the-farm, and farm-to retail or wholesale losses, but rather only the losses at retailer, consumer, and food service levels (Trivers and Bynum, 1997). That is equal to 96

billion pounds (~43.5 billion kilograms) of food per year, which is roughly enough food to feed the combined populations of Texas, California, New York, and Florida for an entire year[2]. This also adds to high waste disposal costs for landfills, for which the government pays close to $1 billion annually (Trivers and Bynum, 1997). So the simple act of being conscientious about amounts of food one purchases or prepares would not only reduce consumer expenditures on food, but should ultimately reduce pressures on farmers who are growing the grains for human consumption/animal fodder that are being thrown away.

The other strategy to reduce stress on agricultural lands that is omitted from this study is the reduction of consumer demand of beef by eating lower on the food chain. This is not meant to suggest that every person should convert to vegetarianism, but simply reducing the amount of red meat consumption per person would have cascading effects on human health, animal welfare, social stresses and the environment. The fact is that in the U.S. Midwest, 70% of the corn and nearly all of the soybeans are used in industrial meat production (Halweil, 2002). Besides the stress on the cropland used to grow cattle feed, livestock grazing is responsible for 14% of U.S. topsoil loss (Miller, 2002). In 1999 the average American consumed 114 pounds of red meat (~51.7 kilograms), of which 63.5 lbs (~28.8 kg) was beef (USDA, 2000). Total meat consumption per capita has increased by nearly 36% in less than 40 years in the U.S. (Texas Cattle Feeders Association, 1999). By slowing or stopping this trend of increasing beef consumption, intensification of grain production would be unnecessary and soils in production would not be continually stressed, reducing the farmers need to produce such high volumes thus reduce their input costs. Of course this strategy as well as the others presented is not nearly as simple and straightforward as they have been presented. However, if frugality with food and reduced red meat consumption were to become accepted as norms to the American society, profound effects would be seen not only in this sector but also around the world, as our consumption patterns have global effects reaching to all sectors of life.

It is recognized that besides the intentional boundaries to this study, there are other limitations that could play a role in the validity of the research. The amount of time spent creating an understanding by data gathering is related to the quality of the theory that arises (Van Maanen, 1983). Therefore spending more than one month performing fieldwork would have added to my understanding. Another factor limiting the validity of data collection was my personal selection of the interviewees. I chose to approach mostly individual farmers whom I was personally acquainted with before the study. Although I attempted to obtain the opinions of different types of farmers, this bias takes away from the randomness of selection that helps to ensure a truer picture of the sample unit being analyzed. I also interviewed one representative of the local supplier company, yet information from this aspect of farming is lacking and can be seen as a boundary as well.

2.3 Hypothesis

I hypothesize, along the lines of the null hypothesis, that there are conflicts between the environmental sustainability and economic sustainability of grain farmers, as well as between local and global goals of farming. In the United States, farming has become like any other business where the options in most cases are either advancement or removal. My initial suggestions for incorporating a more sustainable practice to grain farming in Grundy County could include government support for alternative practices, promotions and rewards for adopting stewardship-based practices; the provision of non-biased information for the farmers; and interactive examples of sustainable practices where farmers will be able to observe viable, sustainable operations in their own communities. Also commodity prices need to increase as to allow foreign producers to compete and to allow American farmers more independence and control.

[2] This figure was prepared by using data from a USDA study (Trivers and Bynum, 1997) concerning the amount of food wasted per year (96 billion pounds) and the amount consumed per person per year, and data from the US Census Bureau concerning the number of inhabitants of each state (US Census Bureau, 2003a).

2.4 Theory/Methods/Materials

The type of research I utilized for this study is labelled interdisciplinary, one that gathers knowledge and techniques from a number of different disciplines in order to draw conclusions. Interdisciplinary research is a way to observe things and phenomena as they naturally occur, without applying the boundaries that disciplinary research creates (Bruhn, 2000). This type of research is viewed as a way to "serve personal, social, political, and professional needs" (Bruhn, 2000) thus is more in tuned to real life situations. It's a way to work beyond the commonly accepted idea that in order for something to be considered scientific, it must be concrete and measurable. Interdisciplinarity, or as Wolf puts it 'integrated thinking', gives validity to intangibles such as personal experiences, meaning, and interactions (1998) that specific disciplines would not necessarily include. With the idea of sustainable agricultural practices, there are many interactions occurring at many levels, so this type of approach was necessary in order to portray the most life-like situations and in order to draw viable conclusions.

This thesis is based on a literature review and statistical analysis, as well as fieldwork in the form of semi-structured interviews and personal observations. Fieldwork was performed between June 10 and July 10, 2003 in Grundy County, Illinois, with further contacts being made from Sweden by telephone and/or email throughout the autumn of that year. I chose to approach and involve individual farmers because it has been argued that social perceptions are influential on the success or failure of a conservation effort (Salafsky *et al*, 2002; Wallace, 2003) therefore these individual perceptions need to be addressed when dealing with conserving local agricultural production. I have used the information gathered to analyze the system behavior from an interdisciplinary perspective. As part of the discussion I have included a causal loop diagram (CLD) to link a number of factors together in identifying possibilities and constraints for change. A CLD is a tool used to show connections between factors by writing them out in a diagram, connecting them with arrows and indicating a positive or negative correlation with the use of a plus or minus sign at the head of the arrow. Using a CLD allows one to look at entire systems holistically.

Farmer interviews were performed either in person or by a telephone conversation, and a fairly consistent list of questions was asked to each individual or pair (farmers and their wives were often both present for the interview). Since interviews were only semi-structured, not all farmers were asked the same questions due to how the conversation had been progressing. Interview questions were categorized into the following segments: Land use history; Social setting; Physical setting; Current practices; Production/Economic/Environmental issues; Alternative production practices; and Future outlook. I attempted to keep my influence on their results minimal during interviews.

3.0 Background of the Study Subject

3.1 History of agriculture

There have been some major changes in food production techniques that have occurred during the course of human history. The first of these is less well known than the more recent agriculture revolution, which occurred parallel to the Industrial revolution approximately 200 years ago, and the so-called Green Revolution from the 1940s. Yet this first revolution, called the Neolithic revolution, took place approx. 10,000 years ago and is just as significant to the shaping of our societies today. (Pryor, 1986) At this point, certain plants and animals were selected by humans to be grown domestically, and special techniques of manipulating the land (i.e. sowing, hoeing, irrigating, and fertilizing) were adopted (Knauft and Gardner, 1998). There are different theories as to why humans began to domesticate certain plants and animals in place of the hunter/gatherer lifestyle, since this lifestyle of hunter/gatherer was less labor intensive and had a higher average productivity than primitive agriculture (Kabo, 1985)[3]. There exists a number of arguments over the advantages and disadvantages of the adoption of productive agricultural activity over the pre-agrarian one (Kabo, 1985), so the whole basis of this historically significant Neolithic revolution is not fully understood. Despite the controversies about its origin, the fact is that agriculture exists today and has made a huge impact, through human selection altering genetic variation and through the intense use of land. What should be taken from this information is that the type of production that is normal to us today and seems to have a connection with nature, has actually originated as a practice that defies the natural order of biodiversity and variability (Knauft and Gardner, 1998).

3.2 History of Agriculture in the U.S.

Early agriculture did not reach the western hemisphere until after 500 AD, thousands of years after it had been established in southern Egypt, Mesopotamia, southeast Asia, Central America and South America (Knauft and Gardner, 1998). Yet certain countries in the west, such as the United States and Canada, have recently out-competed these traditional agrarian societies in terms of total production. With advances in gene technology and production techniques during the Green Revolution (1940s through 1960s) providing increased yields, world grain production increased from 631 million tons in 1950 to 1,769 million tons in 1990 (Brown, 1999). Although these new farming techniques were especially aimed at developing countries to alleviate poverty, the success that farmers in the United States experienced during that time can be attributed to favorable natural conditions as well as the ability to invest large amounts of capital into new and developing technologies (Country Studies U.S., 2003) thus provide a strong foothold for advancement.

Today maize (or corn) is the most important U.S. crop. In 2000, the U.S. grew 43% of the world's corn, equal to 253.2 million metric tons (~9.97 billion bushels) making it by far the world's top corn producer (U.S. Grains Council, n.d.). According to the Economic Research Service (ERS) of the USDA, the top five agriculture commodities in the U.S. are (1) cattle and calves; (2) dairy products; (3) corn; (4) greenhouse/nursery; and (5) soybeans (ERS, 2003a). Most of the corn and soybean production is concentrated in the Midwest of the United States, a vague term used to classify that area lying, according to Page and Walker, "in the crook of the Ohio and Mississippi rivers and up along the shores of the Great Lakes from Erie to Superior...includes the entire states of Ohio, Indiana and Illinois,…southern Wisconsin and southern Michigan,…northern Missouri, eastern Iowa, and south-eastern Minnesota" (1991). The general location of the Midwest is shown in Figure 3 – in this case labelled as the Corn Belt. The terrain of the Midwest is primarily flat, consisting of only small rolling hills, and the climate is a continental climate, which is characterized by a high variation in temperature and precipitation, usually experiencing hot, humid summers and cold, moist winters (Mattson, 1996). Such features help make this area so successful agriculturally. The soils in this area also play a role in determining the success of agriculture. This area,

[3] A number of studies have been performed, whereby it was calculated that adult members of a hunter-gatherer society had only to work between two and five hours per day to secure ample food for a day (Kabo, 1985).

called the Central Plains, consists of extremely fertile soils due to the deposition of minerals during the last Ice Age (Mattson, 1996).

The U.S. farm sector is composed of a wide variety of producers. The USDA has prepared a fact book which outlines the status of agriculture in the U.S. As was previously stated, a small farm is one with sales of less than $250,000 per year (Perry and Johnson, 1999). The USDA further breaks operations down into five categories of small farms (all with sales less than $250,000 but more than $1,000) and three categories of large farms (i.e. (1) large family farms with sales between $250,000 and $499,999; (2) very large family farms with sales of $500,000 or more; and (3) non-family farms)(USDA, 2000). In the United States the large majority of farms are considered small yet contribute only around one third of total production. Small farms make up 94% of all farms in the U.S., control 73% of farm assets, and contribute 38% of annual U.S. farm production (USDA, 2000). A number of farmers derive the majority of their income from off-farm incomes while those operators of very large farms, large farms, and higher-sales small farms receive a substantial part of their income solely from the farm. Small-scale farmers often are participants in certain environmentally based government programs, such as the Conservation Reserve Program (CRP). (USDA, 2000) Collectively, the variety of farms and farm families cover more than 40% of the land area in the United States (ERS, 2003a) and have always been and remain to be "powerful symbols in American culture" (USDA, 2000).

Since the 1930s, governments of most industrialized nations began price-support programs for agricultural production. A history of price support schemes in the United States is presented in the Columbia Encyclopedia (2003) and is as follows. In the U.S. this support began in the 1920s when post World War I production was higher than demand, thus prices dropped. From that time forth, a number of attempts have been made to secure the income of U.S. farmers in a way independent of the supply and demand control mechanism. However, many of these attempts were unsuccessful or created undesired negative effects due to a number of complex factors, including but not limited to the encouragement of overproduction by farmers in their desire to make a higher profit; a change in the global market when other (primarily European) countries were able to increase production thus demand for U.S. products was reduced; and the introduction of extremely efficient production techniques that were introduced in the United States during the Green Revolution which negated efforts to reduce total output by paying farmers to take land out of production.

The ideas of these early agricultural policies have remained intact until today despite all of the changes in agricultural production (Tolman, 1995). Today, government support is in the form of the Farm Security and Rural Investment Act of 2002, commonly referred to as the 2002 Farm Bill. This act raises agricultural support by $180 billion – an 80% increase over the preceding 1996 Fair Act (Langman, 2003) – to be paid to growers of wheat, corn, grain sorghum, barley, oats, rice, upland cotton, soybeans, and other oilseeds in one of three forms: direct payments, counter-cyclical payments, and marketing loans (ERS, 2003b). The price support available for agricultural production in the United States as well as in other industrialized countries is a matter of global controversy and is analyzed in further detail in the upcoming section 'Reliance on subsidies'.

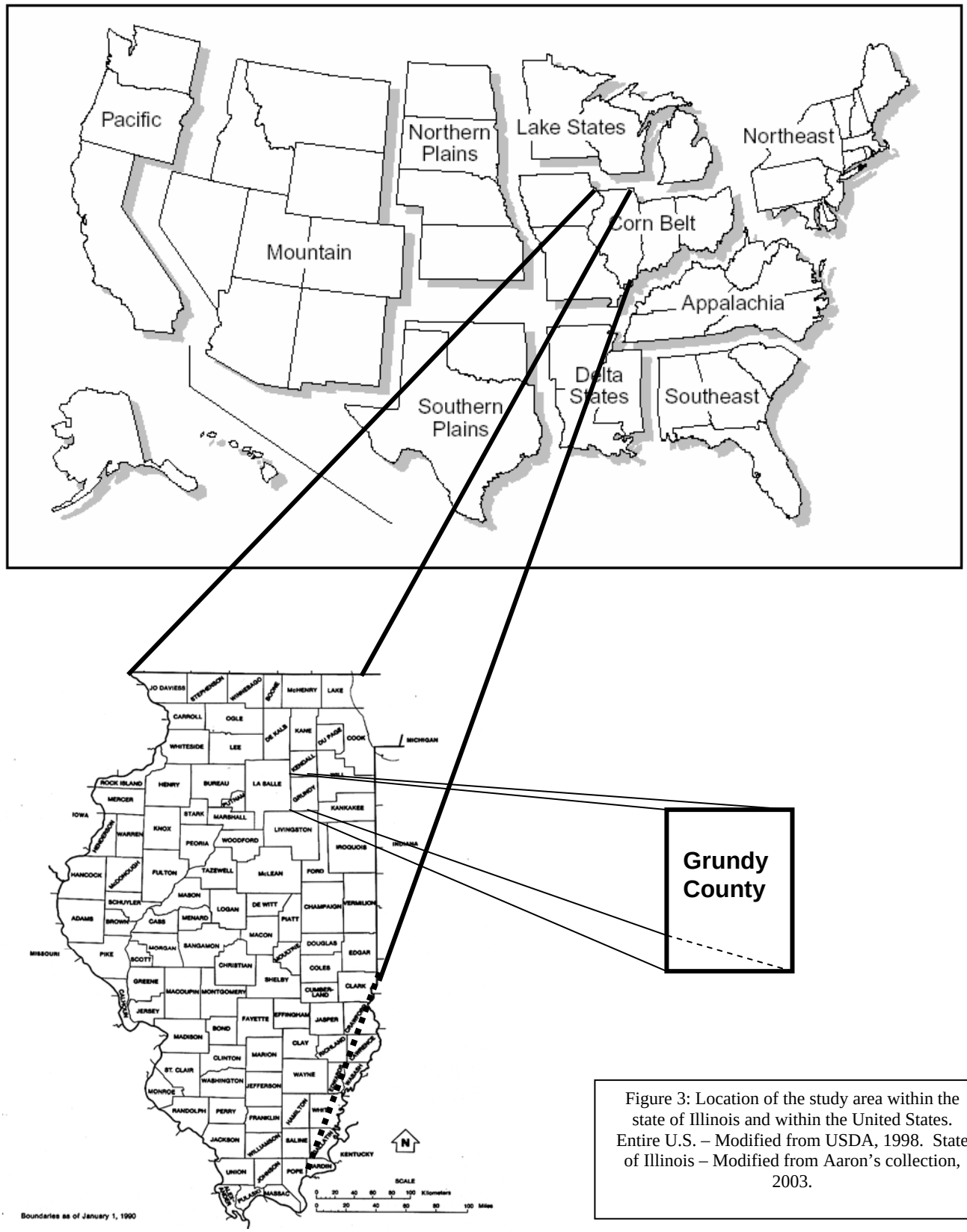


Figure 3: Location of the study area within the state of Illinois and within the United States. Entire U.S. – Modified from USDA, 1998. State of Illinois – Modified from Aaron's collection, 2003.

3.3 History of Agriculture in Grundy County

Grundy County lies in the northeast section of the state of Illinois. (refer to Figure 3 for its precise location) As one can see, Grundy County's close proximity to the large metropolis of Chicago, situated approximately 50 miles (~80 km) away, makes it easily accessible by the intricate interstate highway system. According to the organization Negative Population Growth (NPG), the population in Grundy County increased between 1990 and 2000 by 16.1% from 32,337 to 37,535 inhabitants (NPG, n.d.). This type of extreme growth also occurred in the other counties lying in the periphery of Chicago, with population increases within those same ten years ranging from 14.2 to 41.9% (NPG, n.d.). Low-density residential development is occurring throughout northern Illinois and is encroaching on the fertile farmland that is currently in use. Studies have been conducted analyzing the impact of such low-density development on rural agricultural lands and there are a number of implications for the farmer surrounding such types of development, which will be presented in the section entitled 'Current issued facing farmers' where urbanization is discussed as an issue.

Nearly one fourth of the labor force in Grundy County is involved in agriculture, forestry, and fisheries (U.S. Census Bureau, 2003b). In 1997 201,452 acres of land (~81,525 hectares) was used for farming, representing 74.9% of the total land area, which is a decrease from 1987 when 88.2% of the land was farmland[4]. Grundy County was primarily prairie until the land was first broken in the early 1900s to be used for agriculture. With time and technology farm size started to grow and farmers became more prosperous, making Grundy County one of the country's elite producing counties. Farms size has continually grown as the number of farmers continues to decrease, while at the same time less total area, as stated earlier, is producing more output. (Mattson, 1996) This prosperity can be attributed to the aforementioned Green Revolution that occurred in the 1940s and reached the U.S. during the 1950s and 60s. However, an extra advantage to this area can be attributed to the superior transportation system available throughout the state of Illinois; including highway, railway, and waterways. The Illinois and Mississippi rivers make barge traffic an accessible option for farmers to transport grain towards the Gulf of Mexico, of which the Illinois River runs directly through Grundy County. Due to the favorable farming conditions present in Grundy County, it is ranked in the top third most productive counties in the entire United States when comparing market value of agricultural products sold (NASS, 1997b).

[4] These figures were obtained by combining data from U.S. Census Bureau Quick Facts (U.S. Census bureau, 2003c) and USDA NASS 1997 Census of Agriculture (NASS, n.d.(b)).

4.0 Analytical Framework and Results

In the following section there are four main divisions of topics:

- ✓ Firstly, the term sustainability is analyzed so as to gain a better understanding of the goal of 'sustainable agriculture'.
- ✓ Secondly, different aspects of current agriculture are argued as being unsustainable, and a backing of that argument follows after an explanation of each aspect.
- ✓ Thirdly, the problems faced by farmers today as gathered from interviews are introduced and analyzed.
- ✓ Finally, different methods of farming are analyzed to see how they 'measure up' to fulfilling all aspects of sustainable farming (i.e. social, environmental, and economic).

4.1 What does sustainable mean?

In the quest for defining a sustainable agricultural practice, I have been faced with how the ambiguity of the word 'sustainable' creates some confusion and mixed impressions. Beginning in the 1980s the term sustainability became a publicly recognized notion, yet it portrayed different meanings for different situations depending on what exactly one intended on sustaining. To sustain current growth and prosperity levels of a Fortune 500 company, for example, is a completely different goal than to obtain growth and equality on the level of all humankind in a sustainable manner. According to author Pretty (1995), "precise and absolute definitions of sustainability, and therefore of sustainable agriculture, are impossible". It is difficult to be objective when using the term sustainability because of the 'soft' variables it contains such as "ecological integrity, quality of life and transformation…" (Fricker, 1998). The idea behind sustainability as used in this study deals with a "change in the human trajectory that will require us to rethink old assumptions and engage in the large questions of the human condition" (Orr, 2002). This trajectory should therefore move away from the current path of militarization and industrialization of the world, with an ever-increasing gap between the very rich and the very poor. Along this same argument, the continual economic and technological advancements are creating a treadmill effect where one must keep up or risk falling to the wayside. This type of development as well as the development of stark nationalism in the place of global citizenry are aspects of current development that are unsustainable when looking forward to what living conditions will be for our future generations.

When sustainability is viewed in the context of agriculture, just as in other sectors, the inclusion of economic, environmental and social aspects need to occur. As stated in the introduction, sustainable agriculture can incorporate all three pillars of sustainability. Large-scale farming is not done as a leisure activity, but as a way to earn a living, and many people are dependent on generating a continual income from it. So sustaining an income from one's products is one pillar of sustainability and is usually afforded by farmers themselves or through government assistance programs. The second pillar is promoting environmental stewardship. This includes but is not limited to "(1) protecting and improving soil quality, (2) reducing dependence on non-renewable resources such as fuel and synthetic fertilizers and pesticides, and (3) minimizing adverse impacts on safety, wildlife and water quality and other environmental resources" (SARE, n.d.(a)). The third pillar, which is more easily overlooked than the first two due to its 'soft' nature, concerns the social aspect of sustainable agriculture. The social requisite of a rural setting involves farm families with an overall sense of belonging and community. The invasion of corporate power creates industrial values and factory-like perspectives while also ridding the United States of the rural lifestyle so definitive of American culture.

4.2 Problems of current practices

Different criticisms have been given for different reasons about the current grain farming operations in the United States. In remaining focused on the previously mentioned aspects of sustainability plus the scope of my research, certain aspects surrounding industrialized grain farming will be analyzed and argued as

unsustainable. Some arguments include situations that are present on a national or international scale, but when possible, local instances are used to further argue the point.

4.2.1 Problem 1: Dependence on fossil fuels/ climate change

There is observational evidence that the average global temperature is increasing and this increase may be due in part to human activities. Although scientifically this cannot be proven due to limited knowledge of our complex climate system, most scientists believe that we should choose to follow the precautionary principle: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically"[5]. A strong argument to the anthropocentric ties to climate change lies in the fact that the gases produced from us burning fossil fuels, mainly carbon dioxide (CO_2) and nitrous oxide (N_2O), are greenhouse gases – that is, their molecular composition causes them to trap heat from the earth within the troposphere that would have otherwise escaped back into space. Although this trapping of heat is a natural process which makes the planet inhabitable for humans, concentrations of these gases in the atmosphere have dramatically increased since the Industrial Revolution, with a sharp increase occurring since the Green Revolution. (Miller, 2002) So where does the need for concern arise for farmers? This increase can potentially have two separate effects on agricultural production. The first stems from the fact that the United States comprises less than 5% of the global population but consumes 24% of the world's energy (Energy Information Administration, 2003) and it is argued that the success of industrialized agriculture comes from the exploitation of this cheap oil energy. Including all energy inputs into agriculture and its products[6], this sector alone accounts for 17% of total U.S. commercial energy use each year. (Miller, 2002) It is likely that in the future, fossil fuel use will have to be limited in order to attempt to mitigate the effects of climate change, which will alter the agricultural sector of industrialized countries substantially from what it is today.

The second effect that climate change can have on agriculture is altering the suitability of the climate and soil conditions for certain types of crops. A report prepared for the U.S. Federal Government in cooperation of the USDA, the U.S. Department of Energy, the Farm Foundation, and the Economic Research Service states that climate change will actually have a positive effect on overall crop production in the United States. In their simulations, "productivity of many major crops increased…including cotton, corn for grain and silage, soybean, sorghum, barley, sugar beets and citrus fruits" (Reilly *et al*, 2001). Although this scenario could become a reality, the limitations placed around that study may have significantly altered the outcome, as effects of excess water conditions, losses due to pests, and consequences of increased pesticide use were all excluded from the calculated results[7] (Reilly *et al*, 2001). This study also concerned national effects, while regional and local effects were simply averaged. It was stated in the assessment that "in both cases [if climate change has a positive or negative effect on a region], downturns in commodity prices will continue to take out the vulnerable farmers, and upturns will encourage production expansion" (Reilly *et al*, 2001). This shows that in any case the concerns of the individual farmer are not the main consideration, and the impacts of this social and local degradation are not taken into account when looking at future U.S. farming scenarios as affected by climate change.

4.2.2 Problem 2: Dependence on technology

It is no secret that in the United States, productivity of grain farming has increased and that this increase came over a relatively short period of time. This increase is due mainly to the package deal made available to most of the world during the Green Revolution including better infrastructure, fertilizers, price policy, and most of all technology. Technology takes the shape of things such as new and expensive farm equipment including features such as global positioning; improved herbicides, pesticides and seed varieties and more.

[5] This is a definition of the precautionary principle as defined by The Science and Environmental Health Network (SEHN), following the Wingspread Conference on the Precautionary Principle, January 26, 1998 (SEHN, 1998) yet is not necessarily the only definition available and in use.

[6] This amount includes energy for livestock and crop production, food processing and food distribution and preparation (Miller, 2002).

[7] This last point concerning effects of increase pesticide usage is argued further under the section 'Current issues facing farmers'.

A number of people put the fate of their future in the hands of technology, believing in the idea that 'somehow science will come up with a solution as it always has'. Although technology has indeed proven effective for solving a number of issues throughout human history, caution should be taken when relying upon it with such vigor and enthusiasm, as this can be criticized as creating a dream of complete control and fantasy that does not and cannot exist (Gray, 1999). A report of the U.S. Global Change Research Program states that "biotechnology and precision agriculture are likely to revolutionize agriculture over the next few decades, and that "there are no obvious biological limits on yields that would prevent continued increase" (Reilly *et al*, 2001). According to this same report, these technological processes could make crop production completely unrecognizable, to the effect that biotechnologically created microbial organisms could produce raw biomass into forms of processed sustenance (Reilly *et al*, 2001), a process completely at odds with natural processes of food production.

While this faith in technology has some standing, the counter argument claims that to expect constant innovations places farms in the same category as any other business or factory, where one can out-compete his or her competitors (meaning both local and global competitors) by being the first to adopt new innovations and strategies, thus dominate the market and make a large profit. To some this is the downfall of modern agriculture, where farmers have been persuaded to think of their livestock and grains as commodities and think of everything as loses and gains (Wolf, 2000). The shear cost of keeping up with new technologies as well as the knowledge needed to apply it has caused grief for many farmers. When asked during my interviews what the biggest technical or production problems they are faced with, many of the farmers who farmed smaller areas of land expressed concerns with 'keeping up' with things such as new equipment costs, certification requirements, competition for land, and trying to make a profit when input costs are continually on the rise.

There are also those who express concern as to whether or not we can rely on these human-made processes even if they are available. As David Orr presents it, "a world of ever-increasing economic, financial, and technological complexity cannot be sustained because sooner or later it will overwhelm our capacity to manage it" (2002). The more efforts we put into fixing and counter-fixing our actions, the farther away we get from resembling the median of how the process occurs naturally thus making management more challenging. Technology cannot be seen as a substitute for the natural capital lying in healthy natural communities and ecosystems, which should be recognized as the most important 'capital' to humankind (Giampietro *et al*, 1997). This argument is not, however, trying to make increased technology the scapegoat for any and all ills occurring in the agricultural sector. Even critics of industrialized agriculture recognize that without the food-production technology that is in place today, many more people in this world would be starving and there would be no chance of producing enough food to feed the growing population in the future (Freeman, 1990). The problem arises when current trends in technology open up doors with enticing economic incentives which are damaging to the balance that supports the sustainability of agriculture, and which produce no overall benefit towards alleviating hunger[8].

4.2.3 Problem 3: Loss of natural conditions

Ecosystems are defined as rich or poor depending on the diversity and richness of species they support. Diversity is nature's way of protecting each individual species, where they can live and share resources with each other and also minimize susceptibility to species-specific pests. (Knauft and Gardner, 1998) Therefore, as beautiful and natural as rows of flourishing green corn and soybean crops surrounded by perfectly manicured ditches may seem, there is ultimately nothing natural about it. This has implications when it comes to local wildlife species and their habitat as well as on the crop species itself.

Wildlife implications

[8] According to the World Health Organization (WHO), one out of every three people in the world suffers from malnutrition today (WHO, 2000), and there are nearly equal numbers of obese individuals as there are undernourished in the world- approximately 1.1 billion of each (Gardner and Halweil, 2000).

The predator/prey balance is found in every ecosystem and functions as a 'checks and balances' system for nature. Fragmentation, suppression of top predators and conversion of natural habitat to agricultural land all lead to increased densities of mesopredators- those animals that are middle-ranked in a food chain acting as both predator and prey (Iverson and Schwartz, 1994). In the entire state of Illinois for example, all of these actions have taken place, where 6 million hectares of the original forest have diminished to only 1.7 million (Iverson and Schwartz, 1994) and more than 70% of the land is used as crop land (Mattson, 1996). A study examining the predator/prey relationship was performed by Schmidt in Illinois where the mesopredator raccoon, *Procyon lotor*, has increased in numbers since the early 1980s. The destruction of forest habitat caused a loss of top carnivores that had previously contributed to regulating raccoon populations. Since this mesopredator release has occurred, the low-nesting songbird populations have declined by approximately 10%, a category which includes the official state bird of Illinois, the Northern Cardinal (Figure 4). (Schmidt, 2003)

Figure 4: Picture of a Northern Cardinal- Illinois' State Bird. Songbirds such as these are declining in Illinois

Some agricultural areas do create habitat (Graham, 2002) however these species then become vulnerable to the hazards that would not normally be present in a natural area. These hazards include mowing ditches, vulnerability to predators, and the availability of foodstuff that is harmful to their health[9]. A related problem is that wildlife is forced to condense to small areas, giving their predators a competitive advantage. It was identified by an interviewed farmer that even though he has land that is reserved in the Conservation Reserve Program (CRP) which is a breeding ground for fowl, the predators such as coyotes have zoned in on this area as a target hunting zone, thus contributing to the diminishing local bird population.

Crop implications

As mentioned above, plants are protected in their natural environment due in part to variability within their own species and among other species. During plant domestication, efforts were made to reduce or completely eliminate diversity for a number of reasons, some of which are identified in Knauft and Gardner (1998) and are as follows. Mechanical harvesting would be impossible if plants were growing to different heights and maturing at different times, so in that sense diversity was a hindrance to mass production and was diminished. Another reason for reducing variability in crops has to do with demand side requirements. Consumers ideals about what a product should look like is very influential to how products are prepared. An example presented in Knauft and Gardner (1998) states that high vitamin A content in tomato is associated with an orange color; however the buying public has the ideal that a tomato should be red so the orange tomatoes are selected against. So the consumer demand on products as well as need for efficiency in mass production play a role in reduced variability since there are economic incentive for having uniform products.

There are a number of methods that have been used to change native plant species into a variety that as humans we see as desirable. As identified in Knauft and Gardner (1998), many plant species contain toxic substances as natural protection against pests; however these substances also make the plant unpalatable or harmful to humans. It is possible that through plant-food processing, desirable and undesirable elements can be separated, toxins can be removed, and food can be prepared for preservation or storage (Stahl, 1989). However, a number of plants have been genetically altered to remove unwanted substances in the process of domestication. Examples of undesired traits are steroidal alkaloids that are naturally present in potatoes and resins found in mango, both of which are harmful for human consumption and have thus been genetically removed from the crop through domestication. (Knauft and Gardner, 1998)

[9]According to Graham, geese that eat dry soybeans could potentially damage or block their esophagi when the soybeans swell, which could obstruct food from reaching the stomach. Also, exposure to molding crops can cause aspergillosis in birds- a fungal infection of the respiratory tract which is contagious to other birds thus can cause considerable die-offs. (Graham, 2002)

Altering plant genetics is a process that occurs both in nature and through human actions. Mutation, recombination and selection all occur naturally, of which only mutation can change the genetic makeup of an organism. It was not until the early 1980s that humanity was able to isolate and identify genetic codes responsible for different traits in an organism, thus acquiring the ability to alter genetic variability as only nature had been previously able to do. (Knauft and Gardner, 1998) There is much debate over the use of this molecular biotechnology to transfer DNA from one type of organism into another, concerning both safety and ethical aspects, and the concerns of reducing even more genetic variability thus increasing susceptibility. Yet even besides these 'soft' concerns, some problems with the practicality of DNA alterations have arisen. As noted in Knauft and Gardner (1998), "it is now recognized that…the behavior of genes in a foreign background cannot be predicted accurately, and many desirable transformations that seemed theoretically possible have not worked in actuality". This field of research is still relatively young and there is much that is not completely understood. Besides the uncertainties with the actual process of gene manipulation, genetically modified products are owned and patented by large corporations, centralizing power away from the farmers. This is a topic that is discussed in more detail in the section entitled 'Erosion of social setting'.

The main advantage of plant domestication- the ability to concentrate food production into one area with uniform crops- is also the cause for many problems in this sector. First of all, decreased diversity makes the plants susceptible to pathogens and pests that can now easily concentrate in one area and cause large amounts of damage. Secondly, homogeneity makes the crops more susceptible to inclement weather such as drought or other extreme weather. (Knauft and Gardner, 1998) These problems are quite relevant in an empirical sense since, besides keeping up with technology, dealing with insects, weeds and weather were noted as the biggest problems faced by farmers in Grundy County today.

Thirdly, history shows that dependence on concentrated food supplies based on limited genetic diversity can turn disastrous. The potato famine that occurred in Ireland in the mid 1800s was due to dependence on only a few clone species of potato that became wiped out because of a single fungus infestation, causing wide spread starvation and mass emigration (Knauft and Gardner, 1998). Also, although the true cause of the collapse of many ancient cities remains a mystery, it is speculated that altering the land to produce food for a population that was increasing and becoming more segregated played a part in the collapse (Annenberg/CPB, 2001). Although we are in a new age of production, and techniques used today seems much more advanced than earlier techniques, the underlying components at that time are quite similar to the state of our world today (i.e. dependence on a limited number of food stuffs, high population pressure, soil erosion, soil salinization, variable climate, etc.). Table 1 further illustrates the argument presented in this section concerning advantages and disadvantages of plant domestication.

Table 1: Domesticating and mass producing certain plants has advantages as well as some indirect and unavoidable disadvantages

Plant domestication	
Advantages	Disadvantages
~Creates new wildlife habitat	~Disrupts natural balance of predator/prey
~Food source for some foraging animals	~Food can be harmful/promotes mesopredator release
~Concentrate food production into a small area	~Vulnerability to pathogens and weather increase

4.2.4 Problem 4: Reliance on subsidies

U.S. farmers, when compared to farmers in other parts of the world, are not often seen as poor – in fact they are the elite of the world, being only 0.3% of the world farm labor force (Miller, 2002) while producing

nearly one fifth of world production and earning as much as $54 billion from agro exports (DiGiacomo, 1996). However, the economics of farming is becoming more and more complex and the financial fixes in the form of government support are actually detrimental to the U.S. farmer as well as to producers around the world.

The income received as a farmer in the United States consists of 1) the price received per unit product (commodity price) plus 2) possible government support measures (subsidies), which are currently very controversial in their existence. When asked whether or not they received subsidies, all farmers whom I spoke with confirmed that they were part of a farm program where a market loss assistance subsidy was available for them in the case of low market prices below $1.94/bushel for corn and $5.40/bushel for soybeans. It can be argued that these subsidies are the drivers for production in the United States, thus a false driver. This is similar to the case of farm subsidies in the European Union, where during post-World War II times, farmers were able to exploit the price guarantee that governments made to them during a time of low food commodities to continually produce even when demand for foodstuff had decreased (Tracy, 1989). With today's surplus of certain crops, commodity prices are driven down to prices below production costs; and crops are now selling at prices considerably lower than costs of production. For example, wheat sells for 40% below production costs, corn between 25% and 30% below, soybeans 30% below, cotton 57% below and rice around 20% below (Raghavan, 2003). In this distorted selling environment, non-supported farmers will not be able to make a profit from their own crops. Subsidies that attempt to fix this market problem give an unfair advantage to farmers who are supported by their government as opposed to those farmers in countries where no government support is available and also to all farmers who produce crops that are not supported with government funds.

Global implications of subsidies

Stemming from the Uruguay Round negotiations (1986-1994), the World Trade Organization (WTO) created the Agriculture Agreement, an agreement taken part in by 126 member governments (including the U.S.) with an objective to "reduce export subsidies, domestic support and import duties on agricultural products" (WTO, 2003) in an effort to reforming agricultural trade towards a more fair and market-oriented system. Article 20 of the Agriculture Agreement which pushed for the start of negotiations on the reform in 1999 has been further attended to by the November 2001 Doha Ministerial Declaration where objectives were made more explicit and deadlines for reforms were set. Despite these global intentions, the United States has recently initiated the 2002 Farm Bill (c.f. History of U.S. Agriculture) that intends to *increase* domestic subsidies over the next 10 years rather than decrease them. This puts the U.S. close to violation of their commitments made in the Uruguay Round negotiations and causes some criticism at an international level. Awareness from other countries has arisen concerning the United States' obligations to remove price distorting domestic support (Anonymous, 2002), slowing the global efforts to repair the failing agricultural trade market.

The importance of this issue has been set on a global scale because it has been recognized that domestic protectionism in agriculture discriminates against foreign competitors, mostly those in developing countries. Although protectionism occurs in developing as well as developed countries, the bulk occurs in the OECD countries[10]. Subsidies – along with other trade barriers such as trade preferences, standards, contingent protection, and tariffs – keep poor countries' agricultural products out of markets of rich countries. (Lankes, 2002) Subsidization of farmers by OECD countries "depresses world prices of commodities and increases price volatility, which hurts poor countries and their poorest citizens" (Lankes, 2002). Developing countries rely mostly on traditional agriculture which is highly labor intensive, and is practiced by about 2.7 billion people- 44% of the world's population (Miller, 2002). Agriculture accounts for around 27% of GDP in

[10] OECD (Organization for Economic Co-operation and Development) Member countries include: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States. OECD is a forum for discussion and development, with a commitment to a market economy and pluralistic democracy. (OECD, 2003)

developing countries, one fourth of the exports, and around half of the employment (Lankes, 2002). These astounding figures speak for themselves (remember full-time farmers make up only 2% of the population in the U.S.) in the importance of securing the ability of farmers in developing countries to produce and compete in the global market.

When large quantities of limited commodities are produced in a small area, the foodstuff often ends up being 'dumped' onto the market at lower than cost prices. So along with overproduction comes grain dumping, which is "the sale of goods abroad at a less than cost of production price" (Trade Observatory, 2003). As mentioned, a number of agricultural commodities on the global market today are being dumped at prices between 20 and 57% lower than production costs and are thus discriminating against producers who are not supported for their production. By not allowing these producers to compete, economies of developing countries become completely stagnant thus halting the progress of the regions climb out of poverty. As author Amartya Sen explains, it is *poverty*, rather than food shortage, that is frequently the underlying cause of hunger (1981), thus producing too much food can actually lead to increased world hunger, despite what logic may say. Also inhibiting these countries from producing their own grain commodities leads to their dependence on imports and thus they become vulnerable to the fluctuating prices and availability of import products (Trade Observatory, 2003), destroying their opportunity to become independent. This is a typical situation where logical analysis can actually lead to a solution that can worsen the situation while what seems contrary to common sense is actually the answer (O'Connor and McDermott, 1997). In this case, it is through holistic, systems thinking that issues within a system can be attended to and eventually solved.

Local implications of subsidies

With today's extremely low commodity prices and increasing overhead costs, grain farmers are dependent on either 1) government assistance in the form of subsidies, 2) constantly increasing their production or 3) both. Over-production is a method that cannot be sustained because of the aforementioned problem of market saturation and grain dumping. Locally, this means that farmers have less driving power, since over-production reduces the demand for their goods.

Concerning the subsidy program, the majority of farmers in the United States do not share in this type of government support. The 2002 Farm Bill supports growers of wheat, corn, grain sorghum, barley, oats, rice, upland cotton, soybeans, and other oilseeds (ERS, 2003b) so growers of other commodities do not benefit from this type of protectionism. Agricultural subsidies provide the majority the funds to a small number of producers. According to statistics from the Environmental Working Group (EWG), between 1995 and 2002, the largest 10% of producers of subsidized crops received 71% of all subsidies, with an average payment of $34,800 per year. The smallest 80% of producers only collected on average $846 per year (EWG, 2003). With the new 2002 Farm Bill, approximately the top 10% of eligible producers will receive two-thirds of the funds, and just under half (47%) of commodity payments will be paid to large farms with average household incomes of $135,000 (Mittal, 2002). This divide between recipients of subsidies only adds to the discrimination of small farmers and certain food types as well as to the pressure on producers to continually expand their operation, which is a trend that I am arguing as being unsustainable.

While the removal of market-altering subsidies in the U.S. and other industrialized countries is a complicated process, the economic benefits from a more fair and market-oriented system will likely be felt by the majority of farmers in the world, including producers in both developing and industrialized countries. It is in the interest of the global community of producers that the ideals of the Uruguay round be upheld. Long-term economic benefits can also be seen from allowing a free market to function. As is in the case of New Zealand, where all agricultural subsidies were dropped in the mid 1980s, the agricultural sector has grown faster than the rest of the economy, the margin of increased agricultural productivity per year has increased, and operations have become much more efficient thus costs have been reduced (Sayre, 2003). The example of New Zealand is brought up again during the discussion section of this paper.

4.2.5 Problem 5: Erosion of social setting

As stated earlier in the introduction, agriculture has constantly been in a movement towards less individuals being in charge of more land. In the United States the number of family farms has decrease by 300,000 since 1979 (Andrews and Burke, 1999) to a total of 2.16 million in 2001 (NASS, 2002). Small farm operators are the most vulnerable – the trend is towards only gigantic or small specialized producers. In this case, middle-sized farm operators are forced to either sell their property, or earn a second income from off-farm jobs, spreading their attention to other places than to what is happening in farm developments. The perceived image of a rural farmer does not exist anymore; since most farmers are insurance salesmen/government employee etcetera as much as they are farmers.

In this new line of development, many decisions are being made away from the farm and by a limited number of people. In 2001, four firms accounted for 81% of U.S. corn exports and 65% of soybean exports (McDonald, 2001). These firms are Cargill, Continental, ADM, and Zen Noh, and a proposed merger between Cargill and Continental would give this new firm alone control over 42% of corn exports and 31% of soybean exports (McDonald, 2001). Antitrust laws exist that prohibit practices restraining trade, including restrictions on corporate mergers that could reduce competition, however it has been argued that these laws only protect consumers from high prices and do not protect farmers from low prices resulting from concentrated market power (MacDonald and Hayenga, n.d.).

Other agricultural industries in the Midwest have developed along the same path that grain farming is developing along, and where economic incentives were pursued, the sustainability of these situations is not very stable. One example of such an instance is within the pork industry. Author King (2000) describes how raising swine has changed from independent producers raising swine for the duration of the animal's life, to the compact and specialized factory-like production which generates many externalities and shifts costs to others. This author further states that in the mid 1990s, farm aggregation took place at a rapid pace and most of the farms forced to discontinue swine production were the small and medium sized operations. During this point of industrialization, the number of breeding animals was not altered although the output of pork had dramatically increased (King, 2000) – a trend that is mirrored in the nearly stable use of farmland which produces an increased amount of crops. With advancements in management and facilities, swine production began occurring in non-traditional areas of the country and thus competed with the Midwestern states where this production originated. King continues to explain how this change in production patterns has had a number of social costs such as the generation of large waste lagoons that are cumbersome to local residents and a danger to local environment and health. Also by raising swine in confinement, producers face the possibility for contracting serious respiratory problems, experience bouts of depression, and there is an overall reduction of strength of the rural community (King, 2000).

Such a market mentality and the pursuance of economic incentives have led to a number of these types of external costs. This type of extreme corporate control has happened in other sectors of agriculture as well, such as in poultry production (Tyson, 1995). While there are significant differences between grain and livestock production, the similarities in the factors of development should ring a bell of caution to those contributing to the current development of grain farming so as to avoid the same fate as the farmers of other agriculture sectors.

In spite of the sceptics of the validity of industrialized development, there are some who argue that the situation of industrialization, concentration and condensation is not as dire as people are claiming. For example, Wirtz (2000) discusses that in 1919, five meat packers were controlling 60% of the market, and this trend was also present in the grain industry from early on. Also this trend is occurring throughout the world and even faster in other countries than in the U.S., so the current domestic situation in agribusiness cannot be blamed on industrialization and concentration of power. (Wirtz, 2000) Another argument for consolidation is that mergers and consolidation can create new opportunities. According to author McDonald (2001), some of the reasons for merging are "the desire to handle more volume, international market expansion, developments in information technologies, and the appearance of biotechnologies and its resulting products"

(2001). In this case firms could avoid problems of huge market swings, could cut some expenses, and often gain more profit (McDonald, 2001). However, these advantages are concentrated to a small number of individuals and may be detrimental to other rural residents. The advantages are also short-sighted in nature, thus do not contribute to the overall sustainability of agriculture.

4.3 Current issues facing farmers

The problems of a system as a whole are not always the same problems as seen by the components of that system although they are many times related. In the case of grain farming, what individual farmers see as issues and problems differ from person to person and from location to location. This can be due to differences of perception or prioritization and to what issues are the most acute to that farmer. Regardless of any of these factors though, the entire U.S. food production and distribution system is going through some major structural changes thus each and every farmer is affected in some way, having his or her own difficulties. These changes include altered product characteristics, changing production and consumption patterns worldwide, technological innovations, expanding operation sizes, varying geographic locations (as in swine production), and an increased pace of change (Boehlje, 1999). According to the same author, an assessment of current practices shows that:

> "production is changing from an industry dominated by family-based, small-scale, relatively independent firms to one of larger firms that are more tightly aligned across the production and distribution value chain. Food retailing is increasingly more customer responsive, more service focused, and more global in ownership. And the input supply and product processing sectors are becoming more consolidated, more concentrated, and more integrated" (Boehlje, 1999).

Whether or not one views this trend positively or negatively, it is occurring and effects are felt by all farmers on a continuing basis. Below are some of the responses I received when asked what issues farmers are facing today (including technical and production) as well as an outlook to the future of farming in Grundy County from those who currently make up the present farming in Grundy County thus will play a role in affecting its future.

In asking a number of farmers what they considered to be the biggest economic limitations they face, their responses can be summarized into the categories of unfavorable natural conditions and increasing costs/decreasing returns. Unfavorable natural conditions in this sense include any condition that limits the amount produced in which humans have no or little control over. Things such as insect damage and weed control, drought, floods, and wind damage all fall into this category. Other concerns held by the interviewed farmers include increasing global competition and urbanization. Each one of these concerns has important implications to farmers, therefore they are analysed in more detail in the following section.

4.3.1 Unfavorable natural conditions

Pests

In general terms as defined by the U.S. EPA (Environmental Protection Agency), a pesticide is "any agent used to kill or control undesired insects, weeds, rodents, fungi, bacteria, or other organism", thus pesticides include insecticides, herbicides, rodenticides, fungicides, and nematicides, to mention the main types (EPA, 2003). In data from 1998 and 1999, expenditures on pesticides for agricultural use were $8.2 billion and $7.6 billion, respectively, which represent two-thirds of total expenditures on pesticides in the U.S. in both cases. (Donaldson *et al*, 2002) It is estimated by Estabrook (2003) that globally, 45% of crops are still lost to pests annually. In the United States, about 10% of total production is lost, which accounts for $20 billion worth of crops each year (Estabrook, 2003). And this is all occurring at a time when global pesticide sales are increasing, yet effectiveness is remaining the same. Today farmers spend 17 times as much (adjusted for inflation) on pesticides than in the mid-nineteen hundreds, yet crop loss due to pests has remained rather constant (Halweil, 2002).

Specifically to Grundy County, it's not just the expense of pest management, but the fact that within the past two years pests have adapted to the common corn/soybean rotation which is the problem for today's farmer. The European corn borer (ECB), *Ostrinia nubilalis*, is a non-native insect species that as a larva bores itself into the stalk of corn thus damages tissues and interferes with nutrient and water flow, enhances infection by other fungal diseases, causes stalk breakage, and can ultimately reduce corn yields (Willson and Eisley, 2001). ECB in most of the Midwest states is a two-generation variety, with the first 'brood' having over wintered as larvae in corn stalks thus pupating in early spring. The resulting moths (shown in Figure 5) then lay their egg masses on the underside of corn leaves. The surviving larvae of the first brood then pupate in the stalks and emerge as moths in late July or August. These moths then lay egg masses, which when emerge are called second brood and are responsible for damage such as stalk breakage, dropping of the corn ear, and infestation of the ear itself. (Willson and Eisley, 2001) In order to disrupt this cycle, farmers have rotated crops on a yearly basis so that the over wintering larvae would not have the newly planted corn to lay their egg masses on, thus would perish. But the insects have recently adapted by laying egg masses in the bean stubble instead of corn stubble so that the following corn year will be infested. Another method of managing this pest besides just the yearly rotation is to plant Bt corn, which is a transgenic crop variety that contains an injection of DNA from a bacterium and is lethal to ECB upon its eating of the crop (Ostlie *et al*, 2002). According to a number of interviewed farmers, the corn borer has recently become a nuisance again within the past few years even with the use of this enhanced crop. How can that be the case? The corn borer contains a recessive gene that is resistant to the effects of Bt corn, and as Bt corn is being used more frequently, this recessive gene has a 'selective advantage' as the surviving population will be carrying the recessive gene. (Ostlie *et al*, 2002) Thus ECB gains resistance to Bt corn after a few generations. This has negative implications to farmers because 1) Bt corn costs 30-35% more than comparable conventional varieties (Pesticide Action Network North America, 2003) thus is a significant loss if crops are not protected and 2) organic farmers who rely on Bt insecticides as a natural method of pest management will be losing an important management tool for their type of production (Ostlie *et al*, 2002).

Figure 5: European Corn Borer (ECB) in moth stage

Weather

Inclement weather has also taken a toll on crop productivity. Although some changes in weather situations can be beneficial to crop production, many farmers were concerned with the variability of rain in the area. To demonstrate the variability that can occur in the Midwest, a climate report for the Midwest region from the National Climate Data Center (NCDC) from the month of May in 2000 states that while some parts in the northern Midwest had received 150% or more of normal precipitation, severe drought was occurring in some areas in the central area and areas in the southern portion of the Midwest had experienced floods "by torrential rains or damage by severe winds and hail, thus requiring replanting as soon as the soil is dry enough to allow access to farm equipment" (NCDC, 2000). These extreme variations can be in part due to climate change, but it also must be kept in mind that the U.S. has experienced turbulent weather in the past that has had severe effects on agriculture before the issue of climate change became a factor. The Dust Bowl drought of the 1930s which occurred due to poor land management that left top soil vulnerable to wind erosion caused overwhelming distress to those living on the Great Plains and caused great environmental and economic despair (Paleo perspectives, 2003). The five-year drought in the 1950s caused serious environmental, social and economic percussions and many southern counties were considered federal drought disaster areas (Paleo perspectives, 2003). The three-year drought that occurred from 1987-1989 covered 36% of the United States at one point and was the most expensive federal disaster ever experienced

in the U.S., costing an estimated $39 billion in energy, water, ecosystem and agricultural losses (Paleo perspectives, 2003). These occurrences legitimize the concern farmers showed towards weather, as humans become nearly defenseless in such situations regardless of what technology is in place.

4.3.2 Increasing costs/decreasing returns

"…prices keep going up on inputs but not on what you're selling. [Grain farming] is the only business where you buy retail and see wholesale. That's how I look at it!"- interviewed farmer

Overhead costs continue to increase, a trend which is the biggest concern held by nearly all interviewed farmers and especially to the operators of small farms. According to the Institute for Agriculture and Trade Policy (IATP), the costs of corn and soybean production are increasing. The evidence they provide is that in 1975, the average total cost of production for corn and soybeans was $189/acre and $125/acre respectively, and in 1999 this average cost for corn and soybean production had increased to $322 and $265, respectively (Corselius, 2002). Over this same period of time, prices paid for these two crops have fluctuated and been highly variable even within short periods of time (Corselius, 2002). This variability makes farmers even more dependent on government assistance, which has numerous negative implications (c.f. 'Reliance on subsidies').

4.3.3 Global competitors

A number of the farmers expressed concern for the rising competition, especially that coming from South American countries such as Brazil and Argentina. There was a general understanding among the farmers that the advantages that the United States possessed in technologies and infrastructure are now being developed in these countries. However if one looks at the current status of global grain production, especially production of coarse grains and oilseeds, the United States is by far the most productive country in the world. Figure 6 shows the global coarse grain production and oilseed production by country in 2001/02. Although this information shows a trend over only one years' time and therefore may not be representative of future projections, there are a number of barriers to the success of agriculture in South American countries, including their need to make payments towards high foreign debt. According to an interview with a representative of an NGO in the Mata Atlântica region of Brazil, currently no farmers are receiving financial support from the government in the form of free grants, and only small scale farmers are eligible for a subsidized lower interest rate from a government support scheme called PRONAF (Programa para apoio a agricultura familiar) (Le Brenton, 2003). This is a barrier to their success in agricultural production.

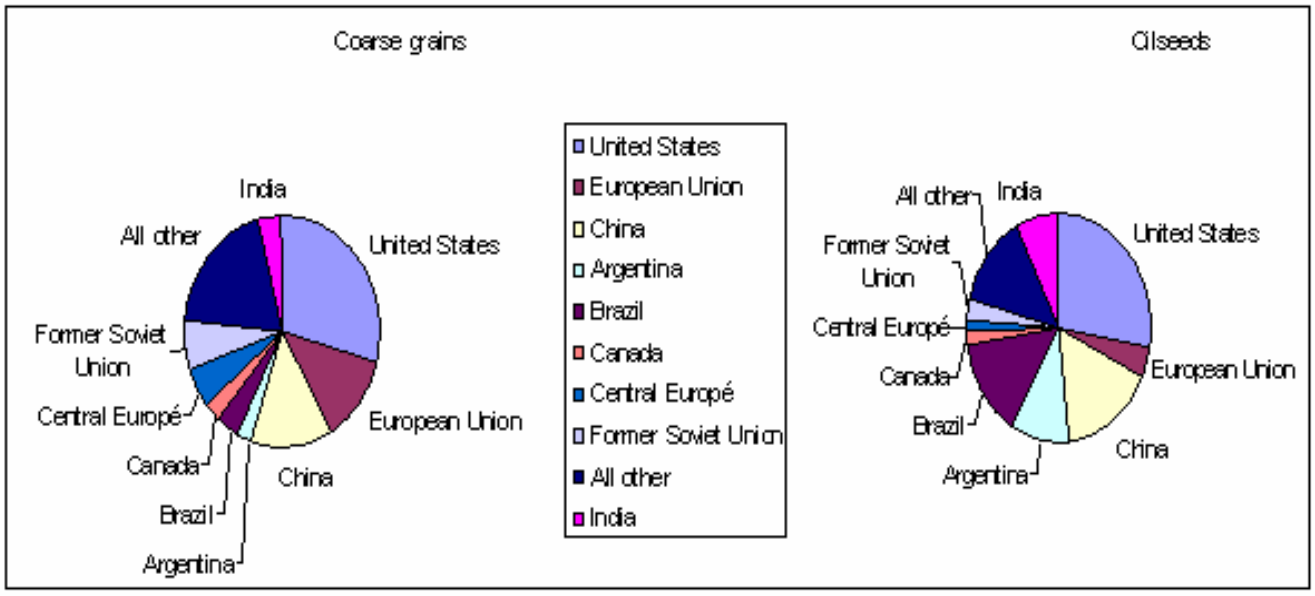


Figure 6: Charts demonstrating the amount of coarse grain and oilseed produced in the world in 2001/02 according to country contribution. Data from Foreign Agricultural Service, 2003

4.3.4 Urbanization

As previously mentioned, the population of Grundy County has risen considerably within the past ten years. This development is encroaching on what once was considered rural area but is now being built up by residential subdivisions and commercial areas. Without exception, a common concern of all interviewed farmers in Grundy County was the urbanization of the rural area. This has a number of effects on farming operations. First of all, competition for land increases, thus driving up land prices and forcing farmers to expand (in the case of Grundy County) westward. Thus fertile land is being transformed into housing, commercial lots, and roads. Secondly, the increased population surrounding farm operations causes problems for farmers. According to a study done in northwestern Illinois counties (specific counties not named), non-farm residents constrict actions of farmers that are seen as a nuisance to them. Their complaints include livestock and fertilizer smells, dust from tractors, pesticide sprays, and early-morning and late night sounds such as tractors and grain dryers (Esseks *et al*, 1998). Yields may also be reduced from residents tampering with production or from storm water runoff from subdivision streets that could potentially flood portions of fields (Esseks *et al,* 1998). The high land prices also create a barrier for new farmers to enter this area, thus aiding in the erosion of the social setting.

A not-so-recognized factor of urbanization is the increase in the generation of waste. As discovered from interviews and from personal observation, this is a pertinent issue for rural residents in southern Grundy County as the garbage from northern areas is being transported through this area to a local waste dump. This may not affect the farmers directly, but truckloads of garbage and waste, arriving continuously day and night, has ended up littering the roadsides and has affected the quality of life in this rural area, thus lowering land value around the dump and discouraging rural societies and development in this areas.

4.4 What options do farmers have? Types of 'sustainable farming'

The long-term sustainability of grain farming in the U.S. seems uncertain, and some big changes seem to be inevitable. I will present what changes of practice are evolving, why they seem to be evolving, and their subsequent effects on society, economics, and the environment. Until now have looked critically at the future of farming and challenged its sustainability and would now like to critically look at different potentially sustainable methods of farming and challenge their sustainability, both in general and locally applied to Grundy County.

Once again, the purpose of sustainable agriculture is to provide a more profitable farm income, promote environmental stewardship, and promote stable, prosperous farm families and communities (SARE, n.d.(a)). Many farmers still maintain the concern that is inherent to the farming business to be stewards of their land, and none would go so far as to purposely deteriorate their land. However, today there are many choices that farmers face, and by weighing a number of different factors, they will follow the practice that seems suitable to their operation and their standards at that time. Some practices claim to be more 'environmentally friendly', others seem to be more of a safe way for securing a profit, while others follow along the social norm; being recognizable for farmers and thus comfortable and requiring the least fuss so as to allow time for other parts of life. But as with almost everything in life, nothing is as simple and straightforward as it may seem in theory. For example, organic farming is a method that is growing in popularity that is recognized as good for environmental and ethical reasons, however can create economic and social challenges. The current trajectory of development, which is highly industrial, can be good economically, but as argued previously can have negative implications for the social and environmental aspects of sustainable farming. So which method is best? Is there a 'right' way to farm? In the following sections I will identify different practices and briefly point out both their positive and negative attributes from a holistic perspective.

4.4.1 Conventional farming

The majority of the aspects of conventional, industrialized farming have already been addressed in the previous sections where unsustainable aspects were presented; aspects such as high dependence on non-renewable resources, dependence on constant technological fixes, destruction of natural habitat, reliance on subsidies, and the erosion of the rural setting. So why is this practice dominating most farming operations? The possibility to exploit such a system became available during the Green Revolution, and due to government assistance has been able to thrive. A number of farmers do consider their practices to be sustainable, and in the short-term and in a local context, they are. When compared to practices one generation ago many positive changes have happened. A number of farmers today are soil testing before applying fertilizers, therefore only applying chemicals as needed. Tillage practice for conventional farming makes use of a chisel plow, usually plowing once in the fall with a secondary tillage occurring in the spring (Wehrspann, 2000). This type of practice is a huge improvement from a generation ago when moldboard plows were used and "everything was just plowed black" (as expressed by one interviewed farmer). Wind and water erosion has decreased by 38% since 1982 (Paul, 2001). Also with the use of transgenic crops such as Bt corn, there is less need to spray insecticides aerially thus less pollution is spread to surrounding neighborhoods through the air. However with the global nature of food production and consumption plus the special needs of communities and the environment, compartmentalized sustainability will not suffice for long-term human needs and these methods need to be viewed in a broader context in order to see the unsustainability lying within them.

4.4.2 No-till/strip till

A number of farmers in the United States, especially within the last 10 years, have begun practicing no-till production. As defined by Wehrspann (2000), no-till is a method in which only a small slit is made into the soil into which seeds are sown, and the detritus left from the previous harvest is left as it is. Strip-till is a variation to no-till, where a narrow strip of each row is tilled (about 8 inches), allowing for more air into the soil for better drying than in regular no-till situations (Wehrspann, 2000). This practice can show up to a 10% advantage over no-till and usually yields within 3% of conventional tillage, however the challenge of this practice is mastering the techniques required to do it (Wehrspann, 2000).

Figure 7: A photo of a soybean field in Grundy County where the residue from the previous years' corn still remains. Photo by C. Prindiville

Since 1990, the number of acres planted without tillage in the United States has increased 200% to a total of 51 million acres (Core4 Conservation, 2000). The majority of that conversion has taken place in the Midwest. In Illinois, Indiana, Iowa, and Ohio, the total soybean acreage planted in no-till increased by 1.8 million acres. In Illinois alone, 43% of soybean acres and 17% of corn acres are planted no-till. (Core4

Conservation, 2000) This practice has a number of advantages. Since no-till techniques were popularized in the U.S., soil erosion rates have fallen considerably. According to the Natural Resources Conservation Service (NRCS), only 41 million acres were eroding at a pace of 5 tons per acre per year in 1997 (NRCS, 2000a) as compared to 111 million acres eroding at the same rate in 1982 (NRCS, 2000b). No-till also reduces working hours required since no-till farmers only need to take a few passes over their fields per year instead of five to ten, plus the need for huge machinery is reduced (Paul, 2001). This therefore also reduces the amount of fuel used plus avoids extra 'wear and tear' on machinery, benefiting not only the farmers budget but also the overall problem of greenhouse gas emissions and oil dependency. Some sources claim that no-till farming can cut costs up to $15 per acre in labor and fuel costs (Swinn, 1994). One farmer in Grundy County whom has practiced no-till farming for 15 years claimed that his costs have decreased by about 70% since implementing no-till practices, which has kept his operation affordable.

However, along with the positive aspects of no-till farming come negative ones. The size of operation is usually limited, as the machinery available is usually smaller. The farmers whom I interviewed who practice 100% no-till noted that residue management was one of the biggest challenges that they face, making sure that the residue is spread out evenly in order to ensure proper drying and to avoid erosion. Another technical problem includes "finding and modifying a planter to get an ideal plant spacing and depth so you get a good uniform stand". This can require experimenting with different attachments and machinery therefore can be seen as one downfall of no-tilling, since there is no single set of rules or instruction manual to follow for this type of cropping system.

Recently, a study was performed by Ghidey and Alberts (1998) in the claypan soil areas within Missouri and Illinois to determine the effects of different tillage practices used in corn and soybean rotations. This type of soil occupies about 4 million hectares within these two states and has poor drainage thus high runoff and soil loss. In this type of soil situation, it was determined that no-till, while reducing the total amount of soil loss, was more detrimental to the contamination of local water resources because runoff intensity increased with no-till operations thus herbicides were washed away. Therefore it can be seen that no-till practices can vary spatially in their suitability. (Ghidey and Alberts, 1998)

There are some soft variables that can be seen as negative aspects of a no-till operation, which are just as significant as quantifiable data. From a social context, there are some aesthetic implications to leaving fields unplowed. A locally observed problem is that the left over corn husks and stalks can become a nuisance to local inhabitants as they blow around in the open countryside, coming into private lawns and clogging up drainage ways. Also the fields just "look messy"; something that farmers are not accustomed to. Many farmers pride themselves in having weed free fields with row after endless row of well-trimmed crops. One farmer who practices no-till farming in Grundy County professed his dislike of seeing weeds in his field "just as much as the next guy" but as long as yields were not compromised then it was something that he would be able to live with. This same farmer, when asked why he thought more people were not practicing no-till farming, suggested that some farmers are probably comfortable with the problems that they have, and that the different problems faced by no-till farmers – although not worse – were unfamiliar and therefore a barrier to change.

4.4.3 Organic farming

Organic farming is defined by the International Federation of Organic Agriculture Movements (IFOAM) as "an agricultural system that promotes environmentally, socially, and economically sound production of food, fiber, timber, etc." (IFOAM, n.d.). Soil fertility is seen as key to successful production, yet this is done by using natures own elements and reducing external inputs such as chemo-synthetic fertilizers, pesticides, and pharmaceuticals. Organic production also takes into account social implications of farming practices, recognizing that "people are as important as the organic system[11]" (IFOAM, n.d.). One concrete positive

[11] There are a number of definitions of organic agriculture. For a complete list of the criteria set out by IFOAM see IFOAM Norms at http://www.ifoam.org/standard/norms/cover.html, which sets out an international framework for organic production and processing.

effect of organic farming is the increased biodiversity that it supports. A study performed in Nebraska in the Great Plains marks the ecological relationship between wildlife conservation and farm management techniques. According to this study, bird abundance was 2.6 times higher on organic sites than non-organic sites, showing that organic fields are advantageous for birds and bird habitat. (Beecher *et al*, 2002)

An analysis of organic agriculture done by the Food and Agriculture Organization (FAO) of the United Nations points out other beneficial factors of organic production, which are presented below. Biodiversity in general is supported on organic farmland, from the crops that are produced to the diverse combination of plants and animals found within the system. It is this diversity that organic producers rely upon to avoid relying on synthetic fertilizers and pest controls. Besides biodiversity, organic agriculture promotes soil conservation and water conservation by building organic matter and preventing nutrient leaching. Organic agriculture also offers a niche market (1-2% of total food retail worldwide) where price premiums are available: a market which is currently the fastest growing food sector with an outlook for continued growth. (Hattam, 2002) Socially, organic agriculture has benefits by helping to build and strengthen rural communities. Since it is more labor intensive and many times the product is sold without added preservatives, there is a need for a local work force plus local food markets at which to sell the production. These actions help secure jobs in the rural area and also create a sense of community and an awareness concerning healthy food production. (Hattam, 2002) Another possible benefit of this type of production is that without the inclusion of chemicals, it is thought that organic food is healthier and has more flavor, although there have not been enough conclusive studies to claim this for certain (Shapiro *et al*, 1998).

A drawback to organic production in the United States starts from its lack of governmental support. There has been virtually no federally-funded program in support of organic agriculture production, besides the funds provided by the 2002 Farm Bill to support the cost of organic certification (Scialabba and Hattam, 2002), a matter of a few hundred dollars per certification. Another drawback is that those who take the initiative to produce organically take a risk. It requires a deep understanding of the functions of different elements within the ecosystem and of the relationships between these elements in order to take advantage of them. One has to be able to make the best use of local knowledge and local resources in order to have a viable production. Another barrier to the adoption of organic production, as presented by Halweil (2002), is the transition period between different types of production when yield losses usually occur. It usually takes a matter of a few years before the soils regain their natural structures and for the flora and fauna populations to return after a long time of suppression due to chemicals and other inputs. Without financial support this transition period can create an impassible barrier, even though studies show that losses felt during transition are often met by greater returns once production is under way. (Halweil, 2002) An impression that I felt during interviews was also that organic production – besides being difficult financially – was just so far fetched that most farmers had not ever considered this production. The possible explanations for this feeling towards alternative practices could possibly be related to the lack of information as well as support for organic production by suppliers and government, a topic that is discussed further under the heading 'Discussion'.

4.4.4 Precision farming

Precision farming (PF) comes under many labels: Site Specific Management (SSM), Precision Technology (PT), Precision Agriculture (PA) and Variable Rate Application Farming (Batte, 2000). Precision farming is "a set of tools that allows an agriculturalist to quantify and manage the spatial variability in farm fields" (Stombaugh and Shearer, 2000). Simply stated, it is the use of new and innovative technology in order to apply more site-specific care to fields rather than a uniform application of things such as fertilizers and pesticides in order to deal with the natural variability that exists even within a small area. Precision farming could potentially "revolutionize farming in the future" (Anonymous, 1998) with the application of technologies such as remote sensing, geographic information systems (GIS), global positioning systems (GPS), and process control (Batte, 2000). This is a way to avoid either over or under-applying any inputs which can be costly to the individual farmer as well as to the environment (i.e. nutrient/pesticide loss into local water sources) and is a trend starting to develop in the United States (Batte, 2000). In the states of

Illinois, Indiana, Iowa and Wisconsin, 20% of farmers employ an advanced precision farming system, and those who have adopted it can be generalized as younger, highly educated, full-time farmers whom have large-scale farming operations (Batte and Arnholt, 2003).

One advantage of such a system is that with the adoption of techniques that intensify production, acreage is likely to decrease or remain constant thus removing the pressure from farmers to increase their farm size (Battes, 2000). Cost variability will likely decrease after initially adopting technologies. Things such as seed varieties and seed populations will become regulated according to factors such as soil, slope and other parameters that can now be accounted for on a local basis. (Battes, 2000) The collected data can also become useful for environmental record keeping when it comes to food safety concerns and recurrent crop problems (Anonymous, 1998; Battes and Arnholt, 2003).

One of the main disadvantages to this system of farming is the increased costs, especially initial costs. For example, author Olson (2000) describes one of the newest technologies in precision farming, which tests the electrical conductivity (EC) of soils. This strategy does not have a direct effect on the productivity of an area, but can map out properties of soils such as cation exchange capacity, water holding capacity, and soil nutrient levels. One such soil EC mapping system costs $11,500 to buy, or a fee ranging from $4 to $8/acre can be paid for borrowing the equipment. The results from this equipment will not always be linear or constant, but rather dependent on factors specific to each field. (Olson, 2000) Since there is no universal method for understanding results, assistance will be needed thus adding to educational requirements and overall costs. Besides this one example, the initial fixed costs to applying precision farming that will likely increase substantially include things such as soil and site surveys, boundary mapping, education requirements, insurance costs, computers and software as well as new equipment costs (Battes, 2000). While some believe that costs for these early forms of technology will decrease with the arrival of newer technologies, this mind frame creates a dependence on the continuation of technological advancements, which is unsustainable as previously discussed.

Another problem concerning this new technology is being able to use the information that is available (Olson, 2000) – a dilemma compared to "a doctor who has diagnosed an illness but is unsure how to treat it" (Anonymous, 2000b). There are many complex interactions that need to be understood therefore a long learning process is required (Battes, 2000; Battes and Arnholt, 2003). Simply the logistics of using this technology can become problematic as many rural areas lack access to high-speed Internet or cable connections (Laguette *et al*, 2001). Employing such technologies also puts more emphasis on the industrialization of farming, where the maximization of profits is the driving force for implementation and the value of farmers' knowledge of the system is diminished (Battes, 2000). Another significant disadvantage to this system is the uncertainty that lies behind it. According to Battes (2000), effects can vary substantially when engaging in precision farming. Profits may increase or decrease. Inputs may increase or decrease. Environmental effects may improve or worsen. (Battes, 2000) These technologies are just emerging and so as of now it is difficult to estimate what their overall effects will be. In addition, precision farming practices are so site specific that profit potential will vary greatly on a field by field basis (Swinton and Lowenberg-Deboer, 1998) making the risks of adopting these practices even higher.

4.4.5 Diversification

Diversification can incorporate a number of different strategies. A report produced by the USDA provides a number of suggestions to manage the risks that come with farming. One suggestion is to diversify ones operation; this can include crop diversity (i.e. intercropping, rotation, and polyculture); incorporate combinations of crop and livestock; find market alternatives (i.e. different end-points or value-enhanced crops); or diversify income sources (Risk Management Agency, 1999). Diversification also comes in the form of growing value-added varieties of the normally grown crops, which is a practice that a number of Illinois farmers are doing with corn and soybeans. In a survey performed by the University of Illinois,

24.4% of Illinois farmers were producers of specialty crops[12] while another 18.2% were interested in this production (Swanson, 2003).

In considering crop diversification alone there are numerous advantages, as presented by the government organization SARE. One could offset crop surpluses and commodity swing prices, plus tap into the market of premium priced crops in order to increase income and avoid some risk of market swings. Crop diversity (just as with diversity in general as previously discussed) has advantages in that it can reduce risks from inclement weather conditions and pest outbreaks as well as allow the soils to recover lost nutrients, thus lowering costs on pesticide and fertilizer inputs. Diverse crops usually host a variety of wildlife, which may or may not have direct advantages to the farmer but do have advantages to the local ecosystem as a whole. (SARE, n.d.(b)) All of these forms of diversification can potentially benefit a farmer by reducing large fluctuations in income on a yearly basis by guarding against low returns in one commodity by having a variety of income sources.

One of the biggest considerations a farmer must make before deciding to diversify his/her production concerns market availability. A number of interviewed farmers claimed that if the market did not play a role in their production, they would like to incorporate hay, wheat, alfalfa, or some type of legume since it is healthier for the soil and it would break up the continual corn/soybean rotation that is currently in place. However, this was not an economically feasible option (except for those farmers who were growing fodder for local livestock) because it was felt that there is no good market for such items. The initial costs of diversifying can also be a barrier to adoption new practices, as machinery and new knowledge are many times requirements (Risk Management Agency, 1999). A disadvantage to diversifying ones income is that it forces the farmer to spread his or her attention to things other than keeping up with the demands of farming. One interviewed farmer expressed concern with "losing track of things that are going on that you should know" since, in order to have an income he and his wife each had 2 other jobs besides grain farming. More than half of all U.S. farmers work off the farm, with 80% working full time off the farm (Whitener and McGranahan, 2003). In 1999, nearly 90% of farm household income came from off-farm sources (Whitener and McGranahan, 2003). This need to spread attention poses another barrier to those farmers who do not have large enough operations to fully support themselves, causing them to fall further and further behind in the technology race of farming today.

[12] Value-added specialty crops in Illinois include but are not limited to corn that is Non-GMO, High oil content, Yellow food grade, White food grade, Waxy, High extractable starch, and High lysine. For soybeans, some options are Non-GMO, Tofu (clear hilum), Organic, High protein, High sucrose, and Low saturated fat (Swanson, 2003)

5.0 Discussion

5.1 Using all above data, what is sustainable farming in Grundy County?

5.1.1 Scope of discussion

Until this point, I have analyzed the factors surrounding industrialized agriculture in the United States, focusing on Grundy County, Illinois (USA) as well as analyzed the various options for sustainable agriculture (SA). It is possible now to model such information in order to determine through which method or methods the goal of sustainable farming can be achieved. However, in keeping in line with my objectives which are to analyze the components of sustainable agriculture from a local perspective and identify possibilities and barriers to change, it is out of my scope to create such a model, and is therefore a recommendation I will have for further research in this topic of sustainable agriculture from a systems and local perspective.

One tool that can be utilized for such a modelling task is the Multiple Criteria Decision Making (MCDM) tool, which has recently been utilized in modelling sustainable agriculture. MCDM breaks down the three criteria of economic, social, and environmental sustainability into nine sub-criteria of sustainability[13]. This analysis makes it possible to integrate qualitative information (such as landscape attractiveness and occupational safety) and data which can be measured in real terms (such as return on assets and nitrogen losses) into one model whereby the sustainability of the system can be measured (Marks *et al*, 1995). MCDM can also be modified to include fuzzy set data which is "an alternative scaling approach…using linguistic variables to represent both quantitative and qualitative criteria" (Marks *et al*, 1995) – in order to better compare noncommensurate units as well as include vague or unclear data (Dunn *et al*, 1995) so as to make the outcome of the model more representative and applicable. I recommend utilizing such theoretical frameworks in continuing research on this topic, especially if the compilation of hard data is an objective of that research.

There is also a factor related to promoting sustainable agriculture which, although powerful, is not discussed in detail in this analysis. The driving power of consumer demand can act as either a barrier or a catalyst towards what types of productions are in place. Public concerns about environmental and health aspects of consumer products exist, and the desire for "natural" and organically grown food is on the rise in the U.S. (Anonymous, 2000a). Thus, targeting the consumer side of food production in an effort to promote sustainable agricultural practices could be a powerful tool. As mentioned in my initial limitations (c.f. 'Scope'), I have not focused on the factor of consumer demand in my analysis, therefore it is not described in detail in my discussion, but is a second suggestion for future research. The factor *Consumer demand for SA practices* is mentioned in the following discussion only to display where it may play a role.

5.1.2 Possibilities and barriers to change

As just presented, there are a number of possibilities of sustainable farming, each with their benefits and drawbacks. As suggested in the hypothesis, there are often conflicts between securing social, environmental, and economic sustainability. However, it should be understood from my argument that sustainable agriculture, in any form, should encompass and be aware of all aspects of sustainability. If the answer were simple, such as having one practice that is 'right', this situation would only resemble the current system in its lack of diversity. There currently are movements towards more sustainable agriculture, and support and funding organizations are available to people who may be interested. Transitioning to sustainable practices, as noted by Feenstra *et al* from the University of California-Davis Sustainable Agriculture Research and

[13] According to Marks *et al* (1995), the three criteria of sustainability are each broken down into three sub criteria which are as follows: return on resources (RR), cash-flow (CF), return on assets (RA), soil erosion (SE), landscape attractiveness (LA), nitrogen losses (NL), occupational safety (OS), the self esteem of the operator (SE), and lifestyle (LS). Quantitative data are used when available, otherwise criteria are mapped on a 0-20 interval scale.

Education Program (1997), is a process which requires small but conscientious efforts, and that "the key to moving forward is the will to take the next step". However responsibility to change does not only lie with farmers, but also with policymakers, researchers, retailers and consumers as well (Feenstra *et al*, 1997). Therefore my suggestions arising from this research on how to more easily incorporate sustainable practices into the operations of grain farmers, including those in Grundy County, primarily encompasses the provision of *encouragement and support* within the country for practices that are fair and just and will have a long continuity. New Zealand is a perfect example of how this type of restructuring to a more sustainable system is possible within an OECD country similar to the U.S., where a complete removal of subsidies took place nearly 20 years ago and today their system is prosperous and sustainable.

In 2001, government support for agriculture in New Zealand was equal to 1% of the value of output generated from agriculture; a figure that is astounding compared to the average of 31% of output value that governments of the OECD countries paid in that same year (Federated Farmers of New Zealand, 2002). Prior to the complete dismantling of subsidies in 1984, New Zealand's farmers were in a similar situation to the ones in the United States and the European Union today, where nearly 40% of the income received by New Zealand farmers (in this case sheep and beef) was from government subsidies and international relations were not very stable due to the extremely high level of protectionism that was detrimental to foreign producers (Federated Farmers of New Zealand, 2002). Author Sayre (2003) has created a short summary of how this transition occurred. In 1982 a group of farming leaders took action against the situation that government protection was creating and called for the abolishment of subsidies in 1984. Over a period of approximately 6 years, all subsidies were removed and the loss during this transition time was minimal despite many controversies and concerns (Sayre, 2003). Today, the rural population has grown steadily along with the rest of the population, and farming has become more efficient as productivity has improved by an annual average of 5.9% since 1986 compared to pre 1984 levels of 1% growth per annum (Federated Farmers of New Zealand, 2002). According to the group Federated Farmers of New Zealand, the countries leading farmer organization, farmers are proud of their achievements and independence and are "determined never again to be dependent on government subsidies" and are attempting to share their methods for success to the rest of the world (Federated Farmers of New Zealand, 2002). Although real prices are not as high as they were under subsidy support, incomes are high enough to supply a return on investment and support a good standard of living, while farmers are proud of their contribution to the longevity of food production (Federated Farmers of New Zealand, 2002) and are confident about their future.

This change is quite remarkable and could be seen as an example for the rest of the world to follow. However, there still remains a complex web of factors regarding changes in current agricultural practices. While some factors may not be so difficult to change or adjust, others would take much more effort as they become very complex in the unravelling. Certain barriers exist to the United States agricultural system following a more sustainable path. At a global level, U.S. agriculture is unsustainable because of the aforementioned protectionism in the form of subsidies. As stated by James B. Bolger (2001), New Zealand's ambassador to the U.S., "liberalizing world trade in agriculture is the key to unlock the door to foster global development." By reducing subsidies, supply and demand would have more control over production thus reduce market saturation. When the supply is lower, then demand will increase thus commodity prices will increase so that farmers can receive a positive return on investment. With increased commodity prices, foreign producers will have a chance to compete with their product thus increase their well being. This would be a step towards overall sustainability on a global scale, plus allow American farmers to make a living off of their own productions thus be more independent.

However, removing these subsidies is not an easy task. According to author Tracy (1989), extreme support for the agricultural sector has existed – especially in the United States and the European Union – since post World War II when food shortage was an immediate issue. Especially in Europe, governments felt the need to protect their own producers by employing high tariffs on imports and providing a guaranteed price to their farmers. In the years following the war, production considerably outpaced consumption, yet the price support that had been guaranteed by governments during the time of food crisis only gave farmers an incentive to produce more in order to increase their own incomes, thus governments became more deeply

involved with agriculture and in their level of protectionism (Tracy, 1989). Although government aid to farmers was substantial, the farming sector was still developing at a pace behind most other sectors; even within the farming sector the gap between poor and rich farmers was increasing thus causing dissatisfaction (Tracy, 1989). The Common Agricultural Policy (CAP) was first developed in the European Union in 1960 in order to attempt to regulate the fluctuations in food production, and since that time the CAP has been adjusted and redeveloped in the midst of the shaky world economic situation in the 1970s and 1980s (Tracy, 1989). The history of government support for agriculture in the United States runs along a similar path as that of the CAP (c.f. 'History of Agriculture in the U.S.') and today the 2002 Farm Bill in the U.S. and the CAP in the European Union are both very controversial due to their creation of discrimination in the global food market. Yet it can be seen that these support measures came at a time when food security, economic instability, and a poor farming sector were all matters of concern and which reinforced the need for government support in this sector of production (Tracy, 2002). To adjust and reform them is a cumbersome effort as there are a number of opposing needs at stake; therefore international efforts of reform are taking a long time to reach agreement.

However, it will be argued now that if an adjustment in government support for agricultural production could occur, a number of positive effects can develop. Instead of contributing money to farmers in a way that supports operation expansion and more production, and which creates a gap between rich and poor farmers, government support could come in a number of different forms. This support could include the offering of financial support for stewardship measures or opening up new markets for a variety of products, or as social support by setting up local examples where the farmers themselves will be able to witness sustainable, viable productions occurring in their own locale, and can judge the different methods for themselves. This could help to reduce perceived barriers that farmers feel towards certain practices as well as remove legitimate barriers such as low market availability and high conversion costs. This support is happening to a certain degree, yet in order to make the system of grain production sustainable, sustainable agriculture needs to happen and be supported at a national level.

In order to more clearly see the possibilities and constraints to sustainable agriculture (SA) – specific to the sector of grain farming – the identified factors from this thesis have been arranged into a causal loop diagram (CLD), shown in Figure 8. The following discussion will walk through the CLD in order to clarify the relationships between different factors as they are presented in Figure 8, with the respective factors being written in italics. First of all, the factor *Government support for alternative SA practices* refers to any of the supportive actions that were just mentioned in the previous paragraph. Also, the factor *SA in practice* refers to the multitude of farming practices which incorporate the holistic view of sustainability as has been discussed throughout this thesis. The capital 'R' with a circular arrow around it shows that the factors in that particular loop are reinforcing each other.

Starting from *Government support for alternative SA practices*, it has been said that an increase in support will increase *farmers' knowledge and trust in SA practices*. The more farmers trust in a practice, the more *farmers' willingness to adopt SA practices* and therefore an increase in *SA in practice* would be seen. SA in practice has a number of subsequent effects, such as (1) an increase in *biodiversity* thus *long-term ecological benefits* (c.f. 'Loss of natural conditions'), (2) a decrease in *corporate control* leading to positive *social benefits* (c.f. 'Erosion of social setting'), and (3) an increase in *long-term economic benefits* (both locally and globally). All of these factors will then have a reinforcing effect on farmers' willingness to adopt such beneficial practices and may also spur governments to increase support. As mentioned in the scope of this discussion, *consumer demand for SA practices* may help promote the amount of SA in practice and is a factor that will likely be influenced by government support such as campaigns for SA practices. This factor has not been previously analyzed in this text therefore the arrows are drawn in dashes in order to differentiate this factor from the ones that have been analyzed.

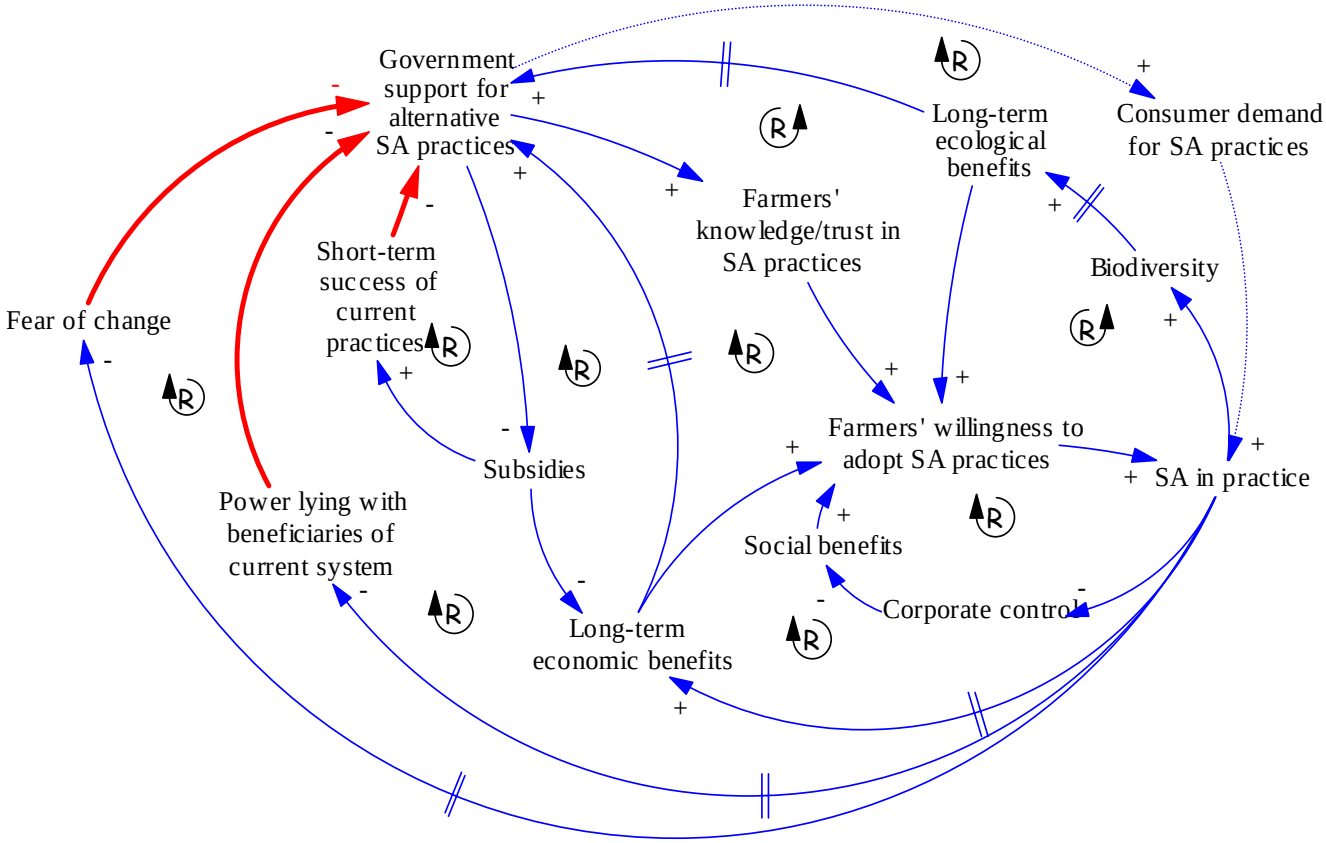


Figure 8: A CLD of possibilities and constraints to adopting sustainable agriculture (SA) practices

There are currently some factors working against government support for alternative SA practices. As previously stated, a small number of farm operators producing limited types of commodities are receiving the bulk of government assistance; therefore those *benefiting from the current system have powerful* commodity lobbies that act as barriers to changing systems (Halweil, 2002). *Fear of changing* or trying something new when so much is tied into current efforts can also act as a hindrance for government support of SA. As discussed earlier, the current system on a day to day and even year to year basis seems up-to-date and sustainable through the eyes of many of those who practice it; therefore *short-term success of current practices* can decrease the likelihood that the government will choose to support any changes. This then leads to the continuation of support through *subsidies*, which only further increases the short-term success of current practices. This reinforcing loop is problematic because by looking at the agricultural system holistically, a different picture than the one of the individual, local, or even national system comes to shape, which shows that this trend is unsustainable.

However, if SA becomes more of a social norm, this can reduce some of the barriers to government support (which are the factors leading to *Government support for alternative SA practice* with a red arrow in Figure 8). With an increase in SA practices, there will be less fear of change since change is already underway, and less fear of change in turn leads to more government support. The current system does not currently support SA practices, but if SA is to become adopted, then the power will likely decentralize or at least no longer lie with the few beneficiaries of the current system. The less power in the hands of the beneficiaries, the more likely that change can occur without being halted by special-interest groups of current practices. The factors that have just been presented and connected are derived from an interdisciplinary and holistic view of SA. The use of a CLD is one method to display factors of a system and be able to see the linkages and feedbacks in a clear and logical way, which is the reason for utilizing a CLD for this analysis of grain farming.

Although one can speculate that long-term benefits of incorporating sustainable practices may not actually occur as expected, one must also try to weigh the costs of making the wrong choice and consider applying the precautionary principle to such a situation. As previously stated, the precautionary principle should be taken into account even when scientific certainty does not exist when human and/or environmental health and safety are threatened (SEHN, 1998). This principle has not been as widely adopted in the United States as it already has in international decision-making processes (Foster *et al*, 2000). However, since we now live and work within a world market, boundaries are becoming less and less defined and it has been seen that the effects of some domestic decisions do not stop at the respective countries borders. An obligation should be felt and acted upon by all those involved in current production to correct the global arena of grain production to be fair to those involved today, and to secure life sustenance to the people of tomorrow.

6.0 Conclusion

Grain farming affects many facets of life therefore it is important that it be carried out in a sustainable way. It is a large consumer of water, land and energy and provides income and community to a large number of people worldwide. It also provides basic sustenance without which life as it is today could not exist. The United States is a hegemony when it comes to grain farming thus should act as the initiator of sustainable farming measures both to sustain its own practices as well as the global food market. However, the current path of development is focused on reaching short-term (mainly economic) goals while not always considering all aspects of sustainability.

Using an analytical framework constructed in this thesis, it has been observed that there are a number of reasons why industrialized agriculture cannot be sustained in the long run. It is highly dependent on non-renewable resources and on the continual development of technology. Biodiversity is being compromised (both of wildlife and of crop species) making the system more vulnerable. Government support in the form of subsidies is unsustainable because it discriminates against foreign producers and small domestic producers, as well as skews the market prices for select crops. Locally this plays a roll in the erosion of the social setting that defines rural America.

On a local level, farmers in Grundy County have different issues that concern them in their day to day routine. Increasing costs and decreasing returns; increasingly challenging pest control; urban encroachment; increasing global competition; increasingly variable weather patterns; and a pace of change that is difficult to stay up to date with are among the problems that affect interviewed farmers on a regular basis. The majority of the farmers feel that their operations are sustainable, but it has been argued that local sustainability does not always promote sustainability of the whole system – in this case – the global arena of grain production.

When analyzing the possibilities for alternative practices, it has been observed that there are advantages and disadvantages to each type of practice; therefore there is no one 'right' way to farm. Some of the barriers were lack of market options, high initial costs to conversion, little or no government support, demand for increased knowledge and technical know-how, and simply the uncertainty that accompanies testing and trying new ideas that are not familiar.

It was discussed that government support needs to occur in order for sustainable agriculture to become accepted into the current framework of production. This support needs to incorporate all parts of sustainability, including both short and long term goals, and needs to recognize the importance of social perceptions. Some barriers to government support for sustainable agriculture exist, yet with the adoption of a variety of production practices that are more sustainable in nature, these barriers will likely be reduced.

Some suggestions for further research in this topic include the incorporation of a Multi Criteria Decision Making (MCDM) model in order to produce hard data from this type of information. A second suggestion includes focusing on the consumer side of the production chain, and to analyze the role that consumer demand plays in the adoption of different, more sustainable production practices.

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