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GENETICALLY ENGINEERED COTTON IN NORTHWEST TEXAS: IMPLICATIONS FOR FARMERS AND RURAL COMMUNITIES

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By

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GENETICALLY ENGINEERED COTTON IN NORTHWEST TEXAS:
IMPLICATIONS FOR FARMERS AND RURAL COMMUNITIES

A DISSERTATION APPROVED FOR THE
DEPARTMENT OF GEOGRAPHY

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LIST OF ACRONYMS

AFD	Associated Farmers Delinting
AMS	Agricultural Marketing Service
BG	Bollgard
Bt	*Bacillus thuringiensis*
CRP	Conservation Reserve Program
D&PL	Delta and Pine Land Company
EPA	Environmental Protection Agency
ERS	Economic Research Service
EWG	Environmental Working Group
FM	Fibermax
FSA	Farm Service Agency
GE	Genetically Engineered
GMO	Genetically Modified Organism
HPUWD	High Plains Underground Water District
HT	Herbicide-tolerant
IPR	Intellectual Property Rights
IR	Insect-resistant
ISD	Independent School District
ITC	International Textile Center
LL	Liberty Link
NASS	National Agricultural Statistics Service

NCC	National Cotton Council
NRCS	National Resource Conservation Service
PCCA	Plains Cotton Cooperative Association
PCG	Plains Cotton Growers
PVPA	Plant Variety Protection Act
RMA	Risk Management Agency
RR	Roundup Ready
RRF	Roundup Ready Flex
TBWEP	Texas Boll Weevil Eradication Program
UK	United Kingdom
US	United States
USDA	United States Department of Agriculture
WTO	World Trade Organization

ABSTRACT

The purpose of this research is to examine how genetically engineered cotton has impacted northwest Texas farmers and the communities in which they live. Accounting for over 30% of the nation's total, Texas is the leading producer of cotton in the United States. The majority of Texas cotton is produced atop the Ogallala Aquifer on the northwest Texas plains. I use an applied community approach to examine two cotton-farming communities in this region. Farmers from Hale Center grow predominantly irrigated cotton whereas farmers in Elliott, my home community, raise dryland cotton. Over 90% of cotton farmers surveyed in these communities grow genetically engineered cotton.

Most often, concern about GE crops and food revolves around the environment or human health. My research is different in that it examines the social implications of the technology. It asks: What are farmers' key motivations for planting GE cotton? How do they understand the risks and benefits of adoption? And my key concern, how have farmers' adoption of genetically engineered crops (specifically cotton) changed the ways in which they manage their land, and have these changes threatened the vitality of family farms and rural communities in northwest Texas?

Transgenic technologies initially made cotton production easier and appear to have very few immediate or perceived costs. But the true costs of these technologies have threatened the long-term viability of Texas farm families and rural communities. Cotton-growing farmers and their communities are at risk from biotechnology corporations and genetically engineered seeds in that they limit and control farmers'

choices in seed, increase their dependency on agribusinesses, especially agribiotechnology and chemical corporations, increase the use of pesticides, encourage monoculture practices, further the consolidation of land, and reduce the number of cotton-related jobs in rural areas.

Chapter 1

Introduction

In 1997, the National Cotton Council (NCC) predicted that within the next ten years virtually all of the U.S. cotton acreage would be planted in transgenic varieties (Hagedorn 1997). In 2005, over 80% of all cotton planted in the United States was genetically engineered (GE) (USDA-NASS 2005).

Several years ago I had a conversation with a good friend about genetic engineering. Up until then I had not heard nor thought much about it. I grew up on a wheat and cotton farm in northwest Texas and feel strongly about the importance of sustainable family farms and rural communities, yet at the time I knew very little about genetic engineering. I went home to Texas the following weekend to discuss biotechnology with my father and my boyfriend (who is now my husband). I discovered that unbeknownst to me, both of them, along with almost every other farmer in our community were growing GE cotton. How did this happen? And how do I feel about it? I was amazed to find that one of the most fundamental components of agriculture, the seed, had been revolutionized and redistributed to some of the most remote pockets of rural America in a matter of years. Why were my friends and family buying and planting seeds for crops that much of the world did not want? At the time, everything I knew about genetically engineered crops was bad. They are created in a laboratory, very expensive, and possibly unneeded. What, if any, were the long-term effects of GE cotton on our land and community? I had to make sense of this.

Contrary to much of what we hear regarding genetic engineering, it is not synonymous with biotechnology. Many biotechnology corporations (such as Monsanto) like to equate early beer brewing by the Sumerians, cheese and wine making, and selective breeding, as with hybrid corn, to genetic engineering. But it was not until 1953 when Watson and Crick described the double helical structure of DNA that the modern era in genetics began. Just as importantly, in 1973, Cohen and Boyer perfected gene-splicing when they cut, pasted, and reproduced new DNA in bacteria. By 1994, the FlavrSavr tomato became the first genetically engineered whole food approved for human consumption within the United States. To date, only twelve GE food crops have obtained regulatory approval. Of these 12, canola, soy, corn, and cotton are regarded as the 'big four.' Collectively, over 60% of all big four acres in the United States are genetically engineered. With this in mind, it makes sense that an estimated 70% of all food items in grocery stores contain at least one GE ingredient (Goldsbrough 2000).

Cotton was one of the first genetically engineered crops approved for commercial production in the United States, and, of the big four crops, is the only one grown on a large scale in northwest Texas. In fact, for anyone interested in U.S. cotton production, Texas is the place to be. The United States is second to China in global cotton production. Over one-third of our nation's cotton is grown in Texas; most of it in the high plains region of northwest Texas (Figure 1.1).

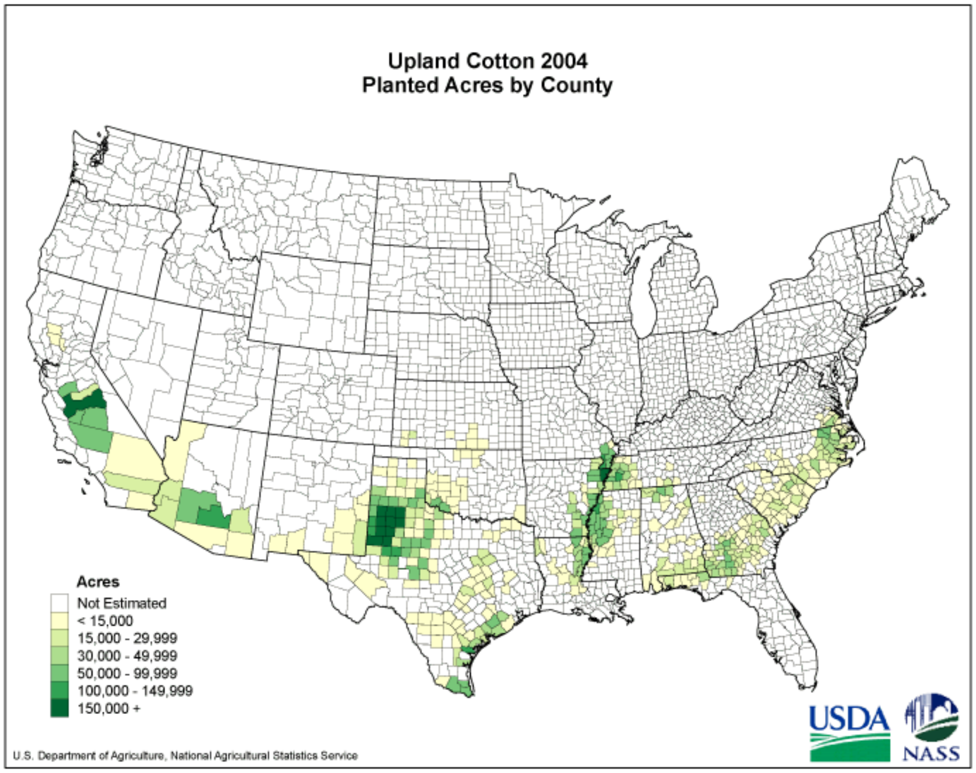


Figure 1.1: U.S. Upland cotton acres planted, 2004 (USDA-NASS, 2005).

Cotton is unique in several ways. First, it is a fiber, feed, and food crop. Cotton lint is the main component of U.S. paper currency. Cottonseed linters are used in everything from sausage casings and makeup to explosives. Cottonseed meal is fed on a large-scale to dairy and beef cattle finished in feedlots. Cottonseed oil is a common ingredient in many processed foods. Cotton is also interesting in that it is highly subsidized in the United States. It has recently become the commodity of controversy in recent World Trade Organization (WTO) negotiations.

There are two types of GE cotton on the market—herbicide-tolerant (HT) and insect-resistant (IR). Approximately 63% of all cotton grown in Texas in 2005 was transgenic, or GE cotton (USDA-NASS, 2005). Texas farmers grow considerably less GE cotton than farmers in traditional cotton-growing states such as Mississippi and Arkansas where over 90% of the cotton crop is GE.

Most often, concern about GE crops and food revolves around the environment or human health. My research is different in that it examines the social implications of the technology. It asks: What are farmers' key motivations for planting GE cotton? How do they understand the risks and benefits of adoption? And perhaps my key concerns, how have farmers' adoption of genetically engineered crops (specifically cotton) changed the ways in which they manage their land, and have these changes threatened the vitality of family farms and rural areas in northwest Texas?

Drawing from a geographic approach, I examine cotton production in northwest Texas with emphasis on two cotton farming communities within the region—Elliott in Wilbarger County (where my husband and I farm) and Hale Center in Hale County (Figure 1.2). Farmers in Elliott grow dryland or rain fed cotton, whereas farmers in Hale Center predominantly grow irrigated cotton with water from the world's largest underground aquifer, the Ogallala. I use a variety of methods, namely participant observation, questionnaires, household interviews, and oral histories in addition to various sources of secondary data. The bulk of secondary data comes from the U.S. Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) and Census of Agriculture.

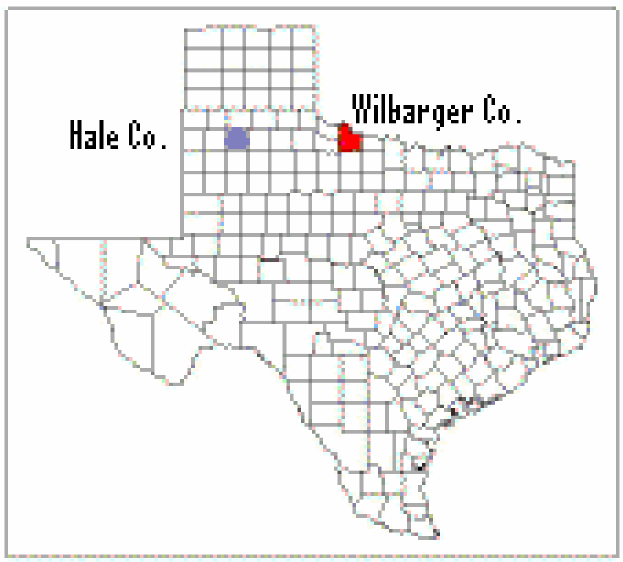


Figure 1.2: Counties in which case study communities are located.

This research has been challenging for several reasons but mostly because I am an integral part of one of the communities under investigation. Although there are some obvious benefits to my position, I have found that many considerations change or increase in complexity when I become an 'insider.' How do I deal with the contradictions of being both the researcher and the researched? What are my responsibilities to my husband, my family, and friends? It is important to ask: What am I trying to accomplish from undertaking this project? I suppose, then, that a secondary aim of this study is that I want farmers to be informed and to think critically about these and other natural resource issues. But more than anything, I want them to remain on the land as part of healthy, rural communities.

My main concern, then, is with the long-term sustainability of family farms and rural communities. I have a vested and heartfelt interest in the economic, environmental, and social viability of the place I call home. This project measures how the introduction of genetically engineered cotton and the cultural practices which have accompanied them, influence rural communities in northwest Texas. My work is important because this particular type of research—an applied community approach—is missing from that which we think we understand about the social implications of genetic engineering technologies in agriculture.

In the mid-1990s, Texas cotton farmers were excited about a new type of cottonseed which promised to give them 'more control and planting options in the field.' It is not surprising that the adoption of transgenic cotton in northwest Texas cotton was quick and widespread. Over 90% of the northwest Texas cotton farmers I surveyed in 2004 grow GE cotton. Most of them have a favorable view of the technology. Only two of the 31 households surveyed had not planted any

GE cotton on their farms. Forty-six percent of those surveyed in Hale Center and 55% in Elliott reported transgenic cottonseed to be the agricultural technology which has been the most useful to their cotton farming operations during their lifetimes (Figure 1.3).

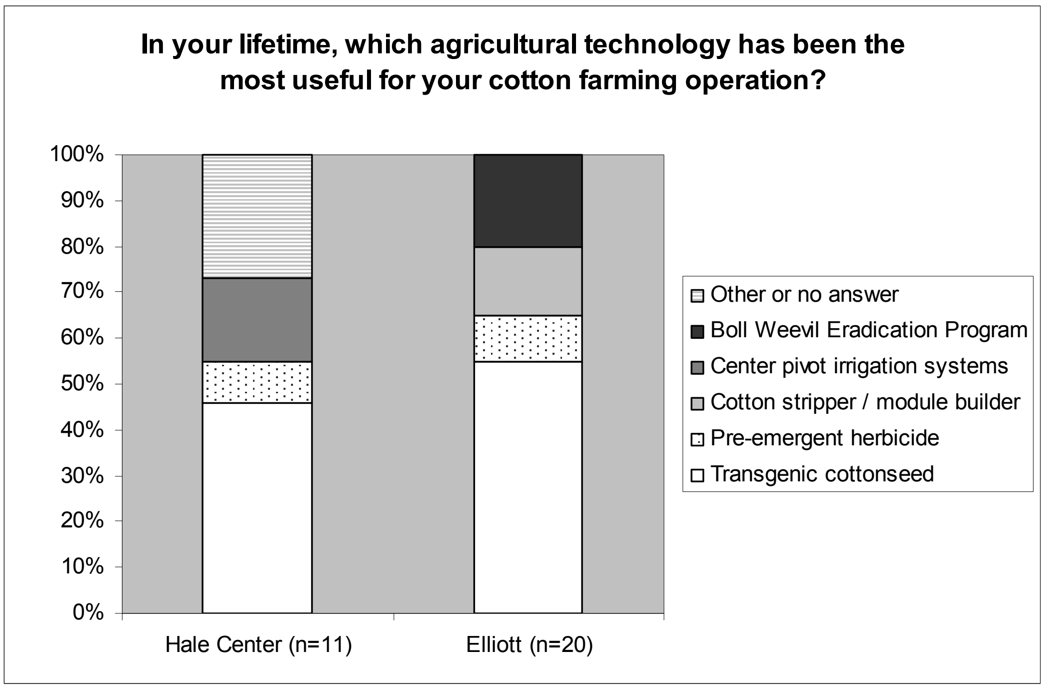


Figure 1.3: Most useful agricultural technologies in surveyed cotton-farming communities.

Despite the importance farmers attribute to GE cotton, this study reveals how, after only one decade of use, GE seeds have taken away more options than they have promised to provide. The main reasons northwest Texas cotton farmers have adopted genetically engineered cotton so quickly is perceived profit maximization and convenience. But consequentially, the adoption of GE technologies has altered the ways in which farmers manage their land and has transformed relationships between farmers and their land, and between farmers and their communities. Rural communities are at risk from genetic engineering technologies which contribute to the increase in agricultural chemical use, the overall consolidation of land, the reduction of cotton-related jobs in rural areas, and the redirection of subsidy payments from family farmers to highly concentrated multinational seed and chemical corporations thereby furthering the industrialization of the U.S. agricultural system. In short, genetically engineered cotton, however convenient, threatens the long-term viability of the American family farm.

In this dissertation, I argue that genetically engineered cotton furthers the industrialization of American agriculture by increasing the dependency of farmers on agribusinesses, especially agribiotechnology and chemical corporations, contributing to the consolidation of land, and by reducing the autonomy of farmers by limiting their choice in seed, and therefore, does not create or support a sustainable agricultural system.

This dissertation is divided into two parts. Part I, Chapters 1-3, provides the background for the study and Part II, Chapters 4-9, discusses the outcomes and implications of the research.

In Chapter Two I set the theoretical framework of the study by positioning my work into a larger body of research. I focus on two broad themes in the literature: power and perception in the GE campaign, and agricultural technology and social change. In particular, this study contributes to specific discussions on the commodification of nature, and the interplay between agricultural systems and the health of rural communities. The chapter ends with a discussion of my research approach, methods, and my position as an 'insider' within the study.

Chapter Three provides an overview of cotton cultivation and the study region of northwest Texas. Specifically, I present an environmental history of the region's physical geography, land use, and the story of how cotton came to be king in northwest Texas. Chapter Three also introduces the two case study communities of Elliott and Hale Center, how and why they were selected, and their demographic characteristics.

Chapters Four through Seven address how farmers have altered their farming methods and cultural practices since adopting GE seed. Each chapter focuses on one of four major cultural and environmental changes taking place on farms throughout the region. Chapter Four looks at farmers' relationship with the seed. As opposed to traditional seed saving techniques, farmers cannot save GE seeds but must buy them new each year. This requirement has deepened the dependency of farmers on agbiotechnology corporations, and, thus, limits their choices and sovereignty.

Biotechnology corporations often advertise seed engineered to be herbicide-tolerant (HT) and insect-resistant (IR) as an environmentally sound alternative to harmful pesticides. Chapter Five discusses the paradox of this promise, and how chemical use in GE fields has actually increased over the last decade.

Cotton, genetically engineered to resist herbicide, has reduced the amount of labor needed to farm cotton. Chapter Six addresses how this change in labor relations has affected farmers, laborers, and their communities.

In Chapter Seven I focus on risk. Farmers have taken on more risk with GE seeds then anticipated. Many of the risks are not immediate but are externalized over time and space. Environmental, health, and socioeconomic risks of GE cotton are discussed along with an analysis of government and corporate risk alleviation programs.

Chapter Eight discusses the theoretical implications of the research findings as addressed in Chapters Four through Seven.

Chapter Nine hypothesizes the future of cotton and agriculture on the northwest Texas plains. I summarize concrete findings from this study with the hope of educating and influencing cotton growing nations of the world who are considering the risks and benefits of agricultural biotechnology.

Chapter 2

Engineering Trouble

Farmers throughout the world face an agricultural crisis of immense scope and gravity. World prices of primary agricultural exports (corn, wheat, rice, and cotton) have declined more than 40 percent since 1996 (Ray, Ugarte and Tiller 2003).[1] Current emphasis on trade liberalization often depresses global agricultural commodity prices to below the cost of production and, as a result, farmers suffer. In the United States, European Union and Japan, producers are subsidized to make up the difference between high production costs at home and low prices received on the global market. Farmers, however, are not the primary beneficiaries of government support payments. Low-price farm policies channel money from taxpayers through a web of governmental departments to farmers and for the most part end up in the hands of agribusinesses that specialize in expensive yield-enhancing technologies (Halweil 2000). Government subsidies "benefit agribusinesses, integrated livestock producers, and import customers and are disastrous for market incomes of crop farmers in the United States and around the world" (Ray, Ugarte and Tiller 2003, 51). Low prices, together with the inflated

[1] The same year the United States implemented the 'Freedom to Farm Bill'; a drastic change in farm policy designed to be more trade liberalizing. It removed production controls and deliberately allowed commodity prices to fall as low as the market would permit. Cotton prices plummeted significantly more than corn, wheat, and rice.

costs of agricultural inputs (i.e., GE seeds, fertilizers, fuel, machinery, and chemicals) encourage farmers to aim for high yields and immediate profit over long-term sustainability. If farmers reduce production in efforts to raise prices and/or conserve resources, they loose out to those in the global market who keep producing (Halweil 2000). If they get off the production treadmill and try value-added or alternative types of agriculture such as organic or niche farming, they are responsible for finding their own markets. In the event of even temporary economic hardship, farmers run the risk of not meeting short-term financial obligations which could result in failure to obtain credit, the loss of land and equipment and, in a worse case scenario, bankruptcy and loss of the farm. Simply put, commodity farmers are caught in a position where they feel as if their only option is to increase production.

In the mid 1990s, as United States' farm policy was transitioning from a controlled supply to open market orientation, advances in genetic engineering provided hope for farm families struggling to stay afloat in the increasingly competitive global market. Those who planted GE seeds were told they would have an advantage in their increased yields and efficiency. Adoption was quick in the United States. Genetically engineered seeds slid onto the shelves of rural seed suppliers, into fields, through processing plants, and onto dinner plates long before American's realized what had happened. By 2004, the majority of

American cropland devoted to corn, cotton, and soybeans, was planted in GE varieties (Figure 2.1).

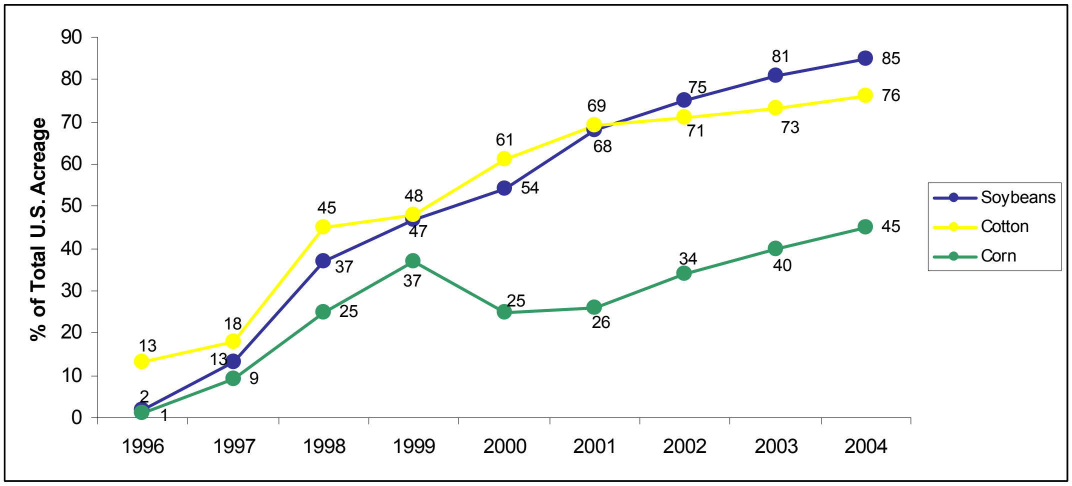


Figure 2.1: Biotech acres as percentage of total U.S. acreage (data from whybiotech.com March 5, 2006).

American consumers and farmers alike have shown little awareness or concern, much less resistance, to the infiltration of GE crops into the food system and the environment.[2] The majority of American consumers are passive recipients of a cheap and abundant food supply made possible by a federal farm policy that subsidizes American farmers who pay more for inputs such as land, equipment, and labor than their global counterparts. Low commodity prices encourage farmers to produce all they can from their land, and, in doing so, most farmers readily adopt technologies such as GE seeds in hopes of increasing yields

[2] Resistance to GE crops in the U.S. has been remarkably light in comparison with movements in other parts of the world such as Europe, Australia, and Japan. Many would argue this is because the agro-industrial lobby has suppressed public awareness about its ubiquity and potential consequences.

to make their operation more efficient and competitive. Management tactics in this type of industrialized farming system focus on high yields and short-term profit (Fitzgerald 2003). Over the past fifty years, the vicious cycle of increasing production to survive has consumed one family farm after the next. "The farmer with declining margins buys out his neighbor and expands or risks being cannibalized himself" (Halweil 2000, 6). Since the 1950s the number of independent, owner-operated, family farms has significantly decreased while the average size of farms in the U.S. has steadily increased (Figure 2.2). Today, less than two percent of the U.S. population is actively involved in the production of food and fiber (USDA-NASS 2005).

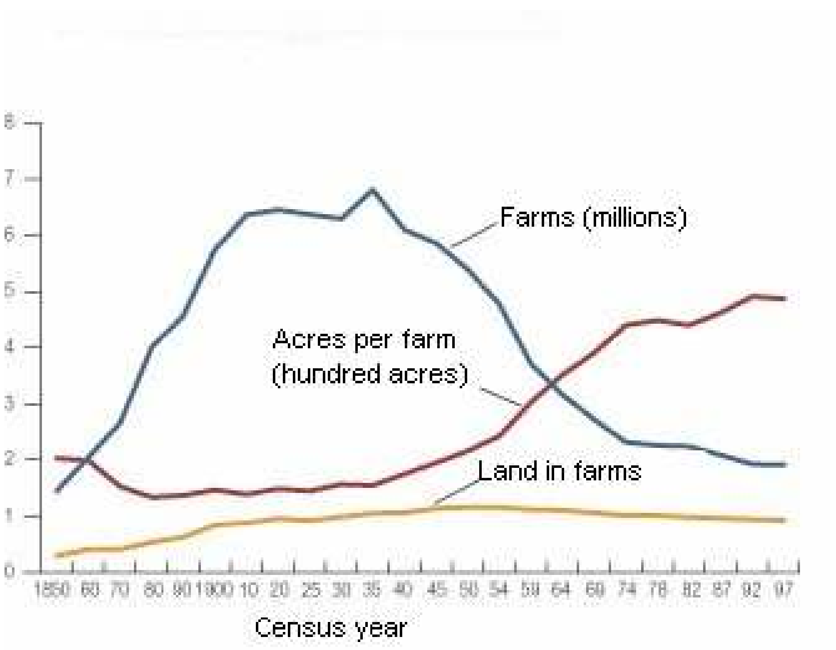


Figure 2.2: U.S. farms, land in farms, and average acres per farm, 1850-1997 (USDA-ERS).

This study looks at U.S. farmers' experiences with genetic engineering at the ten year milestone of GE availability. It examines how adoption and use of the technology has affected farmer cultural practices, and how these changes have had social and environmental repercussions within the farming communities in which they live. It specifically addresses three key questions:

1. How do farmers in northwest Texas come to understand the risks and benefits of genetic engineering (GE) technologies?
2. How have these farmers changed their cultural practices (ways in which they manage their land) since adopting GE cotton?
3. How have rural communities in this region experienced these changes?

To answer these questions, I use what I call an applied community approach to investigate two northwest Texas farming communities producing one commodity, cotton. Farmers in both communities (Elliott and Hale Center—see Figure 4.1) produce cotton, yet their experiences differ greatly. In Hale Center, cotton is predominantly irrigated and the staple crop of production, whereas in Elliott, cotton is only one component of dry-land (rain-fed), mixed cropping systems. Interviews with farm families in these two communities and data from the United States Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) provide the bulk of support for this study.

The following two sections position this study into two, broad theoretical themes: power and perception in the GE campaign, and agricultural change and society. The first theme provides a background for the introduction of genetic engineering technologies. It reviews two prevailing discourses in which GE technologies are justified, discusses the corporate control of seed, and ends with how various groups defend and criticize genetic engineering technologies. The second theoretical theme situates genetic engineering within a historical context of agricultural change and raises questions about the connection between agricultural systems, technology, and the health of rural American communities.

Power and perception in the GE campaign

Farmers' perceptions of GE technologies are inextricably shaped by the dominance of an industrialized and trade-orientated agricultural sector. According to Fitzgerald (2003) agriculturalists in the United States have been conditioned by the "industrial logic" of efficiency and mass production since as early as the 1930s. Beginning with the agricultural extension service and the imperative for farmers to treat their farms as businesses, agriculture in the United States has, in less than one hundred years, been transformed from a subsistence activity to one concerned with the bottom line. Today's highly industrialized agricultural system is premised upon several dominant views, arguably the most important being: 'technology is needed for U.S. agriculture to be competitive in a global market,' and 'production must increase to feed a growing world population.' The biotechnology industry skillfully plays up these discursive narratives to support their *solution* (GE seeds) to the *problem* (lack of adequate production) that they themselves are partly responsible for disseminating. In this sense, the solution feeds the construction of the problem: farmers are not producing enough, technology is needed to help them produce more, and vice versa. These arguments originate from two prevailing narratives or discourses: technology as progress and a Malthusian narrative. Discussion of these two constructed beliefs helps establish the context in which GE seeds are promoted to, and accepted by, American producers.

Faith in science and technology

For many years farmers have been placing their faith in scientists to create better and more sophisticated agricultural inputs. Prior to the scientific creation of yield-enhancing products such as synthetic fertilizers and chemical pesticides, farmers depended upon their own ingenuity and skill, not the expertise of scientists, to manage the productivity of their soil (Worster 1993). Under pressure to streamline and increase production, first with mechanization in the form of tractors and harvesters and currently with GE seeds and chemicals, farmers increasingly relied upon agribusinesses for their agricultural input needs. Before, farms were controlled by the natural limits of conventional breeding, family labor, seasonality, and organic fertilization—all of which humans have, over millennia, manipulated to control, regulate, and boost the production of food and fiber. Today, many farms are so large and complex that they could simply not function without the assistance of agribusinesses and technologies of the "industry of inputs."

The belief that technology will solve the human problem of laboring in the production of food is widespread in today's society. Usually encapsulated within this belief is reliance on technology to correct disruptions in which technology itself was the original cause. The technological fix treadmill is, of course, self-perpetuating. New technologies beget new problems which beget new technologies and so on. As with the use of chemical fertilizers and pesticides, GE seeds create a social system in which those in control of knowledge and capital are looked upon as the continuous source of technological band-aids when prior technology goes awry (Meleo-Erwin 2001). It is easy to defend the high prices of new technologies in which there is a *need* and that we cannot create ourselves. Do farmers rationalize the high cost of GE seeds with the belief that seeds created in the lab by intelligent scientists are superior (higher yielding) than seed varieties they develop in their fields? Regardless if GE seeds are in fact, higher yielding, the root of the problem could lie in our misguided belief that we needed the technology in the first place.

Vertical integration and industrialization in agriculture have over the last few decades, monopolized the inputs and outputs of farming (Heffernan 1999, 2000). Concentration and consolidation in the input industry of seeds, chemicals, and equipment has been rampant. Likewise, the processing, storing, and distribution of food is controlled by a handful of very large companies. But attempts to capitalize upon agricultural production have no doubt been troublesome. Karl Marx actually felt that rational agriculture was incompatible with the capitalist system. Due to the unpredictable nature of natural systems, the production of commodities, or farming, had yet to be industrialized. Although we may try, humans cannot predict much less control the weather. Plants, animals, and insects often respond to the application of technology on their own terms, in unpredictable ways. The manufacture of living organisms presents roadblocks for those wanting to profit from their mass production. Mander (2002) believes that the failure of classic capitalistic concentration in farming arises from the following. First, farmland is unattractive as capital as it cannot be depreciated and is not easily liquidated or sold quickly like gold, for instance. Most corporations are not interested in investing in large amounts of farmland that would be difficult to sell in the long run. Secondly, it is difficult to train and control labor on large extensive farms. Farmers are notorious for being jack-of-all-trades. Corporate farms find it difficult to hire and keep employees with such a variety of skills necessary for farming. Also, risks of weather, disease and pests are harder to control on larger farms, especially those less diversified and committed to monocropping. Finally, Marx thought the cycle of reproduction of capital cannot be shortened as it is linked to natural reproduction cycles of plants and animals. The meat industry, in particular, has gone to great lengths to shorten the time it takes for animals such as poultry, hogs, and even cattle to reach slaughter weights. Fast growing animals result in more meat in less time and thus more profit for companies like Tyson and Smithfield. Nonetheless, science and industry continue in their efforts to profit from the production of food. But corporations are wise to the burdens of the farmer and want nothing to do with the unpredictability and risk he endures. Instead of buying the farm, as they have with vertically integrated poultry, pork, and dairy farms, corporations are taking control of the very heart of commodity farms— the seed. Via genetic engineering, corporations are finding it possible to profit from the production process while relegating the risk of production to the farmer. "With hard work and devotion, farmers buffer the idiosycricities of natural processes for the benefit of conniving agribusinesses" (Mander 2002, 18). Agriculture's "industrial logic" (Fitzgerald 2003) and society's faith in science and technology provides a useful context in which we can examine the rapid adoption of GE seeds throughout the United States.

Constructed scarcity

The Malthusian narrative, or as Stone (2002) puts it, the Malthus card, is played by those in the biotech industry who develop and provide new GE seeds to the world with a sense of philanthropic urgency. The argument of not having enough food to feed an expanding population is not new. In 1798 Thomas Malthus put forth in his *An Essay on the Principle of Population* that at the current rate of population growth the world would soon be unable to produce enough food to feed itself. Genetic engineering, at least in agriculture, has been justified through the same ecoscarcity argument, or Malthusian scare. Biotech advocates claim that via genetic alteration, it will be possible to grow enough food to feed an exploding and hungry population (via increased yields), reduce the amount of pollutants released into the environment (via chemical-tolerant and insect-resistant plants), more efficiently use and protect natural resources (via drought, salt, and disease-tolerant plants), and secure a healthy human population (via the genetic implant of nutrients, vitamins, medicines, and vaccines into plants and via plants with built-in insecticides therefore ensuring farm worker safety). The problem is Malthusian—too many people trying to exist on too few and fragile resources. The reality is, however, that food is not scarce. If food were truly scarce, it would have economic value and those who grow it would be rich (Mandigo 2005). Instead, food is wasted and in excess in developed countries and in short supply in developing countries where, paradoxically, the neediest people are those engaged in the production of food (Watts 1983). Moreover, farmers in the U.S. and Europe have, at times, been paid not to grow food in an attempt to keep prices high.

Just as the Green Revolution promised to solve the world's problems through agricultural intensification and technological diffusion, today's "problems" are again defined in Malthusian terms whereby the solutions are built into the definition of the problem. By dramatizing hunger and framing the problem to have only one solution, the biotech industry monopolizes our society's faith in the power of science and technology to create a highly sophisticated answer—miracle seeds.

Together, these two discourses pave the way for acceptance of agricultural technology, namely bioengineered seeds and plants. These widely held arguments, that food is in short supply and that technology is needed to help produce more, has influenced and supports an U.S. agricultural policy dedicated to agribusiness interests and international market access, not domestic food security, fair trade, or rural sustainability.

Seed control

Genetic engineering, at the very core, is about control of the seed. Corporations that dictate which seed is available, where it is to be grown, how it is to be grown, who can grow it, and at what cost, have power over the production of food and fiber throughout the world. In recent years, the number of those who have addressed the corporate control of nature, and in particular the seed, is growing. In 2003, Castree published a useful piece which theorized the various elements of the privatization or commodification of nature. Castree's study took from the work of Jack Kloppenburg (1988, 2004) who produced one of the first and arguably the most comprehensive accounts of the privatization of nature in *First the Seed*.

According to Kloppenburg (1988, 2004) the ability of seeds to naturally reproduce themselves was one of the last barriers of capital accumulation within the agricultural sector. Hybrid seeds toppled the capital hurdle since they could not be saved and replanted. Inherent in hybridization was the necessity of farmers to purchase new seed each year: "Thus what we have in hybrid seeds is not simply a technique of increasing food production, but also the emergence of a mode of production that is destroying the productive base of subsistence" (Yapa 1993, 262). Genetically engineered seed follows in the footsteps of hybrid seed, but instead of the seed being inferior the second year, as with hybrids, the seed returns true to its genetic manipulation. Biotechnology corporations originally intended to insert "terminator" genes, developed in part by the USDA, into the seeds inhibiting growth in the subsequent seasons. However, the technology was highly controversial and is not in use today. As with hybrids, genetic engineering technologies have the ability to transform the source of life, seeds, into nonproducing commodities.

The work of environmental activist and scientist Vandana Shiva builds on the work of Kloppenburg to illustrate how biotechnology corporations have staked claim to the genetic resources of the world's biodiversity via "biopiracy" and intellectual protection rights (IPR) (Shiva 1997). Through intellectual property rights rules and provisions such as patents, the ownership of nature is being transferred from farmers and society at large to corporations and individuals. "By reducing human knowledge to the status of private property, intellectual property rights shrink the human potential to innovate and create; they transform the free exchange of ideas into theft and piracy" (Shiva 1997, 122). Given the power of the technology, industry and government support is no surprise.

Reputable support

Many governments and scientists give credence to the corporate line. In September of 2003, USDA Deputy Commissioner, Lester Crawford stated that "biotechnology can offer a safe and important tool for both exporting and food-deficit countries" (Crawford 2003, 11). According to Marra, Pardy, and Alston (2002, 48):

> The adoption of many first-generation transgenic field crops represents a win-win situation for farmers. They can expect higher profits, reduced health problems resulting from using safer pesticides, and fewer negative environmental impacts compared with conventional production methods.

Uzogara concludes genetic engineering will "make life better, improve human health and welfare, save time and money…reduce processing costs, eliminate harmful wastes, help the environment…[and] create jobs and yield sizable foreign exchange" (2000, 203). Carpenter *et al.* (2004, 4) of the Council for Agricultural Science and Technology argued in their study on the environmental impacts of biotech soy, corn, and cotton that,

> Given that biotechnology-derived crops can provide positive net environmental benefits, we recommend continued development of agricultural biotechnology to enhance environmental stewardship.

How these positive "net environmental benefits" are defined is, of course, subjective and has no long-term basis in scientific study. In a governmental report on the use of transgenic seeds, the Economic Research Service (ERS) of the USDA concluded, "it appears that farmers are, at least, not being disadvantaged by the advent of GE pest and herbicide-resistant seed" (USDA-ERS 2002, 30). It is disturbing, at best, that the ERS finds it appropriate to comment on what *is not* happening as opposed to what *is* happening as a result of widespread GE technology adoption.

Not only have agribusinesses, governments, and scientists supported GE technologies, but so have commodity organizations to which farmers turn to for advice and support. The National Cotton Council (NCC) website proclaims that GE cotton has the potential to reduce insecticide use, lower production costs, improve yields, lower farming risks, reduce the use of pesticides and air pollution, increase farm worker safety, decrease fuel use, and improve soil quality (http://www.cotton.org/ 2004).

Beyond reasonable doubt

The dispute over genetic engineering is inherently political: a tug-of-war between industry and its antithesis. Opponents from the so-called Green Lobby, express concern over the ill-effects of genetic engineering on human health, the environment, and rural communities (Kloppenburg 1988; Shiva 1997, 2000; Manning 2000; Tokar 2001; Commoner 2002; Mendelson 2002; Altieri 2004). Kimbrell, for example, tells us "a careful examination of the new claims about GE reveals that instead of solving the problem of modern agriculture, biotechnology only makes them worse" (2002, 32-33). Lipton, Sinha, and Blackman (2002) question claims that GE technologies reduce poverty. They state that if "new technology raises farm labour productivity faster than farm output, farm employment falls" which is exactly what happened in northwest Texas (Lipton, Sinha, and Blackman 2002, 126). This kind of labor reduction can be a serious problem for many agrarian societies in the developing world. Some hypothesize that just as the Green Revolution decreased the quality of life for those farming and living in rural areas, advances in biotechnology will also devastate the vitality of rural communities (Manning 2000; Mendelson 2002). Others refute that GE crops reduce the amount of chemicals used by farmers, therefore making them safer for farming communities and the environment (Tokar 2001; Shiva 2000; Benbrook 2004). Many argue that genetic engineering is a "qualitatively different and highly uncertain application of agricultural science" (Wilkins *et al.* 2001, 168). Altieri (2000, 620) warns us that "transgenic crops can produce environmental toxins that move through the food chain and may also end up in the soil and water." Additionally, scientists such as Mae-Wan Ho (1997), Barry Commoner (2002) and Jeffery Smith (2003) argue that genetic engineering in not a precise science. Contrary to the belief of James Watson, traits are not hard-wired into DNA genes but rather change in response to gene combination and environmental stimuli. Genetic engineering speeds up natural processes by literally forcing the genetic merger of unlike species to create genetic combinations never before known to nature (Smith 2003). In January of 2003 the USDA released a report stating that it will be difficult to completely prevent genetically engineered plants and animals from having unintended environmental and public health effects (Pollack 2003). We see this prediction played out in the case of GE cotton in northwest Texas.

Other research expresses concern over various aspects of the genetic revolution such as the privatization and consolidation of GE seed research and production (Kloppenburg 1988, 2001, 2004; Heffernnan 1999, 2000); "deskilling" as a result of insect-resistant Bt cotton in India (Stone 2002); biotechnology governance and the development of a black market seed culture (Jepson 2002); ethics and legal issues of coexistence between GE and non-GE crops (Levidow 2001); food sovereignty and concentrating on GE crops as solution to world hunger (McAfee 2004); and the spread of GE corn (or maize) from the United States to remote indigenous villages where corn is central to the religious life of communities and transgenic corn is unwanted (Quist and Chapela 2001). Others have shed a positive light on the debate by noting a public backlash to the concentration of GE seed development (Kloppenburg 2004), and increased democratic participation in local decision making (Middendorf *et al.* 2000) as a result of the conflict. Many concerns are specific to GE cotton.

Scientists in the cotton industry are also questioning the touted rewards of GE cotton. Entomologists have reported a rise in secondary pest infestations as a result of Bt cotton in the southeast United States (Fairchild 2004). Southern agronomists and extension specialists have commented on the overuse of Roundup (glyphosate) and the resulting resistance that many weeds, such as the tropical spiderwort (Burchett 2004) and pigweed (Giles 2005) have developed. Randy Boman, a Texas A&M extension cotton specialist based in Lubbock, Texas has been comparing the performance and net value of cotton varieties on the southern high plains. In two of the three 2004 field plots, conventional, not genetically engineered, varieties had the highest net value per acre (Boman, Kelley, and Stelter 2005).

Lessons learned: Agricultural change in perspective

Prior to regulatory approval in the United States, very few studies questioned the possible social effects of biotech crops. Most research was carried out by private biotech companies interested in farmer readiness, needs, and pricing strategies. Even work done by those in public institutions, such as Buaha (1999, i) centered around the economics of adoption when she concluded, “Bt corn will be adopted if profits from adoption exceed returns without adoption.”

An economic emphasis, especially in regards to GE cotton, prevails in the literature (Traxler and Falck-Zepeda 1999; Marra, Pardey, and Alston 2002; Ward *et al.* 2002; Ismael, Bennett, and Morse 2002; Wolf *et al.* 2002; Qaim and De Janvry 2003; Runge and Ryan 2003; Traxler 2004; and Boman, Kelley, and Stelter 2005). Wolf *et al.* (2002, 69) found that for Californian cotton-growers “economics drive adoption of cotton transgenic varieties.” Economists tend to see farmers as rational actors who make land management decisions to maximize profit in a market economy (Fitzgerald 2003), whereby social scientists ask a broader range of questions steeped within the cultural or social milieu of adoption. Traxler and Falck-Zepeda concluded, "Clearly, farmers must be receiving some benefits, or they would not choose to adopt" (1999, 95). Early on, interest in *why* farmers were adopting GE crops was more important than *what happens* as a result of adoption. And economic justification is almost always the stated rational behind *why* farmers adopt GE seed. But do farmers make decisions based on perceived profit maximization only, or do other factors such as past experiences, religion, lifestyle, ethics, and perceived environmental and community well-being influence the choices they make regarding the adoption and continued use of GE technologies? Mehta and Gair (2001), argue that a social and anthropological perspective is needed in an area where economists have dominated the literature.

Today many countries throughout the world are feeling pressure by the biotech industry to clear the regulatory path for introduction of GE seeds. All the while, consumer resistance is growing. As a result, numerous reports and technical papers have been produced as governments and consumers alike consider the consequences of GE technologies. In 2002, the U.K. Soil Association interviewed a range of U.S. farmers regarding their experiences with GE crops and found that "widespread GE contamination has disrupted GE-free production, … destroyed trade and undermined the competitiveness of North American agriculture overall" by increasing the "reliance of farmers on herbicides" and has "led to many legal problems" (Warwick and Meziani 2002, 4). The Farmers' Legal Action Group teamed up with the Rural Advancement Foundation International in 2004 to produce a farmers' guide to genetically modified organisms (GMOs) which acts as a manual for 21st century farmers and advises them on liability issues related to their rights in saving seed, technology agreements, securing markets, and GE seed contamination (Moeller and Sligh 2004). Charles Benbrook (2004), with support of the Union of Concerned Scientists, scrupulously documented the increase in chemical usage in the first nine years of GE crops in the U.S. and warns farmers of the chemical trap in which GE farming systems are part. The Center for Food Safety published a report documenting the extent to which American farmers have been impacted by litigation arising from the adoption and use of GE crops and found that with the introduction of genetically engineered crops and seeds, "farming for thousands of America's farmers has been fundamentally altered; they have been forced into dangerous and unchartered territory and have found they are worse for it" (2004, 5). Most recently, researchers at The Open University in the United Kingdom are documenting English farmers' understandings of GE crops with phone and personal interviews (Oreszczyn 2005).

My research seeks to contribute to this growing body of literature on farmers experiences with GE crops, but in a novel way. Instead of a broad focus on GE crops in the United States, my work is unique in that it takes an applied community approach to examine how the GE controversy plays out where the plow meets the soil; with real farmers in very real situations at a regional scale. It is one of the first of its kind devoted to understanding the very local effects of biotechnology adoption.

From green to gene: Revisiting agricultural revolution

The Green Revolution was based on the assumption that technology is a superior substitute for nature (Shiva 1991, 1997). International development projects such as mechanization, irrigation technologies, hybrid seeds, synthetic fertilizers, chemicals, and the availability of credit, all in the name of progress lest we be reminded, transformed communities and farming systems of agriculturalists throughout the world (Wright 1990).

Few will refute the fact that technology affects the society in which it is introduced. My key concern is not if social transformation takes place but rather *what kind* of change occurs when it does. As long as human culture has harvested and cultivated the earth's plant and animal resources, technology has aided the task (Worster 1993). How we choose appropriate technology is reflective of our society's greater value, or cultural, system (Sauer 1952). How has the adoption of modern day agricultural technologies influenced rural societies? In this section I review the most recent and major technological changes in U.S. agriculture along with some of the social repercussions of adoption (Figure 2.3). This review helps situate GE technologies within the context of past agricultural change.

Period	Revolution	Agricultural change
Early 1900’s	Mechanical	Reduced farm labor, increased farm size, increased fuel dependency, increased input costs.
1890-1920	Educational	Farms were businesses, not lifestyle; promotion of farm efficiency and benefits of science and technology.
1930-1940	Blue	Altered types of crops grown, need for credit, fuel and pump suppliers.
1940-1950	Chemical	Dependency on external source of weed and insect control, altered insect and plant communities, threat to human and environmental health, reduction of labor, increased farm size.
1950-1960	Hybrid	Increased yields, need to buy seed annually, increased need for credit and technology, supported monocropping.

Figure 2.3: Agricultural revolutions and associated repercussions.

Today’s industrial agri-food system arguably began with the mechanical revolution of the early 1900s. In 1900, 42% of the U.S. population lived on 5.7 million farms (Hurt 2002). Steam-powered tractors were available as early as the late 1800s, but they were bulky and not practical for fieldwork. Similarly, gas powered tractors existed at the same time of the automobile, but it was not until 1923 when International Harvester introduced the iconic tricycle-type Farmall tractor that agriculture made the switch from horse to machine (Paarlberg and Paarlberg 2000). At the time, the USDA estimated that a farmer must have 130 acres of land for a tractor to be economically feasible (Hurt 2002). Tractors were the first link in a long chain of dependency tying farmers to agribusiness. It is interesting to note that during the Great Depression era many tractors sat in barns or under shade trees. Fortunately most farmers with no money for fuel could revert to horses and mules to plow and plant their crops. As I discuss in more detail later on, reversion to prior cultural practices, unfortunately, is easier said then done in the instance of conventional versus GE seeds.

In 1887 and 1914 the Hatch Act and Smith-Lever Act were respectively passed to provide agricultural experiment stations and the agricultural extension service. The framework was set up to transfer scientific knowledge and efficiency from the test plot to farmers' fields. Mechanization coupled with agricultural research and extension is arguably the root of today's industrial ideal in agriculture (Fitzgerald 2003) and was the first step of many towards reforming agriculture into a production orientated industry.

The blue revolution brought pump irrigation technology and water to the fertile Great Plains, central valley of California, and much of the Western United States in general. By the late 1940s it was both technologically achievable and economically feasible to utilize the largest underground water source in the world, the Ogallala Aquifer (Green 1973; Brooks and Emel 2000). Plains farmers were eager to access abundant groundwater reserves beneath their farms but the adoption of pump irrigation technology made them depend upon outside suppliers for irrigation equipment and either oil and gas or electricity to fuel their pumps. The availability of irrigation also influenced the types of crops farmers grew.

Farmers on the southern high plains of Texas switched from a predominantly grass-based agriculture (grass and grains) which mimicked local ecosystems to cash row crops such as cotton, corn and vegetables.

Technological advancements in chemistry and molecular biology during WWII instigated the chemical revolution in agriculture. After the war, agricultural commodities were in great demand in Europe. American farmers used surplus nitrogen for fertilizer and newly developed chemical concoctions as pesticides. Many chemicals such as DDT were used with little understanding of their long-term effects. The pioneering work of those such as Barry Commoner and Rachel Carson fueled an escalating awareness of the impact of human technology upon the earth. Commoner and Carson felt strongly about how technologies such as agricultural pesticides were harmful to humans and the environment. Carson's (1962) *Silent Spring*, especially, warned of the ill-effects of agricultural pesticides such as DDT in the food chain. Up until this time, scientific reasoning, rationality, faith in progress, and the use of technology to achieve mastery and dominance over nature went unchallenged. Most were confident in the possibilities of science and technological advancement.

Hybrid corn, developed in the 1930s and hybrid grain sorghum developed in the 1950s, dramatically increased crop yields within the U.S. But farmers could not save and replant hybrid seed. Because the second generation reverts to one or the other parent varieties, they found that it was necessary to make higher yields in order to pay for new hybrid seed each year. Farmers were trapped. Hybrid crops produced more but farmers no longer had control over the seed. They had to buy new seed each year. The brutal cycle of producing more to pay for more became the norm for farmers increasingly dependent on agribusinesses for their crop input needs.

Despite the work of scholars such as Rachel Carson, irrigation technologies, pesticides, hybrid seeds, and synthetic fertilizers were seen as a huge success within the United States. So much a success, that they were packaged and shipped to the developing world as part of the Green Revolution—the U.S. solution to the so-called Malthusian demographic and economic development problems of the Third World. Geographer Carl Sauer and others expressed concern over the cookie cutter method of technology transfer to the global south (Sauer 1952; Yapa 1978, 1993, 1996; Pearse 1980; Wright 1990; Shiva 1991, 1997, 2000).

The main assumption with the diffusion type model of the Green Revolution was that poverty was the result of underdevelopment and that development in the form of capital, credit, technology, and know-how could somehow bring the underdeveloped "up to speed" with the rest of the developed world. Much of the motivation behind development initiatives of the 1960s, 1970s and even 1980s, and, as we now see with the Gene Revolution of the 1990s and early 21st century is the creation of a larger consumer class; in continuous *need* of sophisticated agricultural inputs and highly processed and improved agricultural outputs or products. A crucial mistake of the Green Revolution and diffusion-type thinking is that it ignored the ecological, cultural, and social relations and effects of production innovations (Shiva 2000). The Green Revolution destroyed "diverse agricultural systems adapted to the diverse ecosystems of the planet globalizing the culture and economy of an industrialized agriculture" (Shiva 1997, 107).

Acknowledgement and documentation of the hidden costs of increased production is perhaps the most important lesson learned from the Green Revolution. High-yielding seeds increased the production of food but there was no serious discussion of the social consequences of technological adoption (Yapa 1993, Shiva 1997). Large monocultures of hybrid seeds were more susceptible to pest infestations than areas with a diversity of crops and plant varieties (Wright 1990). Leaf blight was a serious concern of U.S. corn farmers in the early 1970s when over 15 percent of the crop was lost as a result of genetically detassling certain corn varieties (Kloppenburg 1988, 2004). Today, large commodity farmers in the United States battle with problems such as soybean rust, leafhoppers, thrips, and worms to name but a few outbreaks which could be greatly reduced with increased genetic diversity throughout fields. Hybrid seeds that are superior in yield are grown in such large amounts that one of the easiest ways to deal with increased pestilence pressure is with the use of chemical pesticides. Chemical use contaminates soil and groundwater reserves and threatens the safety of farm workers who apply the chemical, consumers who digest the produce, and farm families who live on the land (Wright 1990). The use of synthetic fertilizers, as with the use of chemicals, creates a system in which farmers are literally on a treadmill, dependent upon fossil fuels and chemical producers to continuously aid them in the task of boosting the limits of their soil and eradicating pestilent weed and insect species. Long-term use of chemical instead of organic fertilizers robs the soil of its nutrient bank by putting in enough synthetic fix each year to try to maintain previous yields (Meleo-Erwin 2001, Berry 2002). Yields may have increased during the Green Revolution but considering the environmental and social costs of higher production, it is difficult, in retrospect, to justify the technologies.

One of the first and most powerful critiques of the Green Revolution was undertaken between 1970 and 1974 by the Research Institute for Social Development for the United Nations Development Programme. Authored by Andrew Pierce in, *Seeds of Plenty, Seeds of Want*, the Global Two project went to great lengths to document the unexpected social and economic consequences of the Green Revolution. Central to these were rural to urban migration and increased need and dependency on agribusinesses for expensive crop inputs such as seeds, chemicals, water, credit, and mechanized machinery. Bernhard Glaeser, too, published an edited volume entitled, *The Green Revolution Revisited,* in 1987 which gave validity and credence to the arguments of Pierce and fueled further speculation on the actual benefits of development via technology diffusion in the absence of addressing social inequality and power concentration innate to the technology diffused. In the mid 1980s a consultancy study was conducted by Michael Lipton with Richard Longhurst to assess the impact of the so called Green Revolution and resulting fourteen International Agricultural Research Centres (IARCs) to see if they, in fact, had been appropriate both technically and socioeconomically. Lipton and Longhurst (1989, 3) concluded,

> If plant scientists are to achieve the hope of bringing out 'revolutionary' changes in poor people's well-being, their research design will need to go beyond the aims of growing more food at less risk and lower cost. These designs will need to take much more explicit account of power: both purchasing and political power.

The Green Revolution required farmers to invest heavily in the system of hybrid seeds, chemicals, fertilizers, water, and energy and ignored the social relations of production in the places in which the technology was transferred. "In many cases, modern technologies, have contributed to scarcity by destroying existing sources of supply and creating demands for new ones" (Yapa 1993, 262). Previously used farming practices and knowledge were marginalized and eventually forgotten.

Beginning in the 1970s when Secretary of U.S. Agriculture Earl Butz was encouraging U.S. farmers to "plant fencerow to fencerow," research in the genetic engineering of plants and animals began. Today more than seven million farmers in 18 countries grow over 167 million acres of genetically engineered crops (www.whybiotech.com last accessed on March 13, 2006). Many governments, with consequences of the Green Revolution fresh in mind, are cautious of the American led Gene Revolution and are watching closely to see how they (the United States) fare in their own unfettered biology experiment. Others, such as China and Brazil, have recently come to see GE technologies as an opportunity to make up lost time in the global market place and are eager to adopt. Others, however, remain suspicious. It is the goal of this project to provide a better understanding of the local and regional effects of technological adoption of GE farming systems in the cotton-growing region of northwest Texas to benefit farmers in Texas as well as other parts of the globe.

Agricultural systems and healthy rural communities

The technological "miracles" of motorized farm machinery, irrigation pumps, pesticides, synthetic fertilizers, and hybrid seeds allowed U.S. farmers to have larger and more efficient farms but required fewer farm families in rural communities to manage the same amount of land. Sociologist Walter Goldschmidt was suspicious about how the industrialization of American agriculture was affecting rural communities. In the early 1940s Goldschmidt conducted a social analysis of two central Californian farming-communities. His research showed that residents of rural communities consisting of a larger number of smaller and more diverse farms have a higher level of civic engagement, well-being, and overall quality of life than those living in communities made up of a fewer number of larger and less diversified industrial-type farms (Goldschmidt 1946, 1978; Lyson, Torres, and Welsh 2001). Goldschmidt's findings were, at the time, quite bold and spoke directly to the social costs of agricultural industrialization, technology, and farm consolidation. His work was so controversial that he was let go from the USDA and the once prosperous social science arm of the organization was disbanded.

Goldschimidt's landmark study initiated an undercurrent of concern regarding the relationship between industrialized or 'big' agriculture, the decline of family farms, and the 'drying up' of rural, agriculturally-base communities throughout the United States. Following his lead, writers and thinkers such as Wendell Berry, Wes Jackson, Donald Worster, Thomas Lyson, Laura DeLind, William Vitek, and Deborah Fitzgerald have addressed the connection between 'good agriculture' and 'good communities.' As Wendell Berry expressed throughout *The Unsettling of America*, "If we corrupt agriculture we corrupt culture" (1997, 91). The two are inextricably linked. My research refers to this body of literature as it examines the sociological implications of genetic engineering technologies in northwest Texas farming-communities.

Methods and data collection

Self-administered questionnaires, ethnographic interviews, farm policy analysis, historical and environmental research, and participant observation are used to collect data. Data collection follows the growing season of upland cotton in northwest Texas and takes place in cotton fields, family homes, community centers, churches, cotton gins, seed distribution venues, and research and extension centers. I used different sampling procedures in each of the communities. Due to my insider status, almost every farm family within the Elliott community participated in the study. A volunteer at the Hale Center Farm and Ranch Museum is good friend of mine and is responsible for introducing me to most of the Hale Center participants. In Hale Center, snowball sampling allowed farmers to suggest others to participate in the study. The genetic engineering perception questionnaire was administered to farm families in the spring and summer of 2004. In the summer and fall of the same year I conducted follow-up interviews with each of the farm families surveyed. Several of the more experienced farmers from the first round of farm-level interviews participated in oral histories done in early 2005.

Data collection took place in three phases. Fifty-two informants completed Phase I questionnaires, 17 in Hale Center and 35 in Elliott. During Phase II, 33 participants, 10 in Hale Center and 23 in Elliott participated in personal interviews. Phase III consists of six oral history interviews involving 10 informants; five in Hale Center and five in Elliott. In total, I either surveyed and/or interviewed over 62 informants.

I arranged interviews over the telephone and conducted them in the evenings at family homes. Semi-structured interviews worked well in that the perception survey served as a guide and stimulus but remained flexible enough to let the interview evolve. It is important to me to get to know the families on more of a personal level so I often let interviews flow. I had no problem with letting the interview stray if it meant learning more about the everyday lives of those interviewed.

I recorded some, but not all of the interviews. Each interview was done under variable circumstances and many of them simply did not lend themselves to recording. If I did not know the family very well and sensed that recording our conversation would be uncomfortable or intrusive, I did not ask. Sometimes I asked if I could record the interview but would not if there was much, if any, hesitation. In these instances, I took extensive notes—some during and many after completing the interview.

At first I used a digital recorder but after numerous disappointments and technological glitches, I bought a simple mini tape recorder and used it for the remainder of the project. After the interviews, I downloaded the audio onto my computer so I could transcribe them at a later date. In retrospect, I have found that the transcripts I now have of the recorded interviews are very useful. My notes from unrecorded interviews, however, are more thoughtful. Many of what I consider my most important research epiphanies took place as I tried to recall and think through unrecorded interviews.

Interviews lasted anywhere between 20 minutes to over three hours. Many times, especially in Hale Center, I was on a tight schedule and had to get things done in a timely manner. I conducted interviews whenever farmers could fit them in—sometimes out in the barn or in the pickup going down a bumpy, dirt road. Most of the interviews in Elliott were more like scheduled visits than interviews. I know most of the Elliott participants, many since I was a child, so to term our meeting an interview felt absurd for me and my neighbors. They preferred it be called a visit—something we seem to have less and less time for these days. The interview process was about more than collecting data. The process of sitting down and talking to other farmers struggling in the same plight of my husband and I connected me to a part of something much larger and created in me a greater sense of urgency on the matter.

I conducted the oral history interviews after most of the phase II interviews were completed. The oral history interviews seemed more straightforward whereas the phase II interviews were a little uncomfortable. Even though I tried to explain who I was, what I was doing, and what my intentions were, sometimes it felt as if I might have come across as overly critical or meddling. Farmers are well aware of the controversy surrounding GE crops.

Even as an insider, for me to raise certain unspoken questions regarding the "what ifs" of genetic engineering and our farming future, was suspect. We all know that agriculture is changing and family farming may soon be a thing of the past. I felt like the grim reaper talking about what would happen if the aquifer goes dry, if the price of farm diesel goes over three or even four dollars a gallon, if cotton and farm subsidies are cut, if technology fees on GE seed, equipment prices, or chemicals go up in price any more, if our groundwater becomes too polluted to drink. I found it difficult to talk about some issues because their jobs, our jobs as farmers, involve more than the family business. Family farming decisions are tied up in heritage, status, reputation, and the land and therefore contain more risk. The oral history interviews were fun. They felt much less accusatory and are seen as useful in that they preserve past knowledge from those great in experience. It was common for an oral history interview to start in the afternoon and extend over snacks, dinner, and late into the night. Once informants started thinking about the past, a whole new world of experience was revisited. It was very rewarding to witness the return of memories buried deep within their life experiences of joy and hardship. Phase II interviews however, were much more difficult. It is easy to look back on a life well lived and recount the good and the bad. It is much more troubling, however, to answer for our everyday decisions not knowing what consequences they may have for the future.

In addition to the phase II and III interviews, I talked with agricultural extension specialists, school superintendents, community leaders, gin managers, research scientists, cotton trade organization officials, and boll weevil eradication employees. Again, because of individual circumstances, I did not record each of these interviews.

From the inside out

The use of a reflexive approach helped me learn more about myself and our community while studying the influence of genetically engineered cotton upon farming communities in my home state. Reflexive research is generally qualitative and makes a concerted effort to pay attention to how the researcher experiences his or her research. Many times reflexive research can be overly researcher-centered, focusing too much on the researcher and too little on the research. While I am not the sole focus of this project, it is useful to reflect on my position within the research. As a farmer's wife and member of one of the communities being studied, my everyday life became the object of scrutiny. I found this ironic as I watched many of my colleagues shaping their lives around their academic pursuits. I did just the opposite. My work was molded by the daily happenings and cyclical nature of life on a farm.

Every researcher must consider the ethical dimensions of his or her role and purpose in the research project. Many considerations change or increase in complexity when the researcher is considered an insider in the community under investigation. I feel an overwhelming responsibility for the well-being of not only my home community, but also for our way of life—our profession as farmers, if you will. This dissertation has been a personal quest to reveal the injustices of those who profit at our expense—the expense of farmers, farm families, rural Americans, and the thousands of consumers who entrust in us the responsibility of producing healthy and nourishing food.

As both the researcher and researched I have a particular responsibility to not only the community, but also to myself. Benard (1995, 149) speaks of the difficulty of being an insider when he states, "most of what you do naturally is so automatic that you don't know how to intellectualize it." I found this truism to be one of my largest obstacles. Wilson (1993, 198) tells us "learning can only occur if we start from admitting that we do not know." This was without a doubt one the most difficult aspects of this endeavor – learning to forget what I thought I knew in order to learn anew.

The dual engagement between personal and professional raises questions about the management of ego and ambition; about friendships; about what is legitimate as data, about obligations to truth, openness and confidentiality; and about commitment to expose and transform power relations (Wilson 1993). Luckily, I am not the first to attempt research as an insider. Many before me have struggled with these questions. St.Pierre (1999) returns to her hometown to finish the ethnography she says she started at the age of five. She refers to her homecoming as a form of 'homework' where she was haunted by many of her 'rememories' and apprehensions about her writing that she saw as arrogant. I too felt arrogant to differ in opinion from those who so thanklessly gave of their time. I truly struggled with how to make sense of the conflict between what people were telling me and what I thought it actually meant.

There is truth in Denzin's (1994, 503) assertion that "representation, of course, is always, self-presentation." If the representation that one puts forth is really a reflection of how one sees him or herself, then perhaps an insider perspective can speak more responsibly about the social workings of the inside? Undoubtedly, it is more difficult for the insider researcher because the responsibility for him or her to report 'the Truth' is compounded by their own self-interest in the good of the community. So often though, "research too easily becomes the desire to expose the smallness of people, the meanness of power, and the inability of societies to create systems sustaining their values and binding their members" (Wilson 1993, 192). Perhaps the tendencies Wilson describes are less of a concern for those who work from inside where they are held socially responsible for the knowledge they produce? Then again, I wonder about how this type of governance could limit or control the production of knowledge.

Creswell (1994) provides a good starting point from which to reflect on the ethical dimensions of research and suggests that qualitative researchers think about the confidentiality of data, anonymity of informants, and the intended use of the research data. Surveys, audio cassette tapes, and my personal notes are kept in a confidential location but what about the confidentiality of the thoughts that linger in my mind? Am I not to discuss what informants tell me with anyone else? At first I had a very difficult time positioning my husband into the research project. He is at the same time a farmer whom I interviewed, and also my partner who over the past several years has become very significant in shaping the research project itself. Most of the other farmers in Elliott are either relatives or long-time friends. Pseudonyms are used in the study but I wonder how useful they are in a small community? I feel more than mere responsibility to each of the communities. Researchers from the outside are responsible to the degree that they maintain respect in the eyes of the community after departure. I feel as if the bar of responsibility is somehow raised when the one observing is part of those being observed. Regardless, as part of the community I am one bound to the unspoken communal laws of fairness and respect. I am held accountable to the well-being and maintenance of a social institution of which I am an integral part.

In conclusion, this study examines the social implications of genetically engineered cotton in northwest Texas. It is situated within a diverse body of literature and contributes to two particular veins of thought: power and perception in the industrialization and control of agriculture (namely the seed), and the effects of agricultural technology on society (specifically rural communities). Surveys, interviews, and secondary sources are used in the collection of data. My insider status is unique to the study and provides advantages as well disadvantages.

Chapter 3

Northwest Texas Cotton and Communities

No other crop can compare to the legacy of cotton in the United States. It has brought inconceivable wealth to some and bankruptcy for others; the root of hope and the reason for despair. It is rumored that at one time a farmer could pay off his land, buy a tractor, and build a new house with his first year's crop alone. But many have gone to an early grave toiling for a bumper crop of 'white gold.' According to historian Stephen Yafa (2005, 6), "No legal plant on earth has killed more people by virtue of the acrimony and avarice it provoked." Cotton was central to the industrial revolution in Britain and perpetuated slavery in the American south. Currently, it is at the forefront of a contentious international trade dispute between the United States and Brazil. But imagine a world without Levi's, cotton sheets, Q-tips, or your favorite t-shirt. It comes as no surprise that cotton was one of the first plants targeted by the biotech industry. "It has stirred up more mischief than any penny-ante royal, and yet it remains so casually seductive in its look and feel that we are willing to forgive its sins even as we continue to pay for them" (Yafa 2005, 8).

The purpose of this chapter is twofold. First, I discuss cotton: its development as a commodity, its legacy in the American South, and its reign on the plains of northwest Texas, the region of focus for this study. Second, I introduce the two case study communities of Elliott and Hale Center, why they were selected, and how they contribute to understanding the regional consequences of GE cotton in northwest Texas.

King cotton

Gossypium origins

Cotton is a native, perennial shrub of the tropics and subtropics of America, Africa, Asia, and Australia. It is an herbaceous plant with a long taproot and upright stem ranging anywhere from two to five feet in height. Of the roughly 50 identified cotton (*Gossypium)* species, only four have been domesticated (J. Sauer 1993).[3] Of the two genomes (A and D), only the A genome found in India and Africa contain genes for true lint. It is hypothesized that A genome cottonseed drifted across the Atlantic ocean millions of years ago and crossed with a relative of the American native *Gossypium raimondii* (DD) to produce the South American *Gossypium barbadense* (AADD) and Mexican *Gossypium hirsutum* (AADD) species of today (Figure 3.1). Indigenous cotton plants produce few bolls and scarce lint. Only through cultivation and careful, prolonged breeding has cotton become the one of the world's leading natural fibers.

[3] The four domesticated cotton species are *Gossypium herbaceum* (Africa/West Asia—Genome AA), *Gossypium arboretum* (Pakistan/India—Genome AA), *Gossypium barbadense* (South America—Genome AADD), and *Gossypium hirsutum* (Mexico—Genome AADD).

Figure 3.1: *Gossypium hirsutum* (www.golkum.ru.jpg).

Early cotton production in the United States

Cotton was not produced on a significant scale in the United States until the Yale-educated Eli Whitney masterminded the cotton gin in 1793. Prior to Whitney's invention, cotton lint had to be separated from its seed by hand. African slaves developed a combing method which aided in the task, but even with that technique, one person could separate only one or two pounds of lint from the seed per day (West 2005). The cotton gin revolutionized the production of cotton in the United States. No longer limited by the time and labor of separating lint from the seed by hand, cotton production exploded in the American south.

Once the technology to efficiently separate the seed from the lint was created, cotton became a principal crop of the subtropical southern United States. A demand for the fiber in Europe encouraged southern planters to increase their cotton acreages. The plantation era began. Land was cleared of trees and planted in cotton year after year until it could produce no more. “As land became exhausted in the old cotton states, the planters either abandoned their farms and moved to the virgin soils of the Southwest, or gave up cotton raising as a regular business and betook themselves to the breeding of slaves for the Western markets” (Hammond 1897). Cotton production skyrocketed to over 16,736 bales in 1794 up from 6,276 in 1792 (Sitton and Utley 1997). According to other accounts, production rose from 150,000 pounds in 1793 to 6.5 million pounds in 1795 (West 2005) to 400 million pounds in 1831 (Rivoli 2005) (Figure 3.2). Not only did planters grow more cotton but they also expanded the size of their landholdings and assets, namely slaves. In 1850 at the height of the plantation era over 75% of the estimated 2.5 million slaves in the United States were involved in the production of cotton (West 2005).

Two types of cotton were grown in the southeastern United States prior to the Civil War; *Gossypium barbadense* (Sea Island cotton) and *Gossypium hirsutum* (Upland cotton). *Gossypium barbadense* is a long-stapled, fuzz-free cotton. It is ideal for spinning but only grows well in the West Indies, and on islands off the coasts of Georgia and South Carolina. The hardier *Gossypium* *hirsutum,* or Upland cotton, has a fuzzy green seed and can be cultivated more widely. Today over 90% of all cotton grown in the United States is Upland.

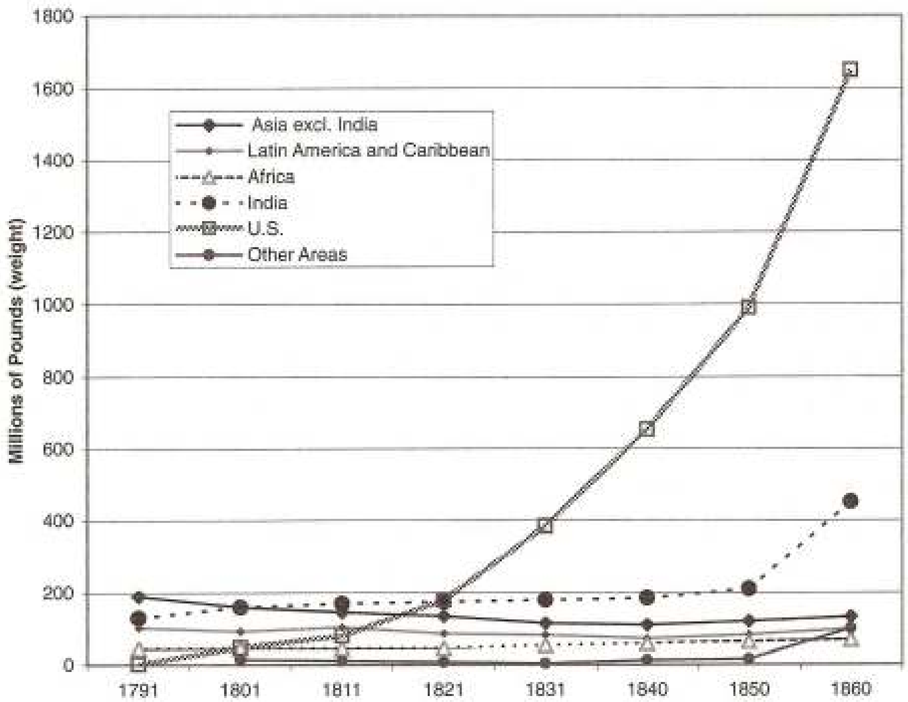


Figure 3.2: World cotton production, 1791-1860 (Bruchey 1967 as in Rivoli 2005).

Pima or Egyptian cotton is predominantly grown in West Texas, Arizona, and California and accounts for the remaining 10% of American cotton production. It is estimated that during the plantation era, over 1,000 varieties of cotton existed (Wilsie 1962). Westbrook (1956) reports that by the 1950s 87% of all cotton planted in the United States was from only 10 varieties. Three of the 10 varieties accounted for 67% of all cotton acreage (Westbrook 1956). In 2005, cotton farmers chose from over 100 cotton varieties and/or trait combinations. As detailed in Chapter Four, today's cotton farmers are not limited in their selection of cottonseed varieties but by the type (conventional vs. genetically engineered) of cottonseed available for purchase.

After the abolishment of slavery, plantations unable to hire laborers were divided and sold. Some planters moved west in search of richer and better soil. When land no longer produced it was deserted. Land wore out quickly because little or no fertilizer or crop rotation was used. Cotton requires many nutrients to produce lint, especially nitrogen. According to Kevin Bronson, Associate Professor of Soil Fertility and Nutrient Management at Texas A&M University, soil on which to grow cotton needs 180 pounds of nitrogen/acre to produce three bales of cotton/acre. Growing cotton year after year depletes the soil of valuable nutrients such as nitrogen, phosphorus, and potassium. Whereas today's cotton farmers are dependent upon synthetic fertilizers such as anhydrous ammonia to replace nitrogen in the soil, plantation era farmers relied on the abundance of the American landscape. Land was so inexpensive that planters simply moved from one virgin parcel of land to another.

Other factors prevented southern planters from adopting more beneficial systems of cultivation. Grain could not be grown in the south due to rust—a parasitic fungus problematic in areas with high rainfall—so there were few crops other than corn with which to rotate cotton. Secondly, because of cotton's status as a valuable cash crop, it was always the planters' first choice. The agricultural credit system was built on the backs of the cotton industry and helped perpetuate the 'one crop' system. When a farmer's cotton crop failed, one was often 'locked in' to cotton in hopes of paying off the banker with the next year's crop. Lastly, cotton required almost a whole season of constant labor. If cotton was rotated with other crops, there might be a lull in the work to be done thus making slave labor less efficient. "The planter, who had the bulk of his fortune invested in slaves, had an almost uninterrupted use of his capital, which would not have been the case if the slaves had been employed in the cultivation of the cereals" (Hammond 1897). I will revisit these issues in later chapters but it is necessary to point out how, even before the use of many labor-saving technologies in the production of cotton, the demands of growing large amounts of cotton created a particular type of social and economic system by which it was cultivated.

After the Civil War the value of land and cotton plummeted in the southeastern United States. The price of cotton dropped to 17 cents per pound in 1871 (Hammond 1897) (Figure 3.3). Planters trying to stay in business attempted to hire many of their ex-slaves on a wage system. The system failed because planters did not have the capital to pay workers on a daily or weekly basis. Workers could not survive if they were to wait until the cotton had been harvested and sold in order to be paid. Many plantation owners were forced to sell their land. Poor southern whites obtained credit and bought land in small portions. This era is one of the only times in recorded American history that the size of farms significantly decreased in size dropping from 401 acres in 1860 to 230 acres in 1870 (Hammond 1897). The sharecropping system became the solution for struggling plantation owners in need of labor and ex-slaves in need of employment. Under the 'share' system, the owner and tenant both share the risk of growing cotton. Depending on who provided the equipment, animals, housing and other necessities, tenants received anywhere from ½ to ¾ of the income from the cotton crop and would usually pay all or most of the expenses. Farms were divided into either 'one horse' or 'two farms.' Before mechanization, most tenant families could not grow more than 10 or 15 acres of cotton (Erickson 1948).

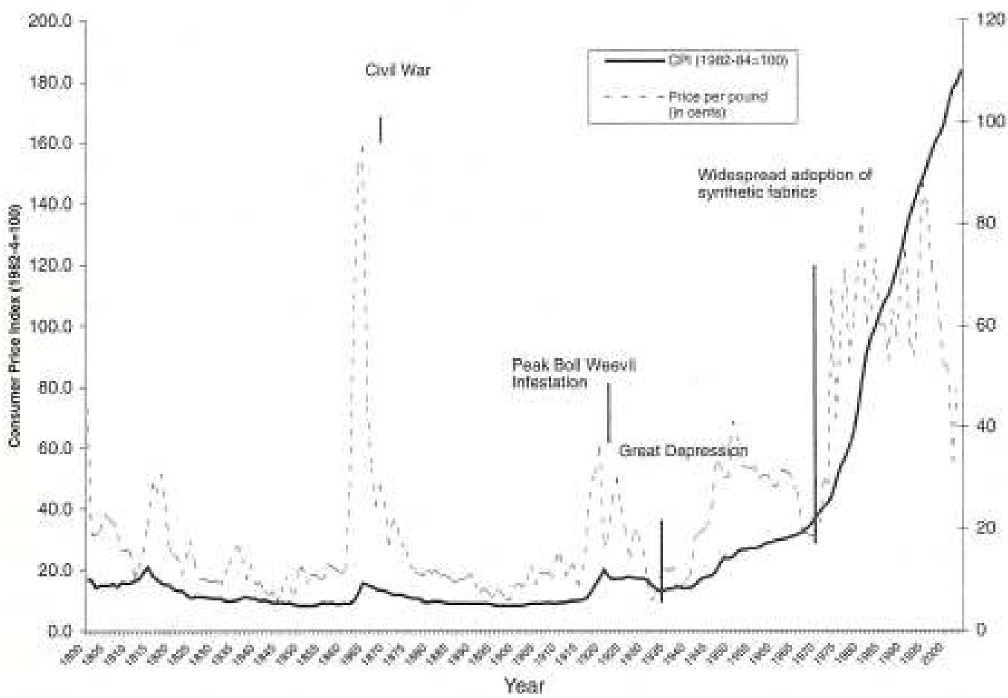


Figure 3.3: Cotton prices and consumer index (Rivoli 2005).

As cotton production expanded westward (Figure 3.4), the number of cotton acres increased and the price farmers received for their cotton decreased. By the early 20th century, the plains of northwest Texas were coveted as prime cotton land due to their even terrain deep in rich topsoil and free of rocks and trees. Today, Texas is by far the leading producer of cotton in the United States.

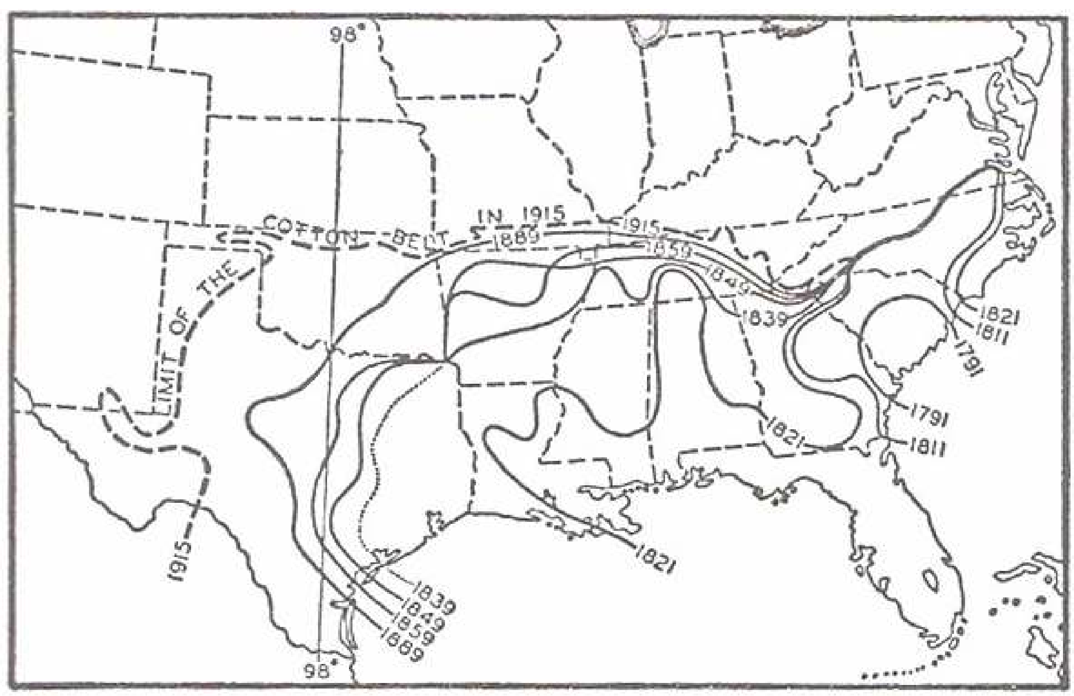


Figure 3.4: The expansion of the cotton kingdom, 1791-1915 (*Atlas of American Agriculture 1936*).

Cotton comes to Texas

Eighteenth-century Spanish missionaries from San Antonio are believed to be the first cultivators of cotton in Texas. Plantation cotton systems expanded east into Texas after the cotton gin (Sitton and Utley 1997). By 1924, 56.7 percent of all Texas cropland was in cotton—accounting for over one-third of American production (Sitton and Utley 1997). With the development of the railroad, Texans further increased their cotton plantings, plowing a record 17 million acres of cotton in 1929 (Sitton and Utley 1997). Cotton production was the center of the Texas economy until the 1930s when it declined due to the prolonged drought known as the Dust Bowl and increased boll weevil infestations (Wagner 1980). The drought passed and it was not long before production increased on the northwest Texas plains due to irrigation and inhospitable living condition for the weevil. According to Wagner (1980, 465), "The superiority of Texas as a cotton-growing region is to be explained partly by her new and fertile lands, which, without fertilizers and with relatively little labor, will produce more cotton to the acre than land east of the Mississippi." Cotton could be produced in Texas at a cost from one and a half to two cents less per pound than in the eastern states (Wagner 1980, 466).

The concentration of cotton production in northwest Texas is a relatively recent phenomenon. As parts of the southernmost reach of the Great Plains, the plains of northwest Texas were until recently, grasslands—part of the great

American prairie. The cotton culture of northwest Texas is relatively young and much different from that of the antebellum south. Many area cotton farmers can themselves remember the pre-cotton days of the Texas plains. What makes the Texas plains unique and how did they become the number one cotton producing area in the United States?

Settlement of the northwest Texas plains

Northwest Texas was one of the last frontiers colonized in the state. Early Anglo settlers feared the Comanche and Kiowa and were apprehensive about moving to areas that had little surface water and sometimes insufficient rainfall for growing crops. Hunters and gatherers of the Great Plains, such as the Comanche, depended upon buffalo herds for their livelihoods and utilized prairie lands more extensively than Anglos by migrating through them rather than settling in one place. On the contrary, immigrant Anglo 'nesters,' or dirt farmers, were interested in taming nature for the production of crops and livestock through hard work, diligence, and staying put.

Northwest Texas land in the late 1800s was inexpensive, plentiful and available to those who were willing to take the risk of raids, drought, and isolation. It was reported that in 1867 "no white man dared to venture alone as far out as Eagle Flat, where Vernon is now located" (*Early-Day History of Wilbarger County* 1933, 26). One bold settler reports, "Both Dawson and myself plowed for several days with our guns swung to our plow handles" (*Early-Day History of Wilbarger County* 1933, 194).

Despite their efforts, most early attempts to farm in northwest Texas before the late 1880s failed. There was much fighting and hostility between the Texas Rangers and Plains Indians before the 1875 defeat of the last band of Comanche in Palo Duro Canyon near Amarillo. Between 1860 and the late 1880s cattle ranchers occupied and grazed large areas of grassland on the northwest Texas prairies. Free-range cattle were a nuisance for farmers trying to establish crops to feed their families and stock. Drought and failed crops caused many families to turn their covered wagons around and return from where they came. Drought hit the southern high plains in the late 1880s and early 1890s driving many settlers back east (Green 1973). The drought of 1886 forced one family away leaving nothing behind but a chalked up cabin door which read, "250 miles to the nearest post office; 100 miles to wood; 20 miles to water; 6 inches to hell. God bless our home! Gone to live with wife's folks" (Fite 1966).

Farming the Texas Frontier (1890s-1920s)

At the turn of the century, European farmers were quickly moving into northwest Texas from both south Texas and the eastern United States. Many farmers came in search of cheap land or in efforts to escape the boll weevil which had at the time decimated the cotton crops of south Texas. Others came to buy large sections of land in hopes of selling it off piece by piece for profit. Corn and grain sorghum were some of the first crops grown and were used mostly for animal feed. Cotton soon became a popular crop on the southern plains. The absence of the boll weevil at higher elevations was the major selling point for land in the area (Figure 3.5).

Figure 3.5: Social commentary on the superiority of the Texas Plains for growing cotton (Dallas News, January 21, 1924).

Settlement increased on the high plains with the mechanization of farm equipment. As opposed to the cotton belt of the old south, the plains were virtually devoid of a labor supply. Some believe that the area might never have been farmed, much less on a large scale, had it not been for the invention of tractors. Plains geography was perfect for maximizing efficiency with the use of tractors. Mechanization of farm machinery mushroomed in the area during the 1920s. The flat, vast plains, as opposed to the forested and undulating bottomlands of the southeast, were not only ideal for tractors but also for growing row crops such as cotton and corn. As early as 1928, before the full potential of irrigation on the plains was realized, L.P. Gabbard predicted the southern high plains to be the eventual epicenter of cotton production in the United States. He envisaged the steady settlement of new farm lands in the panhandle, increased land values, increased specialization, reduced cost of production, and an increase in the size of farms (Gabbard 1928). The large expanses of prairie land coupled with the marked improvements in farm machinery made the high plains prime for large-scale cotton production. According to Wilsie (1962), the dark, friable soils and extreme weather of the northwest Texas prairies are perfect for cotton cultivation. Hot and dry summers paired with cold winters are optimum growing conditions for the cotton which grows best with at least a 200-210 day frost free growing season (Wilsie 1962).

It was not unusual for one to see cotton fields as large as two or three hundred acres in the 1910s and 1920s. Between 1925 and 1930 the land under cultivation in the region almost doubled. In the 1930s anywhere between fifty and 70 percent of all cultivated land was in cotton (Gibson 1932). Cotton farmers on the Texas plains produced more cotton than their counterparts in the south simply because of the sheer size of their farms.

By 1900 the existence of subsurface water resources lying at shallow depths beneath the Texas high plains was well known (Green 1973). The problem was finding an inexpensive and effective pump to bring the water to the surface. A single windmill could pump water from the underground reservoir for family and garden use but could not provide water enough to irrigate on a large scale. A few wells were drilled but enthusiasm for the technology was waning. The technology was not yet cost effective and good rainfall between 1900 and 1909 created a lack of interest by farmers unaccustomed to irrigation. By 1920 there were only 187 wells in the four counties of Bailey, Deaf Smith, Floyd, and Hale (Green 1973). Even so, rumor of the potential benefits of the underground lake brought large numbers of settlers and speculators into the area to buy land which was increasing in price by the minute (Figure 3.6). By 1920 the populations of plains counties were booming. Yet it took the extreme drought conditions of the 1930s to instigate the initiative to feasibly irrigate the Texas Plains.

KING COTTON

Cotton production on the South Plains increased from 9240 bales in 1909 to 132,489 bales in 1919, or 1400 per cent. Since that notable success was advertised, the South Plains have rapidly become one of the most dependable cotton producing sections of the United States. At this time cotton is the main cash crop of the South Plains.

No Boll Weevils

The South Plains have no boll weevils, and in the judgment of competent authorities we shall never be troubled with the boll weevil. Cotton is peculiarly adapted to our climatic and soil conditions, and the South Plains is today regarded as one of the great cotton producing sections of the United States.

South Plains Yield

It is rather difficult for one not intimately acquainted with this country to visualize its productivity. We give the following comparison as to yields, taken from the 14th United States Census for the crop 1919-1920:

County—	Acres.	Yield Bales	Bales Per A.
Williamson	266,979	77,733	.29
Collin	176,901	49,311	.27
Ellis	298,729	65,192	.21
McLennan	234,730	54,655	.23
Lubbock	35,476	17,693	.49

(From Lubbock Technological College Brief.)

AVERAGE YIELD FOR 10 YEARS

South Plains Experimental Farms, Sub-Station No. 8, at Lubbock, Texas.

From the records kept at this station, which is located but thirty-seven miles from Littlefield, we learn, from their Bulletin No. 299, that for the 10-year period, 1912-1922, the average yield of lint cotton per acre for the ten best varieties was 348.87 pounds.

From the same source we get the following averages of four varieties over a 9-year period:

Average Production 9 Years—

Burnett	407.96	Pounds
Mebane	357.92	"
Lone Star	288.65	"
Rowden	233.36	"

Figure 3.6: Advertisement from a Yellow House Land Company brochure (Yellow House Land Company).

The Dust Bowl Years (1930s)

The "dirty thirties" hit northwest Texas hard. Many farmers, too poor to feel the effects of the economic depression, could not ignore the lack of rain or endless storms of dust which engulfed their homes, schools, and churches. Twenty states, including Texas, set record rainfall lows for the entire span of official weather data (Worster 1979). Young plants which made it from seed to sprout soon withered from intense heat, lack of rain, and blasting sand storms.

During the 1930s a large percent of farms in northwest Texas were owned by non-residents. For example, of the farms in Wilbarger County in 1936, 513 were owner operated and 1,178 were worked by tenants (Wilson 1938). Landowners often required tenants to grow cash crops such as cotton in order to make a return on the land. Cotton was grown year after year and according to Wilson (1938), exhausted the land quickly. Between 1929 and 1932, commodity prices received by farmers fell 56 percent (Paarlberg and Paarlberg 2000). The depression and dust storms of the thirties forced many tenants to go West in search of work in California. One plains cotton farmer confessed, "I would have moved, too, but I owed so much I had to stay for they would not let me go" (*Early-Day History of Wilbarger County* 1933, 180).

The government responded to the disaster most felt in the agricultural orientated plains states with the Agricultural Adjustment Act (AAA) of 1933. Under AAA legislation, the government paid farmers to plant no more than 85%

of their base acres in crops.[4] Farmers who contracted with AAA to restrict their acreage under cultivation were eligible for government loans from the Commodity Credit Corporation (CCC) on commodities placed in storage (Goodman and Redclift 1991). Farmers in Wilbarger County where Elliott is located received a total of $386,800 in 1935 alone from the Agricultural Adjustment Act (Wilson 1938). The Soil Conservation Act, passed in April 1935, developed the Soil Conservation Service and paid farmers to follow soil building practices instead of planting crops such as cotton or wheat. In 1936 the Supreme Court ruled the AAA unconstitutional because the money paid to farmers was raised by taxing companies that processed commodities into food and fiber. In 1938 a revised AAA funded by general taxation rather than a processors tax was passed.

Plains farmers who invested in tractors during the 1920s were forced to return to their draft animals for horsepower during the depression. Many tractors sat under shade trees until their owners could afford to purchase fuel. Even amidst the social and environmental turmoil of the 1930s, the plains continued to be promoted as a farming oasis (Figure 3.7).

[4] A farmer's base acreage was the average of the acres planted in crops the previous three years, 1930-1932.

Figure 3.7: Postcard depicting the abundance of northwest Texas groundwater, 1937 (Postcard courtesy of Corinne Gibson, Hale Center, TX).

Post World War II Boom (1940s – 1950s)

World War II created a demand for agricultural commodities grown on the Texas plains. War-time technologies went from battlefields to agricultural fields in the form of newly developed chemical pesticides. With new forms of technological assistance, crop yields increased dramatically—so much that they kept up with the demand for agricultural commodities in war torn Europe and Japan. The average per capita farm net income rose from $706 to $2,063 between 1940 and 1945 (Hurt 2002). The Korean War provided another surge in demand in the early 1950s. It was not until the mid to late 1950s that agricultural surpluses began to once again stack up and deflate commodity prices.

Green Revolution technologies such as chemical pesticides, synthetic fertilizer, hybrid seeds, and the continued mechanization of farm machinery escalated the industrialization and consolidation of agriculture on the plains. Increased wheat and cotton yields on the northwest Texas plains in the 1940s are attributed to the overwhelming adoption and use of synthetic chemicals and fertilizers. Paul Müller, a chemist working for the Swiss company J.R. Geigy, developed the potent and effective insecticide DDT in 1935. DDT was used widely in the 1940s and 1950s. Its vast use prompted Rachel Carson's influential 1962 work, *Silent Spring*, about the detriment of DDT to wildlife as it moves through the food chain. DDT was banned in the United States in 1972. Although synthetic nitrogen was developed during WWI, use of fabricated fertilizers did not skyrocket until after WWII (Paarlberg and Paarlberg 2000). While farmers' yields increased, their added income went to pay for outside sources of fertilizer and pest control which deepened their dependency on the off-farm economy for farming inputs.

The invention and adoption of the mechanical cotton picker in the 1950s forever changed the culture of cotton production on the plains. International Harvester Company first marketed their mechanical cotton stripper in 1942. Large scale cotton producers on the Texas high plains were some of the first to adopt the technology. Many Mexican laborers working under the wartime Bracero program were no longer needed. By the early 1960s, mechanical cotton pickers harvested 72 percent of the American cotton crop (Hurt 2002).

By the late 1940s it was both technologically achievable and economically feasible to utilize the largest underground water source in the world, the Ogallala Aquifer (Green 1973; Brooks and Emel 2000) (Figure 3.8). Counties on the southern high plains of northwest Texas grew socially and economically during the Blue Revolution of the 1950s. Record amounts of water were pumped from the Ogallala in the 1950s and 60s before the advent of more water efficient irrigation methods such as center pivot systems (Blakely and Koos 1974). The total economic benefit of irrigation on the Texas high plains in 1959 was an estimated $330 million (Green 1973).

Farming in Flux (1960s – present)

As irrigation became more widespread, plains cotton farmers increased their plantings of corn and grain sorghum. Cattle feedlots and meat packing plants moved to the high plains to take advantage of the cheap feed grains produced in the area with irrigation. In 1969, after twenty years of intensive irrigation in the area, signs of groundwater depletion started to show (Brooks and Emel 2000). All the while in 1971, Secretary of Agriculture, Earl Butz, encouraged farmers to plant “from fencerow to fencerow.” Commodity prices, especially for wheat, were high and in demand on the world market. Government support to farmers had never been greater. Many farmers in northwest Texas paid off farms, invested in larger machinery, and purchased additional land in the 1970s. The adage "get bigger or get out" was accurate of the times. Farms continued to consolidate and get larger as more family farmers "got out" of the business all together. Agriculture had become highly mechanized, subsidized, and regulated—very different from one century earlier when settlers came in mass to break the prairie sod.

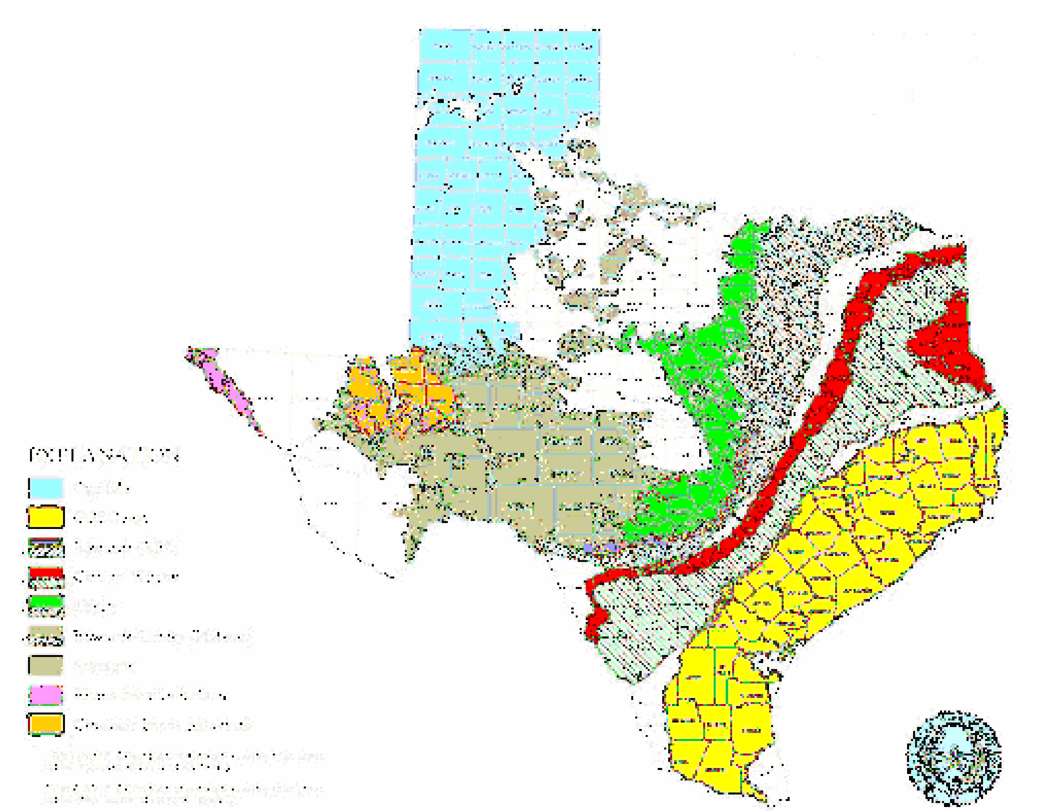


Figure 3.8: Major aquifer formations of Texas (Texas Water Control Board).

Agricultural prosperity came to a halt in the late 1970s and 1980s. The 1980s farm crisis created national concern over the fate of the American family farm. According to Goodman and Redclift (1991), the farm crisis of the 1980s was a result of overproduction, intensification, rural depopulation and poverty, the fiscal strains of agricultural protection, trade reform and environmental problems.

Concern over the fate of the Ogallala heightened as reserves in shallow areas diminished. Many counties started organizing groundwater conservation districts. The Conservation Reserve Program (CRP) began as part of the Food Security Act of 1985 and paid farmers to take marginal land out of production. Due to falling water levels of the Ogallala, 121,924 acres of Hale County cropland was put into the CRP program between 1987 and 2003. The program was popular and remains a strong component of current American farm policy. As energy prices increased, it also became more and more expensive to pump groundwater from deeper depths within the aquifer. Center pivot sprinkler systems conserve more water than row irrigation techniques and therefore grew in popularity during the 1980s and 1990s. Most recently, farmers with the economic resources to do so are installing even more efficient irrigation systems in the form of subsurface drip lines at a cost of over $700 per acre.

Genetically engineered cottonseed entered the north Texas cotton scene in the mid 1990s. Currently there are two types of GE cotton on the market; herbicide-tolerant (HT) and insect-resistant (IR). HT varieties are marketed as part of a production system (GE seed and herbicide). They are genetically engineered to tolerate multiple applications of the requisite herbicide which kills weeds but not cotton. Three types of HT cotton varieties are available for purchase— BXN (Bayer), Roundup Ready (Monsanto), and Liberty Link (Bayer). Both Bollgard I and Bollgard II (also referred to as Bt because the cottonseed contains genes from *Bacillus thuringiensis*—a soil bacteria most often utilized by organic farmers as a natural insecticide) are patented by Monsanto and are the only IR cottonseed varieties available at the time of this writing. Insect-resistant cotton is lethal to targeted cotton pests such as the cotton bollworm and tobacco budworm. Herbicide-tolerant traits can be used alone or in conjunction with Bt traits. When used together the seed is referred to as 'stacked.' Seed companies make arrangements with patent-owning biotechnology firms to insert patented and protected traits within certain varieties developed by individual seed companies, not biotechnology corporations. Seed technology fees return to the biotech 'owners' of the trait/s. However, an increasing number of seed companies are owned by biotechnology firms (reducing farmer agency as discussed in Chapter 4). For instance, Monsanto bought Stoneville for over $300 million in 2005. Bayer owns FiberMax and purchased AFD in early 2005. Cotton varieties are developed by breeders from individual seed companies and are marketed as unique in germplasm and quality (i.e., maturity and fiber strength). Seed companies decide which varieties will contain various GE traits. For example, the seed company Deltapine might develop four new seed varieties in the coming year. They may choose to put the Roundup Ready trait in two, the Liberty Link trait in another, and the Roundup Ready Flex trait in yet another. Owing to the relative affordability of the herbicide glyphosate, Monsanto's Roundup Ready trait is by far the most widely used. In 2005, over 90% of all planted seed containing HT traits was Roundup Ready (USDA-NASS 2006).

Accounting for 25% of total production, Texas is the leading cotton-producing state in the nation. Encompassing over 5 million acres, it has a total economic value of $5.2 billion. Upland cotton (*Gosspium hirsutum*) is the dominant type of cotton grown throughout eight cotton-growing regions of the state (Figure 3.9). In 2005, 7.8 million bales of cotton came from Texas soil. That is enough cotton to make over 1.6 billion pairs of blue jeans. Today, over 80% of all cotton grown in the United States is genetically engineered and over 60% of all cotton grown in Texas is GE (USDA-NASS 2005) (Figure 3.10).

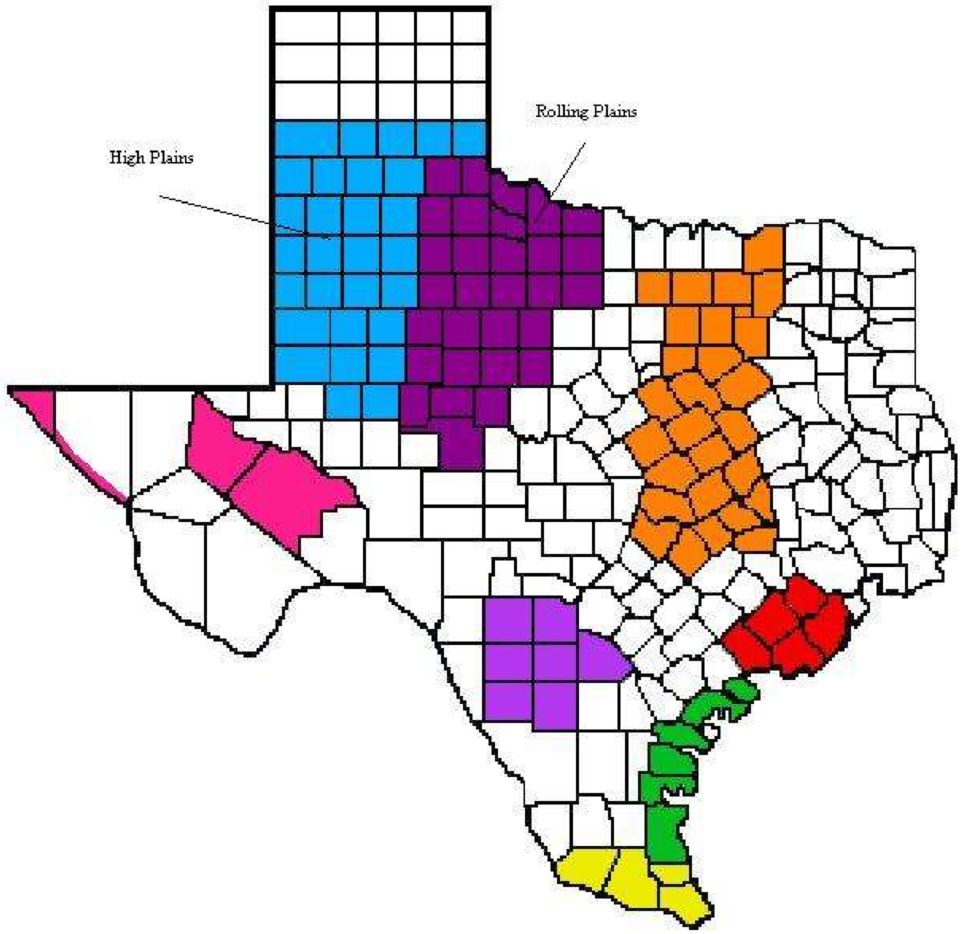


Figure 3.9: Texas cotton-growing regions.
Note: For the purpose of this study, the High Plains and Rolling Plains regions are together referred to as the Northwest Texas region.
Life and innovation on the Great Plains

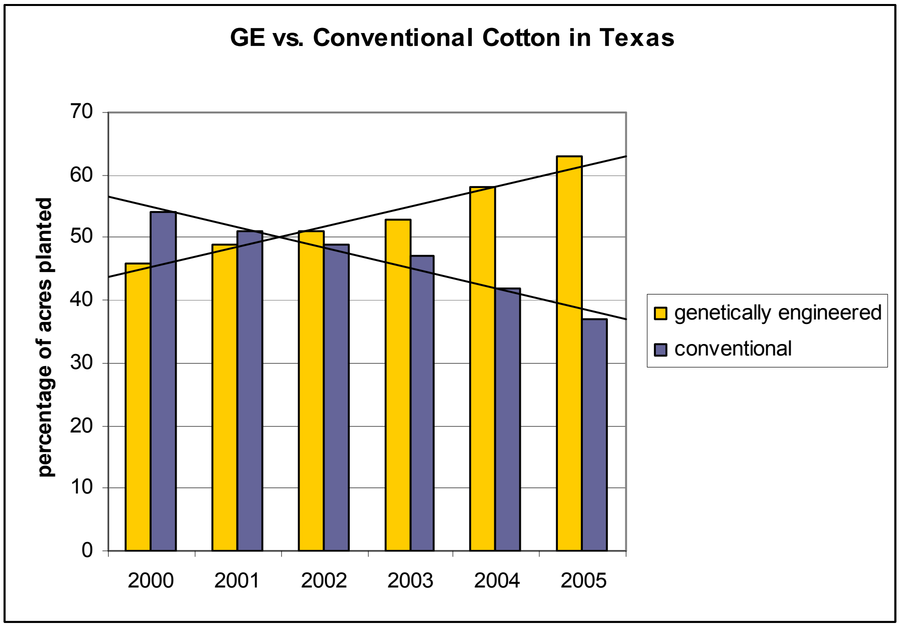


Figure 3.10: Genetically engineered cotton in Texas, 2000-05 (USDA-NASS).

A historical look at the production of cotton in the United States and Texas reveals the dedication with which society pursued its cultivation. As one of the most labor and resource intensive plants grown in the world, humans have been innovative and persistent in finding new ways to reap profit from the highly desired crop. Slavery in the pre-antebellum south, post-war sharecropping, WWII Bracero programs, and the U.S.'s current blind-eye to illegal migrant workers, are all examples of how the exploitation of labor has subsidized wide-scale production of the crop. More recently, agribusinesses have capitalized upon technologies that have either increased yields and/or reduced labor requirements making it easier for fewer farmers to raise more cotton. Many of these technologies benefit corporations while externalizing the long-term costs of the technologies over time and across space. The social costs of industrialized cotton production in northwest Texas have been adding up for some time and are apparent in the social and environmental landscapes of the region. Mechanization literally fueled the development of agriculture on the northwest Texas plains while simultaneously ensuring its demise. As machinery grew larger, less laborers and farmers were required to work the land. Irrigation, pesticides, and synthetic fertilizers boosted yields over the short-term but damaged soil health and necessitated the continued use of the technologies to maintain production. Biotechnology companies have made many promises regarding the benefits of GE cotton. Unfortunately, the implications of GE technologies seem graver than those which came before.

Study communities

I selected two communities to study the influences of GE cotton on the northwest Texas region. Elliott and Hale Center are typical of 21st century farming communities on the Great Plains. Agriculture is the traditional center of industry, land holdings are consolidating, farmers are aging, and rural populations are declining. This has been a steady trend since the Great Depression but takes on new meaning in the context of yet another technological innovation and adoption. Hale Center is a farming community of no more than 2,300 people. It is located in the heart of Hale County approximately 60 miles north of Lubbock, Texas on Interstate 27. With approximately 200 people, Elliott is considerably smaller and more isolated. It is located in the northeastern corner of Wilbarger County, roughly 150 miles northwest of Dallas/Ft. Worth (Figure 3.11).

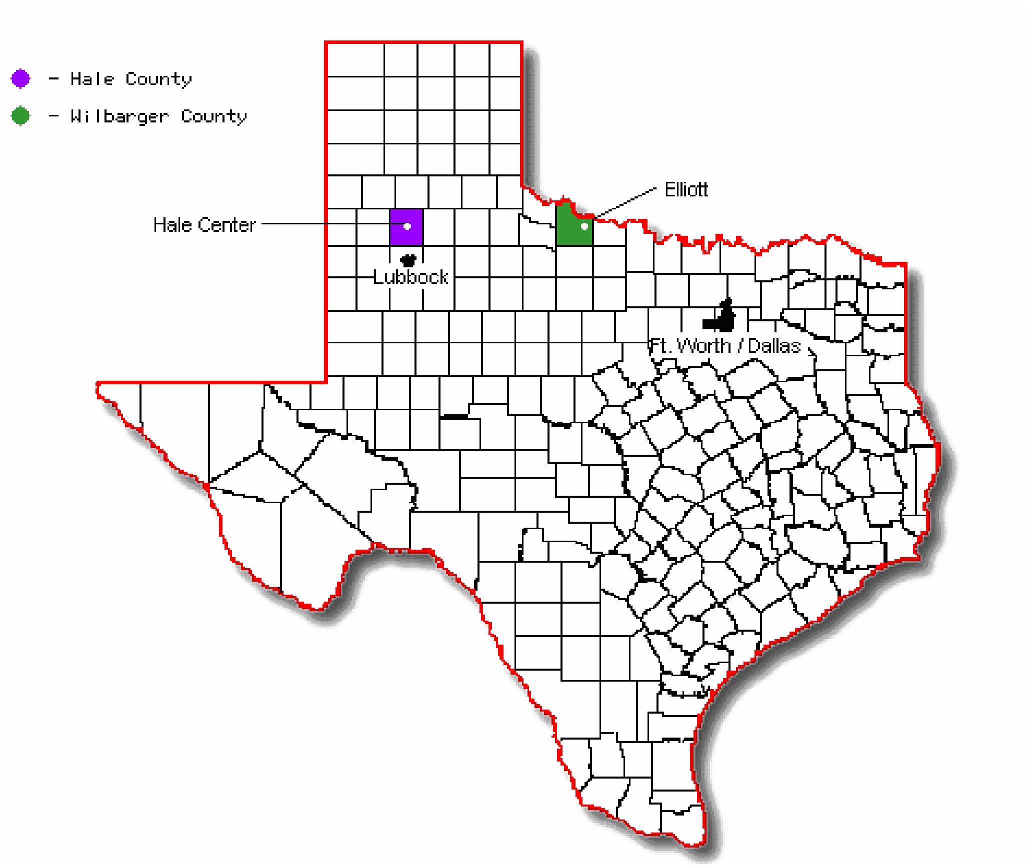


Figure 3.11: Study communities and counties in which they are located.

Community selection

Elliott was originally the sole focus of the study. I grew up there and had recently returned to marry a farmer. Elliott is on the periphery of one of the largest (in size and volume) cotton-growing regions in the United States (Figure 3.12). Therefore it is a practical location for looking at the effects of GE cotton use in Texas as well as the United States. As the project developed it became clear that a community in the true center of the northwest Texas cotton-producing region would be a valuable addition to the Elliott case study. Since, in 2002, farmers in Hale County produced more cotton than any other county in the state, I added Hale Center to the study. In 2003, total acres of cotton planted in Wilbarger County amounted to less than 10% of acres devoted to cotton in Hale County (Figure 3.13). While Elliott remains central to the focus of the research, Hale Center contributes to understanding the consequences of GE cotton for northwest Texas.

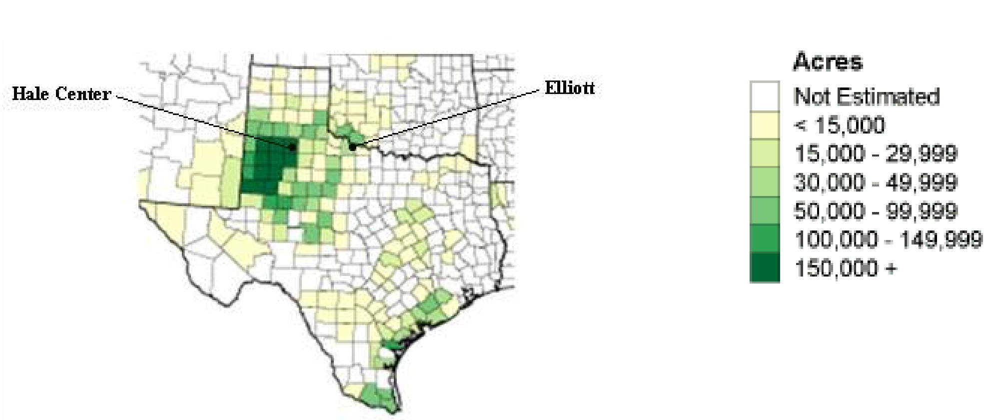


Figure 3.12: Acres of Upland cotton planted by county, 2004 (USDA-NASS).

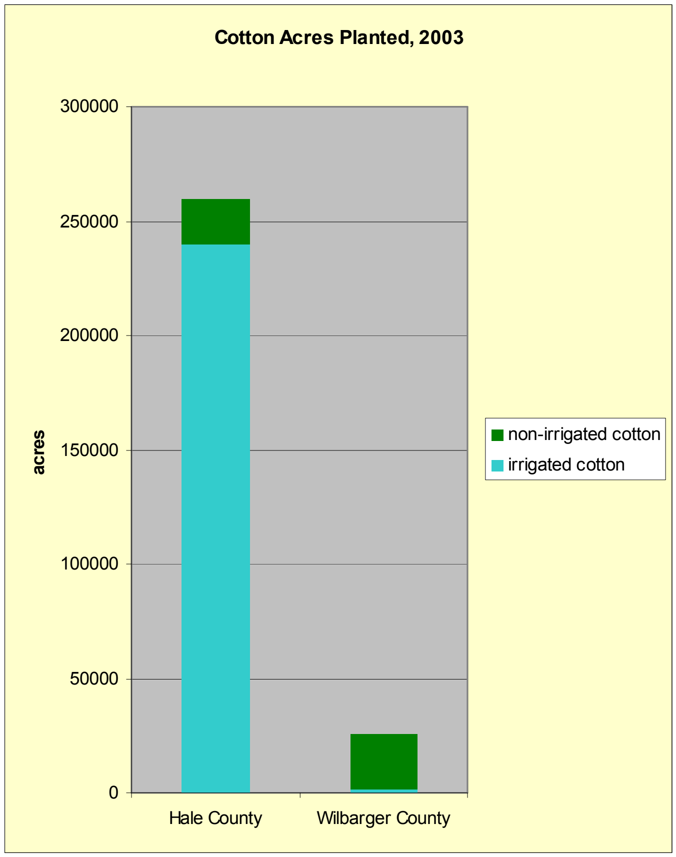


Figure 3.13: Cotton acres planted in Hale and Wilbarger Counties, 2003 (USDA-NASS).

Several communities in Hale County were considered as possible sites of study. The ideal community needed to be composed of people dependent upon the cotton industry to better gauge how the advent of GE cotton was affecting their community. It was important to select a place that was larger and had more community businesses and infrastructure than Elliott but did not have more than a few thousand people. I also wanted to look at a community where the majority of cotton was irrigated. Hale Center fits each of these criteria. It is a small, cohesive community where most everyone is involved in some form or fashion, in the production of cotton. Contrary to cotton production in Elliott where rain-fed cotton dominates, over 85% of all cotton harvested in Hale County in 2002 was irrigated by the Ogallala aquifer (USDA-NASS 2002).

In retrospect, it would have been useful to include an additional community in the study. Dryland cotton is the main crop of the *southern* portion of the northwest Texas cotton-growing region. In this area, unlike Elliott, cotton is the major crop and unlike Hale Center, most cotton is rain-fed instead of irrigated. The Ogallala aquifer supports cotton production in the northern part of the northwest Texas cotton-growing region but not in the south/southeast. A considerable way into the research I learned that here many farmers continue to grow conventional or non-GE cotton. Sometimes cotton farmers in the southern part of this region are referred to as low-cost or low-input cotton farmers. They are in a low rainfall area and do not have the resources to irrigate. In order to compete they must reduce input costs however possible. For the most part they do not irrigate and do not plant GE seeds which are more expensive than saved conventional seeds. While a community in this area is not included in the study, telephone interviews with seed company representatives, agricultural extension agents, researchers, and cotton farmers from the area contribute to the study.

Elliott

Most of my childhood was spent exploring the back roads, creek bottoms, and abandoned homesteads of the Elliott community. As a child I knew this place as Bugscuffle. Years later I learned why the tiny green sign south of FM 370 reads "Elliott," something I had always thought was strange. Our community was named Elliott in honor of its first school teacher but Elliott never seemed to stick as a suitable name. Elliott is official on county maps and on a sign outside of town but Bugscuffle, or Bug for short, is what most of us call home.

When I was six years old my family moved north from the black soils of the humid Texas Hill country, the only land my father had known, to a farm not far from the banks of the Red River in northeast Wilbarger County. We knew life would be different on the plains when the temperature was 108 degrees for the entire August weekend in which we moved. My grandfather was retiring so we moved north to take over the family farm where my mother grew up. My parents thought we would have a better future here since my father could farm more land. My grandparents spent their entire lives renting the home place from the Deckeraws in California. They had inherited the land and did not want to sell. My mother felt like they had hopes of finding oil. So, my parents took a chance on the move and rented the old Deckeraw place in anticipation that one day it might be theirs. We moved to Buscuffle in 1980. After ten years, the Deckeraws decided to sell the farm. Today my father is 66 and will be paying on the

Deckeraw place until his 70th birthday. He has no plans of retiring any time soon.

It took a while for our family to gain insider status, something I am not sure anyone short of an original settler ever obtains in a rural community. But throughout the years at our father's side my brother and I learned the secrets of life on the plains. We learned to fish for crawdads, filet catfish, shoot a shotgun, chop cotton, identify weeds, tend a garden, operate tractors, trucks and combines, butcher and clean chickens, make sausage, change plow sweeps, patch tires, stack hay, build fence, vaccinate animals, and most importantly, we learned how to farm by listening to the rhythms of the land. We became part of the social fabric as well. We attended a very small rural Lutheran church with people most of whom were related to us in one way or another. My parents sang in the church choir. Dad was a church elder and my mother taught Sunday school. My parents worked at the Elliott Cooperative Gin during cotton season. When my mother was on Christmas break from her full time job as a high school business teacher, she helped with accounting at the gin office. My father drove a module truck. By the time I was in high school, I felt somewhat like a local.

At 18 I had little appreciation for farming, so I left for Texas A&M University and the enticing world beyond our farm's gate. Ten years later, it was quite a surprise for everyone, myself included, when I returned home to marry a farmer from down the road. My homecoming has been full of surprises. I have always had an interest in agriculture but could not foresee it being such a large part of my life. My husband and I have talked about how we ended up here. Though a cliché, I think it is really in our blood. Not necessarily the blood that flows from parent to child (although both of our families for as many generations as we can count have been farmers) but that life-giving connection between people and place that strengthens with time, effort, and hardship. When it came time to develop a dissertation topic, I feared that an agricultural topic from home might be too provincial. My advisor encouraged me to expand upon a paper I wrote on genetically engineered cotton in his graduate seminar. So I did. Almost one decade has passed since the introduction of genetically engineered cotton. I needed to know how such an innovation was affecting my community, my home, my place.

Hale Center

In July of 2003 I set out for the Texas high plains in search of a comparative location for the study. Elliott is a very small, tight-knit community with nothing more than a cotton gin, community center, and a church. I was curious about the influence of GE cotton in larger rural communities – those with restaurants, banks, schools, and retail establishments.

Before leaving on my first exploratory trip to the high plains, I did some background research. In 2002 Hale County produced more cotton and cottonseed than any other county in Texas. It ranked 7th in the state in acres of grain sorghum planted and overall was ranked number three of 254 Texas counties in value of all crops harvested. Farmers in Elliott grow very little cotton in comparison to farmers 'out on the plains' as people in this area would say. Since water issues are growing in importance within the state, I wanted to include an area where irrigated cotton was grown. When I visited Hale County I paid special attention to Cotton Center and Hale Center—two rural communities in the south central portion of the county chosen as possible candidates for study. My trip took me across every farm-to-market and dirt road in the county. It was impossible to get lost. The topography is extremely flat and settlement is laid out in textbook, township and range fashion. The land seems to go on forever. In the summer, the natural environment provides little refuge from the heat. Trees are rare and cherished in towns and on farmsteads. I was pleased to encounter one group of workers chopping cotton. Contrary to how it might sound, they were not hoeing cotton but weeds. Finding workers chopping cotton led me to believe that at least one farmer planted conventional or non-transgenic cotton seed. Before farmers started using cottonseed genetically engineered to resist herbicide, the summer was a busy time with large crews of 'hoe hands' or 'cotton choppers' working in cotton fields from sun up to sun down. Many of the workers came from the Texas Valley to the High Plains in late May to work in the newly planted cotton fields. Some laborers would stay throughout the fall and winter to work for farmers or in local gins during the cotton harvest. I imagined how July might have looked different just ten years ago with people strewn across the cotton fields.

After lunch I took Interstate 27 south through Plainview and stumbled upon the Hale County Farm and Ranch Museum in Hale Center. I spent the whole afternoon talking with museum volunteers most of whom were at one time or another involved in agriculture. One friendship was made that has grown stronger over time. A recently widowed farmer's wife and museum volunteer became my lifeline to Hale Center. We kept in touch throughout the winter and the following summer I started my research in Hale Center.

Community history and land use[5]

Elliott is located in the northeastern portion of Wilbarger County (Pop.14,024) on the Rolling Plains of northwest Texas (Figure 3.14). Due to its location within the floodplain of the Red River, the land is fertile and ideal for farming. The land consists of rolling plains made up of sandy, and loam soils which are excellent for growing peanuts, grain, and cotton. Rainfall varies throughout the seasons but averages 25.65 inches per year. Temperatures range from an average minimum of 29° Fahrenheit (F) in January to an average

[5] Due to the unavailability of smaller scale data, county level data is used throughout this chapter. In most cases, county level data can be generally applied to both of the communities in the study. Where it is not applicable, notation is made.

maximum of 98° F in July. Dry years are detrimental for Elliott farmers who depend on rain, not irrigation from groundwater, for their crops to grow. Diversification is vital for economic survival as it allows farmers to spread their production risk across various commodities throughout the year.

Figure 3.14: Elliott case study location in Wilbarger County.

Wilbarger County was named February 1, 1858, in honor of Colonel Josiah Pugh Wilbarger who came to Texas in 1827 with Stephen F. Austin's Colony. Settlement did not begin in the county for some 20 years after Wilbarger County officially organized in 1881. The Fort Worth and Denver railroad reached Vernon, the county seat in 1886 and brought a large number of people. Due to the lack of timber on the plains, many early settlers lived in small adobe homes made of mud and straw or dugouts built into the ground.

As the western portion of Wilbarger County was being settled and farmed, modern day Elliott was owned and used as grazing lands by Dan Waggoner of the Waggoner Ranch. For this reason, it was referred to at the time as the Waggoner Colony. Dan Waggoner, a sharp cattle and business man and the brains behind the largest cattle empire in Texas, was well aware of the value of these river lands for farming. In the early 1900s when Indian Territory or modern-day Oklahoma was opened for Anglo settlement, Dan Waggoner lost his grazing rights with the Comanche in Oklahoma. In order to buy more land in which to graze his cattle, Dan sold his Waggoner Colony adjacent to Indian Territory for a hefty \$150/acre and bought three times the land near Beaver Creek. The Waggoner Colony was divided and sold to settlers at a premium. Between 1903 and 1915 over two hundred families bought land in The Colony. The first crops were good and many new settlers paid off their land debt in the first several years (Kinard 1941). Even after one hundred years of crop production, land in the Elliott community is regarded as some of the most fertile land in the county.

Presently no more than 200 people live in Elliott. Agriculture is the center of the economy where cattle supplement wheat, cotton, hay, and grain sorghum (Figures 3.15 and 3.16). The only business establishment in Elliott is the farmer-owned Elliott Producers Cooperative Gin. The gin sells seed, chemicals, oil, fuel, and miscellaneous farm necessities such as nuts, bolts, dust masks, and duct tape. The busiest time for the gin is cotton season when it operates seven days a week and up to 14 hours a day. Gin profits are distributed to members at the annual stockholders meeting held once a year at the community center. Without a doubt, the gin is the communication hub of the community. The only other establishment in the community is the old Baptist church. It is now the community center and hosts everything from wedding receptions to gin meetings, family reunions, baby showers, and even an occasional garage sale.

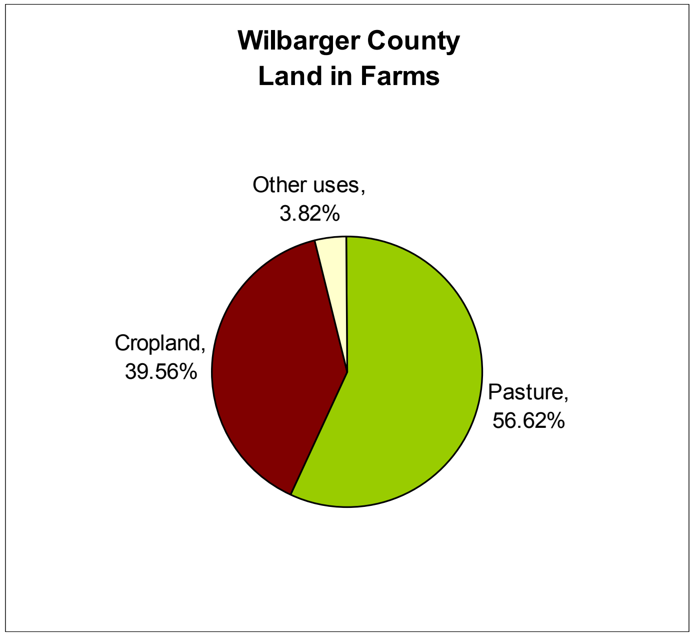


Figure 3.15: Farmland use in Wilbarger County (USDA-NASS, 2002 adjusted for presence of W.T. Waggoner Estate).

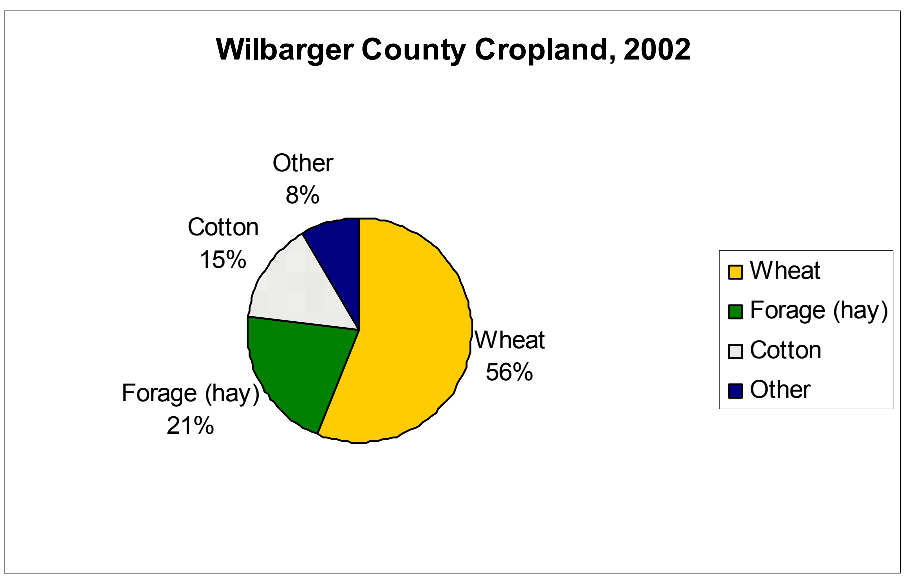


Figure 3.16: Cropland use in Wilbarger County (Data from USDA-NASS, 2002).

In contrast, Hale County is located in the southern high plains region of the Texas panhandle. It is situated atop the southern-most reach of the 174,000 square mile Ogallala aquifer at an average elevation of 3,300 feet. Hale County has a dry steppe climate with mild winters although it is common for winter blasts of arctic air to bring ice and snow on a regular basis. South winds and plenty of sunshine warm things up quickly in the spring and summer. Spring is the most common time for thunderstorms and tornados. Hale County receives an average of 19.8 inches of rainfall a year but with irrigation is a leading agricultural producer in the state. The vast majority of farmland is cropland (Figure 3.17). Corn, sorghum, soybeans, and wheat are grown in addition to cotton within Hale County (Figure 3.18). Most of these crops are fed to livestock and go directly to the concentrated animal feeding operations located within the region. In 1996, cattle finishing feedlots were a $21.8 million dollar industry in the county. The population of Hale County, including the county seat of Plainview, is 35,900. The population of Hale County has increased along with cotton acres planted within the county (Figure 3.19). With a population of 2,255, Hale Center is located in the heart of Hale County (Figure 3.20).

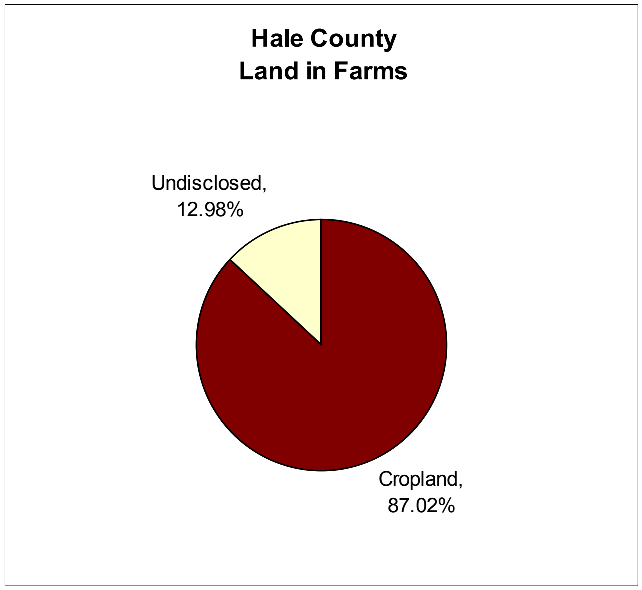


Figure 3.17: Farmland use in Hale County (Data from USDA-NASS, 2002).

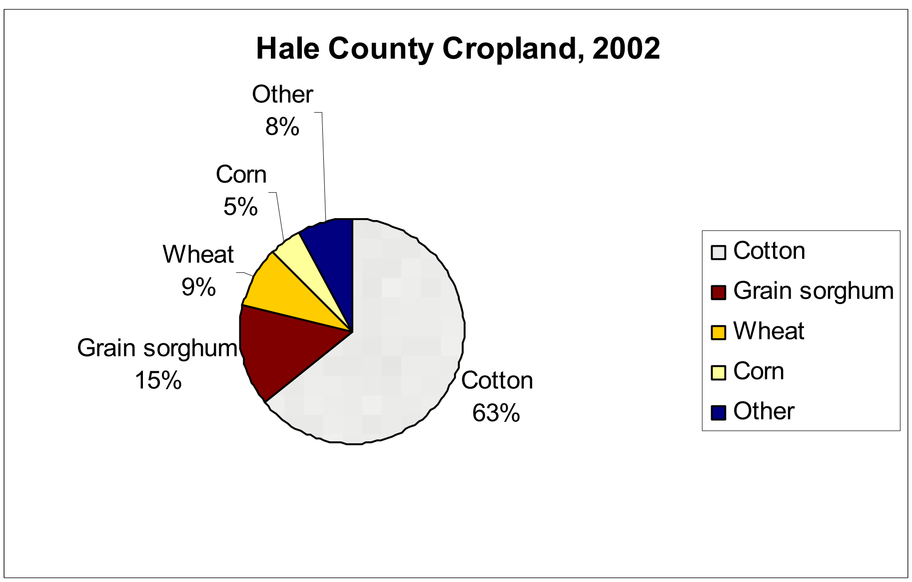


Figure 3.18: Cropland use in Hale County (Data from USDA-NASS, 2002).

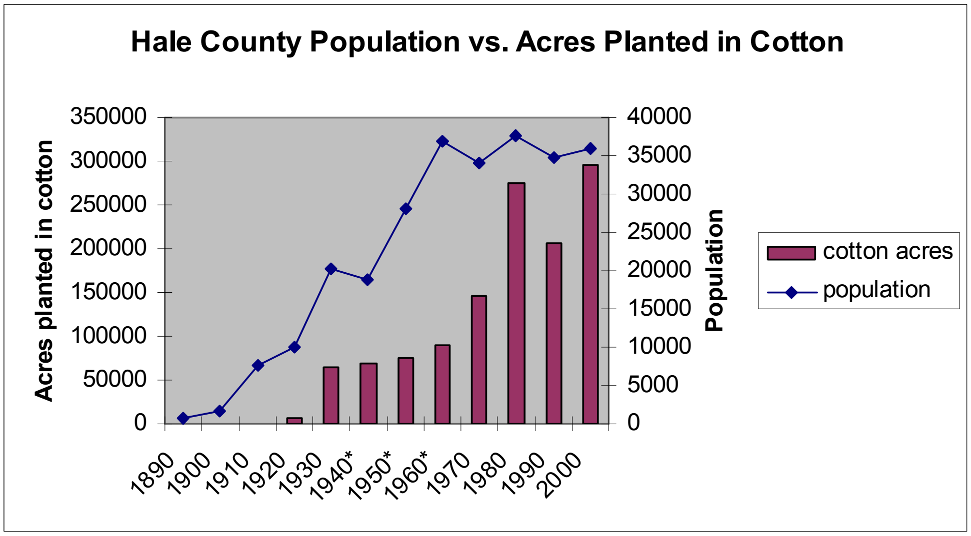


Figure 3.19: Cotton production as compared to population in Hale County, 1900-2000 (*1940, 1950, and 1960 figures are estimates from 25 county totals as published by the Plains Cotton Growers).

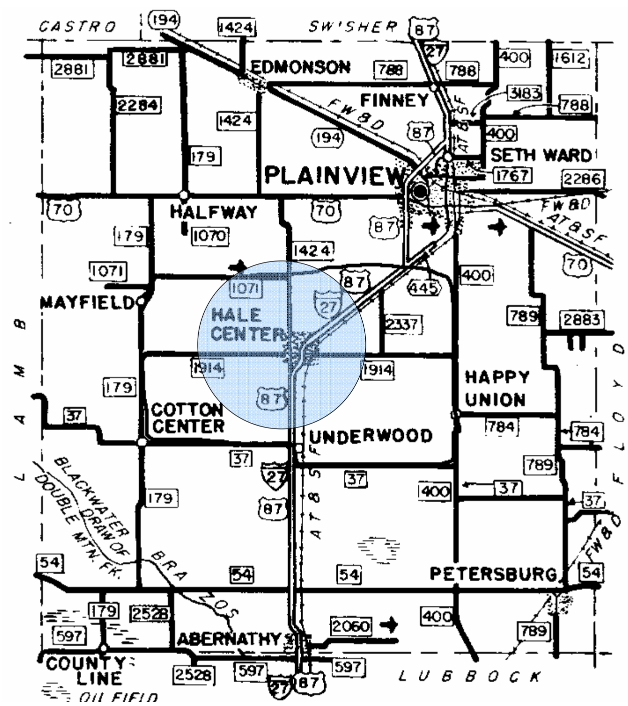


Figure 3.20: Hale Center case study location in Hale County.

Hale County is made up of 626,560 acres of treeless shortgrass prairie. The topography of the county is almost level with interspersed depressions or playa lakes which hold runoff and are critical habitats for the recharge of the Ogallala aquifer. Ninety-six percent of the county has been cultivated at one time.

Interstate 27 dissects Hale Center and has generated a substantial amount of industry in the county. Excel Beef Packers, now owned by Cargill, opened in 1971 in Plainview, the county seat. After Tyson, Cargill is the second largest beef packer in the United States. Excel employs over 2,000 people and processes up to 5,000 head of cattle a day at their Plainview facility. In 2003, over 2 million cattle were fed for finishing in Hale County feedlots. Large amounts of local grain sorghum, corn and cottonseed are sold as feed to cattle feed lots and an increasing number of dairies in the county. In 1986, Wal-Mart built a distribution center with over 1 million square feet of storage on the Interstate 27 artery. In 1990, Azteca Milling built a corn mill between Plainview and Hale Center off of I-27. Some corn for the mill is grown locally yet much of it is shipped into the area. Some farmers I interviewed reported having frustrations dealing directly with the company. Azteca employs over 150 employees. Deltapine (D&PL) also has a seed research and development center located off of the Interstate 27 corridor. Interstate 27 is critical in the transportation of raw and processed agricultural goods from one of the most agriculturally abundant Texas counties throughout the United States.

Forty-five minutes south by car of Hale Center on Interstate 27 is Lubbock, Texas, the U.S. hub of cotton industry, marketing, research, and development. Lubbock, Texas is home of Texas Tech University and the International Textile Center (ITC) world renowned for its work in cotton genetics, processing, and fiber utilization. The Lubbock Cotton Exchange is located in Lubbock and markets over 95% of Texas' cotton. The Plains Cotton Cooperative Association (PCCA) and Plains Cotton Growers (PCG) are two farmer-led cotton marketing and advocacy groups also based out of Lubbock.

Hale Center has a population of roughly 2,300 and hosts a variety of local businesses. A snapshot of commerce includes a grocery store, a convenience store, several restaurants, beauty shops and gift stores, a few banks, several insurance dealers, service stations, a couple of tire shops, and various suppliers of agricultural products and services such as fertilizer and chemical applicators, irrigation supply companies, seed dealers, and a couple of cotton gins. State Congressman Pete Laney has an office in Hale Center as does the area Boll Weevil Eradication Program and the Texas Soil and Water Conservation Board regional office. Hale Center Independent School District (ISD) is the only school in Hale Center. In 2005 it had a total enrollment of 629 students between kindergarten and 12th grade. There is one private school in the county located in Plainview. Hale Center is also serviced by numerous churches, two clinics, a pharmacy, nursing home, museum, and a public library.

For almost fifty years abundance in ground water has allowed Hale Center farmers to irrigate a variety of crops. Large volumes of grain sorghum, corn, and cotton support industries such as seed research and development, grain processing, and large dairies and cattle feedlots in the region. But what happens to agriculture and the industry it supports when and if there is no more Ogallala?

In 1997, the 75th Texas Legislature enacted Senate Bill 1 to address the future of water needs within the state. Hale County is located within Planning Area O or what has come to be known as the Llano Estacado district. The executive summary of the January 2006 Llano Estacado Regional Water Plan reports current water shortages for Hale County and states that by 2060 the county can expect to be short 222,580 acre/feet/year in available irrigation water. Under 'normal' conditions it takes 3 acre/feet/year to produce one acre of irrigated cotton. This translates into the unavailability of water resources to irrigate 74,000 acres or approximately one-third of current irrigated acres in Hale County by 2060. Many would find this report conservative at best, speculating that only 10-20 years of irrigation water is left. The report also predicts that municipal water shortages will be felt in Hale Center by 2030 accruing to 498 acre/feet/year at the current rate of use by the year 2060 (Llano Estacado Regional Water Plan, January 2006). In 2000, 79.4% of Texas ground water was used for irrigation purposes while 13.5% was reserved for municipal use (Figure 3.21). Estimates of Ogallala depletion as of 1995 can be seen in figure 3.22.

Hale County is part of the High Plains Underground Water Conservation District #1 (HPUWD). Currently serving 6.8 million acres across 15 counties, the HPUWD # 1 was formed in 1951. According to Allan White, HPUWD #1 1956 newsletter editor, “The water district was not created to do away with the rights of the individual but rather…to maintain those… rights and…provide for orderly development and wise use of our own water” (White 1956). Today the HPUWD #1 issues permits for new wells and, regulates the use of existing wells, and educates users on water conservation issues.

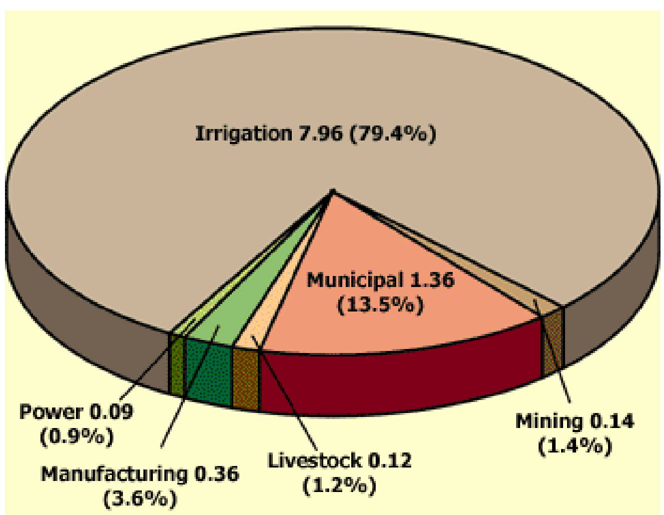


Figure 3.21: Texas groundwater use in 2000 (texasep.org, 2005).

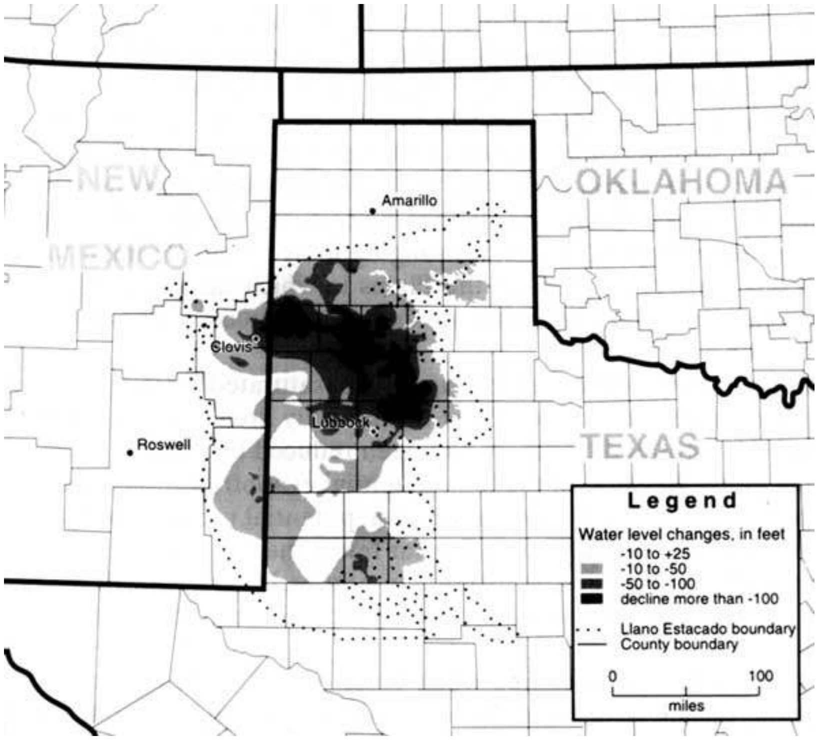


Figure 3.22: Depletion of Ogallala aquifer, 1995 (Kasperson, Kasperson, and Turner 1995).

A comparison of agriculture in Elliott and Hale Center highlights differences in land use, crops planted, and farming practices utilized. Figure 3.23 contrasts differences in agricultural statistics from the counties in which the two study communities are located. Hale Center farms are slightly larger than those in Elliott. Irrigated cotton comprises the majority of Hale Center cropland acres whereas Elliott farmers devote more land to cattle and wheat (Figure 3.24). Likewise, farmers in Hale County receive significantly more federal cotton subsidies (Figures 3.25 and 3.26).

Agricultural Statistics of Case Study Counties		
County	**Wilbarger**	**Hale**
Population	14,027	35,900
Annual rainfall (inches)	25.7	19.8
Number of farms, 2002	502	915
Average size of farm, 2002 (acres)	621[1]	661
Total land in farms, 2002 (acres)	533,742[1]	605,020
Acres irrigated	25,000	448,000
Irrigated Upland cotton planted, 2002 (acres)	0*	240,000
All wheat planted, 2003 (acres)	139,200	76,000
Irrigated wheat planted, 2003 (acres)	4,200	37,000
All sorghum planted, 2003 (acres)	8,400	117,200
Irrigated sorghum planted, 2003 (acres)	0*	101,600
All corn planted, 2003 (acres)	1,600	26,200
All cattle and calves, 2003 (head)	52,000	84,000[2]
Beef cows, 2003 (head)	26,000	7,000[2]
Cattle on feed in district, 2003 (head)	59,000[3]	2,193,000[3]

[1] This number is corrected for the presence of the Waggoner Ranch in Wilbarger County. The ranch encompassed approximately 520,000 acres over six counties and is recognized as the largest ranch under one fence in Texas. Without correction, average farm size in Wilbarger County is 1,738 acres. The average farm size in Texas in 1997 is 676 acres.

* Negligible acreage.

[2] The large difference indicates the large number of feeder cattle in Hale County.

Figure 3.23: Agricultural statistics of Hale and Wilbarger Counties (Data from USDA-NASS).

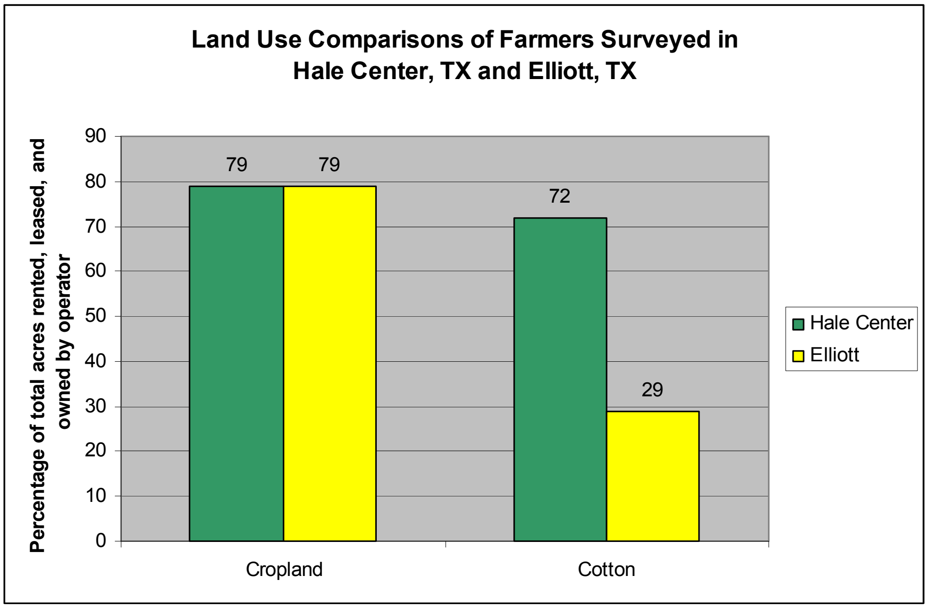
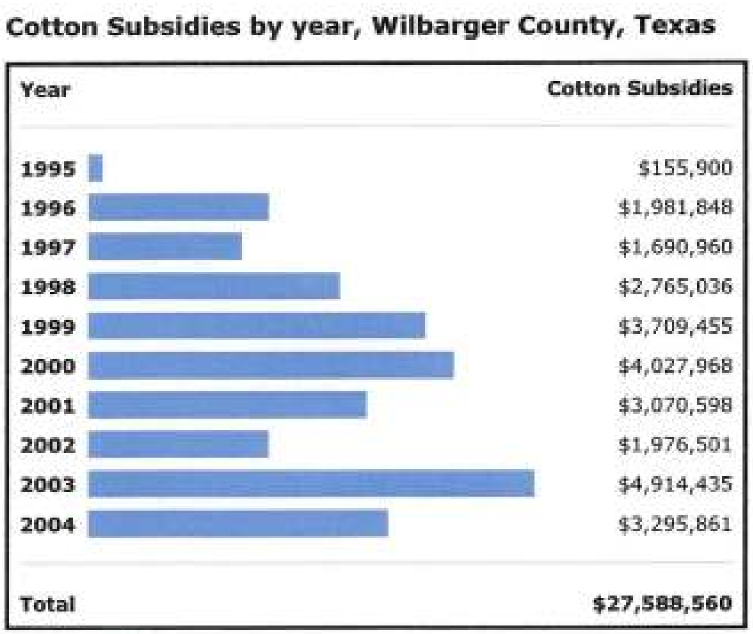


Figure 3.24: Percentage of farmland in crops and cotton.



Cotton Subsidies by year, Wilbarger County, Texas

Year	Cotton Subsidies
1995	$155,900
1996	$1,981,848
1997	$1,690,960
1998	$2,765,036
1999	$3,709,455
2000	$4,027,968
2001	$3,070,598
2002	$1,976,501
2003	$4,914,435
2004	$3,295,861
Total	$27,588,560

Figure 3.25: Cotton subsidies by year, Wilbarger County (ewg.org).

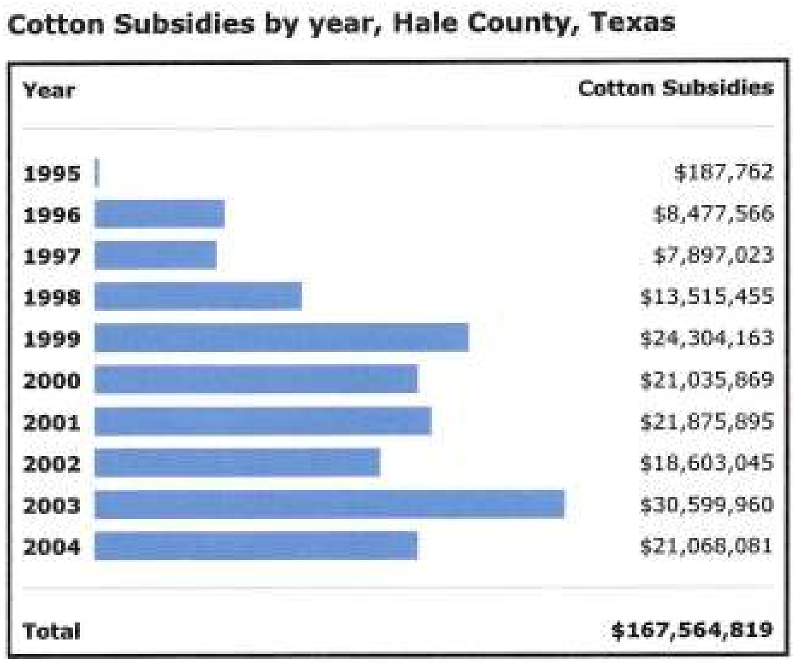


Figure 3.26: Cotton subsidies by year, Hale County (ewg.org).

Farmers in Hale Center grow more cotton and spend more money doing so than Elliott farmers who disperse risk between cattle, wheat, and cotton. While Hale Center farmers can rely on irrigation (at least in the short term) to produce a crop, rising input costs of energy, seed, equipment, and chemicals make the risks of irrigated cotton seem akin to those of dryland farming in Elliott. With pressure from world trade delegations to reduce and even eliminate farm subsidies, nothing can be certain regarding the upcoming 2007 Farm Bill. With these and many other variables looming, an examination of the consequences of genetically engineered cotton in the region to date is sorely needed.

Chapter 4

Seeds of Deception

Genetic engineering has altered farmers' relationship with the seed. For thousands of years seed selection and saving has been central to the farming way of life. Good farmers watched their crops closely to learn which seed and soil combinations produced plants with the most desirable traits. Seed from select plants were saved for their ability to prosper under certain soil and climate conditions unique to particular fields, farms, and regions. Farmers bartered with seeds, trading them with neighbors for goods and services they were unable to provide themselves. Seeds contributed to social systems of reciprocity where each farm family became an integral part of the community. Through seed saving and seed exchange rural people became linked to their land and community. The bond between people and place weakened with hybrid seeds and the expansion of the seed industry. But hybridization was merely a stepping stone to the more powerful technology of genetic engineering, patents, and the corporate ownership of seeds.

This chapter addresses how Texas cotton farmers' relationship with the seed has changed since adopting GE cottonseed. As the first of four themes discussed within Part II of this dissertation, the transformation of farmers' relationship with seed is perhaps the most fundamental and disturbing of them all.

In this chapter I detail how the corporate control of cottonseed has transformed agricultural systems in northwest Texas in three broad and interconnected ways: the almost complete elimination of seed saving, diminishing alternatives in processing, types of cottonseed, and companies from which to buy cottonseed, and creation of what I call the transgenic treadmill.

No more seed saving

The corporate takeover of cottonseed breeding has redefined rural seed saving networks, undermined farmers' time-honored relationship with the seed, and seriously threatened farming livelihoods by relinquishing local control and knowledge of the seed to multinational biotechnology and seed corporations.

Before the introduction of transgenic cottonseed many farmers saved and replanted seed based on its performance in previous years. If a farmer made a good crop, neighbors might ask permission to "catch" some of his or her seed at the gin as the cotton was being processed. According to one farmer:

> You didn't have to catch your seed [to replant] but most people did because you wanted to know what it was and where it came from and all of that. Like if Larry planted some new seed and I wanted some, I could go catch it. … You can go up there [to the gin] and catch anyone's seed as long as they didn't want it.

Seed sharing was important as it helped build networks of reciprocity within rural communities. Genetically engineered seed injures the social cohesion of rural communities in that it replaces a community-based seed system with dependence upon an external and corporate one.

Texas farmers have been more accustomed to saving cottonseed than their counterparts in old cotton belt states such as Mississippi and North Carolina. In 1997, one year after the first GE products entered the market, 39% of Prairie Gateway (Texas, Oklahoma, and Kansas) cotton farmers used homegrown or saved seed. In comparison, only 2% of farmers saved cottonseed in the Mississippi Portal states (Mississippi, Louisiana, Arkansas, and Tennessee), and 0% on the Southern Seaboard (Alabama, Georgia, South Carolina, and North Carolina) (Brooks 2001).

Texas farmers also purchased cottonseed from local seed companies. Regional breeders developed varieties adapted to area growing conditions. The need for qualities such as stormproofness (to hold the fiber tighter in the boll and protect it from strong wind and rain typical on the plains), length of growing season, fiber quality, and plant growth characteristics vary across regions. Local seed breeders, as we will see, are being replaced as large, global seed companies come to dominate the market.

False assumptions

When GE cottonseed entered the market in the mid 1990s, farmers were excited about the new management “tools” provided to them in the seed. The new cottonseed with "built in" weed and insect control seemed too good to be true. At the inception of GE seed, farmers did not worry about the higher costs of the seed. It was a small price to pay for such a marvel of a technology which initially saved them labor and insecticide expenses. Besides, biotechnology and seed companies promised to decrease their prices as soon as they regained the initial costs of developing the seed. Unfortunately, seed prices have yet to decline. And now many farmers are finding themselves stuck in a high expense system with few alternatives.

Hybrid seed laid the foundation by which farmers experienced GE seed. Hybrid seed reverts to its parentage if planted a second generation. So when GE seeds first came onto the market, farmers accepted the stipulation that they could not save or replant the seed. Many farmers experienced with hybrids understandably assumed that GE cottonseed was developed in the same manner as hybrids—by selective crossbreeding. It was clear to them that if they are not allowed to save and replant the seed, then genetically engineered cotton must be the same as hybrid grain sorghum or corn. In the words of one well-experienced cotton farmer,

> Well, I don't know if you realize this, or have been told but this is nothing new. Our plants have been genetically engineered since back in the forties…. It was straight corn or straight milo and in the 1940s they developed hybrid corn and hybrid milo. That's genetic engineering.

Uncertainty about GE seeds prevailed in my interviews. One farmer referred to them as “this special stuff” while others alluding to their mysterious origins called them “miracle seeds.” One older farmer told me that he would not have bought and planted GE seeds had he known they were created with DNA from a species other than cotton.

Other farmers, however, know well the details of genetic engineering. Several farmers I interviewed in Hale Center had taken trips to Monsanto headquarters in St. Louis, Missouri to tour their research laboratories and greenhouses. Their trips had been part of Monsanto’s customer visit program (see Appendix A). Several of the same farmers host Monsanto or Bayer tests plots on their land. These farmers are well informed innovators. They grow large amounts of cotton (>1000 acres) and are respected leaders in their communities.

Distributing discourse

Seed companies spend millions of dollars on advertising campaigns to convince farmers and consumers of the benefits of biotechnology. Their campaigns are so successful that one often finds farmers and those in agribusiness repeating ‘chunks’ of corporate discourse. Farmers are rarely exposed to information outside of the biotech paradigm. It is delivered to them weekly in the form of numerous and free farm publications and annually at “grower” meetings.

Seed dealers, gin managers, and crop consultants are the most likely to repeat 'chunks' of industry discourse, or canned phrases from advertising campaigns. They receive the most contact with seed and chemical companies and serve as industry informants in the field. When asked who they turn to for advice in cottonseed selection, the majority of farmers surveyed in Elliott replied their local seed dealer and/or gin manager. A higher percentage of cotton farmers in Hale Center employ the services of crop consultants. Crop consultants act as a resource for seed selection and scout fields for insect and weed infestations.

Some of the most common biotech phraseology includes, "over-the-top," "full season protection," "built in crop protection," and "value added traits." Monsanto has even redefined what it means for a farmer to be a "good steward." This techno-talk has two purposes. First, it is powerful in that it succinctly states the clear benefit of the technology leaving no room for the unknown. It simplifies the complicated. Secondly, techno-talk is sticky. It embeds itself into one's mind ensuring effortless iteration. Techno-talk double-dips negative connotations in virtue with the use of language. For instance, I know very few farmers who refer to the chemical Roundup as a "crop protection tool." The creation and use of such phrases help educate farmers about GE technologies without providing them with much if any substantial information on the mechanics of the technology.

Early each spring seed and chemical company representatives travel throughout the cotton growing regions of Texas to promote their new products for the upcoming cotton season. They entice farmers to meetings with free meals—usually steak. In return for their steak, farmers feel obliged to sit and listen to what representatives have to say. Presentations are usually composed of numerous power point slides illustrating the superiority of their seed in various field trials. Representatives remind farmers of the "rules" and inform them on the progress of "pipeline" products. Biotechnology companies justify current technology fees by talking up future technologies. The idea of new products, like drought-resistant cotton for instance, creates hope and makes it easier for farmers to write the check out for this year's seed bill.

What started out as an arena for marketing seed and chemicals has additionally turned into a place where farmers have the opportunity to voice their frustrations with the corporations to which they are beholden. I succinctly remember the 2005 seed meeting at the Elliott community center. Monsanto representatives announced that technology fees were going to increase but farmers were not to worry. Monsanto had generously decided to decrease the price of Roundup. Farmers were quick to catch on to the ploy. Generic glyphosate is much cheaper than Monsanto's Roundup ($12 versus $28 a gallon) so most farmers are indifferent to the price of Roundup. It has always been too expensive for them to buy anyway. Farmers saw the rise in technology fees as first, a punishment from Monsanto for not buying their name-brand chemical and secondly, an insult to their intelligence. One outspoken farmer openly expressed his disgust with Monsanto and their rising technology fees:

> You guys stood up there and told us that this tech fee would only be for the first couple of years to help cover the costs of what you put into it. Those fees have been going up ever since. We're sick of it.

Most of them, however, go for the meal and then get back to work:

> We're kind of into this deal now and when you go to the meetings and stuff, you know, it's the same ol' same ol'. You go to get the meal and then you leave. … We're all sitting there thinking they're out there working on something and yeah and that's good and we need that and stuff but they're not really telling us anything new right now, you know? So we kind of blow them off. … And when they first came out with the Roundup [Ready seeds] and first came out with the stacked [genes] that was interesting and stuff and we went to learn about that. We wanted to learn everything that we could. … I'm sure they're working on it [new technologies] and you read these things about that and stuff but it's not coming available for us yet so, it's there and you know its there but it's not to you yet, so you go eat their steak and come home. …I don't really care what they're up there saying as long as they feed me my steak so I can get back to work. I have to be honest.

Like Medieval tax collectors, corporate representatives are sent into rural areas to bolster support for biotech firms and lay straight the law of what is and is not permitted within the GE kingdom. Unfortunately time and options are running thin. Each year the number of conventional varieties available dwindles. Stipulations, rules, and regulations for GE crops increase each year in reach and complexity. If things continue at the current trajectory it will not be long before farmers have no say in what seed they plant, what it costs, or to whom they must sell their crop.

Repercussions

It is illegal for farmers to save and replant GE seed. Since 1997 Monsanto has filed over 90 lawsuits against 147 farmers and 39 small businesses/farm companies in 25 states. As of December 2004, 19 of the 90 cases against farmers are on-going. All four of the farmers charged in Texas raise cotton; three in northwest Texas (Monsanto vs. U.S. Farmers, 2005). One of the Texas farmers was ordered to pay Monsanto $1.25 million dollars and is forbidden from buying and/or planting Monsanto products (Monsanto vs. U.S. Farmers, 2005). Farmers who resist the biotech system are legally attacked. When asked how he felt about having to comply with the terms of Monsanto's technology stewardship agreement (TSA) (the contract farmers are required to sign upon purchasing GE seed) one farmer replied:

Farmer: I don't like it. … They [Monsanto] sold it [the cottonseed]. I bought it. It's mine.

Interviewer: Yeah but you can't replant it.

Farmer: No, and I'm not going to try it because I know people who have tried.

This type of tactic promotes fear and ensures that farmers obey Monsanto's terms. Many times influential or large farmers are targeted by companies such as Monsanto. They are set up as an example of what would happen to them if they attempt to save and replant patented seed.

The switch from conventional to GE seed has also caused many de-linting plants to go out of business. When seed saving was still a common practice, farmers would catch their seed from the gin and take it to a de-linting plant. De-linting plants clean fibers from the seed not removed in the ginning process and treat the seed with chemicals to protect it from insects during storage. After delinting, farmers take their seed home for storage until planting time in the spring. One Elliott farmer recalls the closure of numerous de-linting plants:

> Way back there when you go over the river here at Davidson there was a delinting plant, when I was a kid. Then we took it to Elmer, OK. Then that one closed out, well it's been 10 years now. Well I think 10 so it's probably been 15. After that we went to Stamford and I'm not even sure if they're still open. Not Stamford, but Munday. I don't know if they're still open now because we haven't caught any seed to de-lint in 5 or 6 years, which means probably 10 years according to my time. I know that's what closed that one at Elmer. Everyone went to buying this other seed [GE seed] and it kind of put those guys out of business.

I am concerned about the effects of GE seed on rural communities. When farmers saved and exchanged seed, they created and strengthened the relationships between one another. Farmers shared knowledge and germplasm across fence lines. Indian environmental activist Vandana Shiva states, "Free exchange among farmers goes beyond mere exchange of seeds; it involves exchanges of ideas and knowledge, of culture and heritage" (Shiva 2000, 8). But today's farmers work in virtual isolation from one another. Instead of depending upon one another, their dependency for seeds and knowledge has shifted to corporate entities.

Even though most farmers do not catch seed for replanting, many continue to use it for cattle feed. Cottonseed is an excellent source of protein for winter feeding. During my interviews I was told by several farmers that cows seem to prefer conventional over transgenic cottonseed. One cotton farmer commented that his cattle are not as interested in cottonseed as they have been in the past. According to Jeffery Smith (2003), founder of the Institute for Responsible Technology, animals prefer conventional or non-GE crops over transgenic ones. Smith reports that in 1998 a farmer by the name of Howard Vlieger decided to test Bt corn on his cows. He filled half the feed trough with Bt corn and the other half with conventional corn. His cows ate the conventional first and barely nibbled on the Bt corn. Iowa farmers performing the same test received identical results with their cattle and hogs. In Illinois, the same flock of geese visited a soybean field year after year. One year the farmer decided to plant half of the field with GE soybeans. "And you can see exactly where they were planted, for there is a line right down the middle of his field with the natural beans on one side and the GE beans, untouched by the geese, on the other" (Smith 2003, 45). Perhaps we should pay closer attention to the knowledge of animals?

Seed that is not caught by individual farmers is sold to oil mills, cattle feed lots and/or dairies. Cottonseed mills use each part of the seed to make a variety of products. Linters, the fuzzy part of the seed, are used to make everything from sausage casings to explosives. The husk or outside of the seed is used to make high protein cottonseed meal. The oil is extracted and purified and sold as cooking oil to food processors. Most processed foods such as chips and crackers are made with at least some cottonseed oil. Many dairies and feedlots use cottonseed and cottonseed products as a major supplement of protein.

The transition from saving to buying cottonseed was gradual. It did not begin with GE seeds but in the 1930s and 40s with the development of the seed industry and the scientific pursuit to breed higher quality and producing plants. Farmers have purchased cottonseed for many years but usually only in small amounts. They would buy some and save some. But GE seed systems complete with technology agreements, patents, and restrictions of farmer re-use have put the nail in the coffin of traditional seed saving practices. Farmers are feeling the squeeze of GE seed limitations. Those interested in returning to conventional varieties face the reality of diminishing alternatives.

Diminishing alternatives

The ubiquitous presence of GE cotton in northwest Texas makes it difficult for farmers to grow conventional cotton for several reasons. First, there is a lack of seed choice. Farmers are limited in the types of conventional cottonseed varieties available for purchase. Secondly, the consolidation of biotechnology and seed companies provides fewer local or regional seed suppliers from which to choose. The manner in which cotton is processed also complicates the practice of saving seed.

More varieties, less choice

Today's cotton farmers have more cottonseed varieties from which to choose than 50 or even 25 year ago, yet; their seed choices are exceptionally limited. How can this be? Let me explain. In Chapter Three I reported that over 1,000 cottonseed varieties existed prior to the Civil War (Wilsie 1962) but by the 1950s, 87% of all cotton planted in the United States was from only 10 varieties Westbrook (1956). In 2005, the number of cottonseed varieties available to farmers had increased to over 100 (Cotton Varieties Planted, 2005). While it appears as if contemporary cotton farmers have more selection in cottonseed varieties, they really have less. Only 27 or roughly 25% of the 100 varieties available in 2005 were conventional (non-transgenic) (Cotton Varieties Planted, 2005). Between 1996 and 2005, the total number of cottonseed varieties available remained roughly the same while the number of GE cottonseed varieties significantly increased (Figure 4.1). In other words, the number of cotton varieties containing patented traits is on the rise while conventional varieties are becoming a thing of the past.

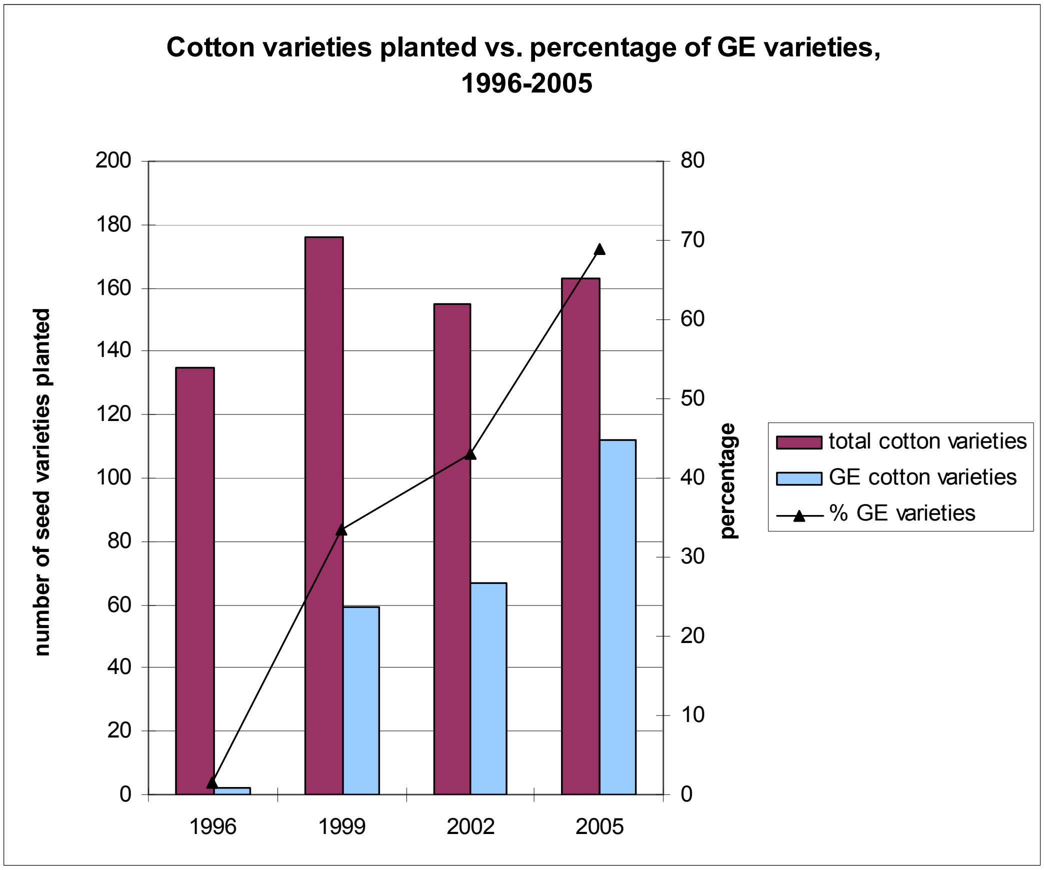


Figure 4.1: Cotton varieties planted as compared with percentage of GE varieties (Data from Agricultural Marketing Service-Cotton Division, 1996-2005).

The changing composition of cottonseed varieties included in local field trials is reflective of the lack of conventional varieties from which to choose. The Agricultural Research Service (ARS) of the USDA conducts cotton field trials throughout the southern United States under the National Cotton Variety Test

Program. Field trials in the Texas Plains region did not contain any transgenic varieties in 1996. Between 1999 and 2001, 23% of the selected seed varieties were GE. In 2002 and 2003, GE cottonseed consisted of 54% of the tested varieties. Field trials conducted at the Texas A&M Extension service by Dr. Randy Boman in Lubbock, TX indicate the same trend. In 2001, 28 of the 41 (68%) varieties examined across three locations were transgenic. In 2004, 36 of 42 or 86% of the cotton varieties tested were genetically engineered types. In spite of the large percentage of GE varieties in Boman's trials, conventional varieties continue to come out on top in terms of greatest net value per acre. In two of three test plot locations, conventional varieties were in Boman's "top tier" earners (Boman, Kelley, and Stelter, 2005).

Ironically, conventional versions of the newest, most marketed, and highest yielding varieties are rarely, if ever, available. For example, Deltapine's stacked gene 555BG/RR or "triple nickel" is one of the newest, most expensive, most marketed, and highest yielding varieties on the market. A conventional DP555 is simply not available. Seed companies put their "best genetics" in their most prized varieties—most of which are *not* conventional. The most pricey cottonseed varieties receive the most promotion since they reap the largest return for seed companies (Figure 4.2). Significant sums of money are spent to advertise new GE seeds and chemical combinations—glossy full-page ads, free hats and T-shirts, and an endless supply of promotional mailings.

Figure 4.2: Deltapine's magazine advertisement for DP 555 BG/RR (Southwest Farm Press, April 15, 2004).

Conventional seed varieties, although competitive with transgenic ones in terms of profit, are being phased out. When asked about what type of seed he plants, one Elliott farmer replied:

> Well, for the past couple of years I've been planting it [GE seed]. It's hard to get the other seed [non-GE] anymore.

Another conversation regarding seed choice went as follows:

Interviewer: When did you start growing GE cotton? Do you remember?

Farmer #1: You mean this special stuff?

Interviewer: Yeah, like Roundup Ready.

Farmer #1: Last year, wasn't it?

Farmer #2: No, about three or four years ago.

Farmer #1: Not all of it though.

Farmer #2: No, not all of it.

Farmer #1: Ok, it goes back to about 2001.

Interviewer: You did a little bit then and increased until this year?

Farmer #1: Yeah, when we had to.

Interviewer: When you had to?

Farmer #1: Well, I mean, you couldn't get no other kind could you?

Texas cotton farmers are not the only ones feeling locked into the biotech system. When interviewed by *The Farmer-Stockman*, one North Carolina farmer and cotton gin owner was concerned over the price and utility of GE seed. "After looking at costs, he toyed with the idea of going back to conventional varieties. … In the end, he found his variety choices so limited that he didn't pursue it" (January 2006, 28). Seed companies offer fewer conventional varieties each year. It is rumored that in 2006, BayerCrop Science will market only two conventional seed varieties, down from 6 in 2005 (Figure 4.3). This is surprising given the high demand for the non-GE varieties FM 958 on the Southern High Plains and FM 832 in the Texas Valley.

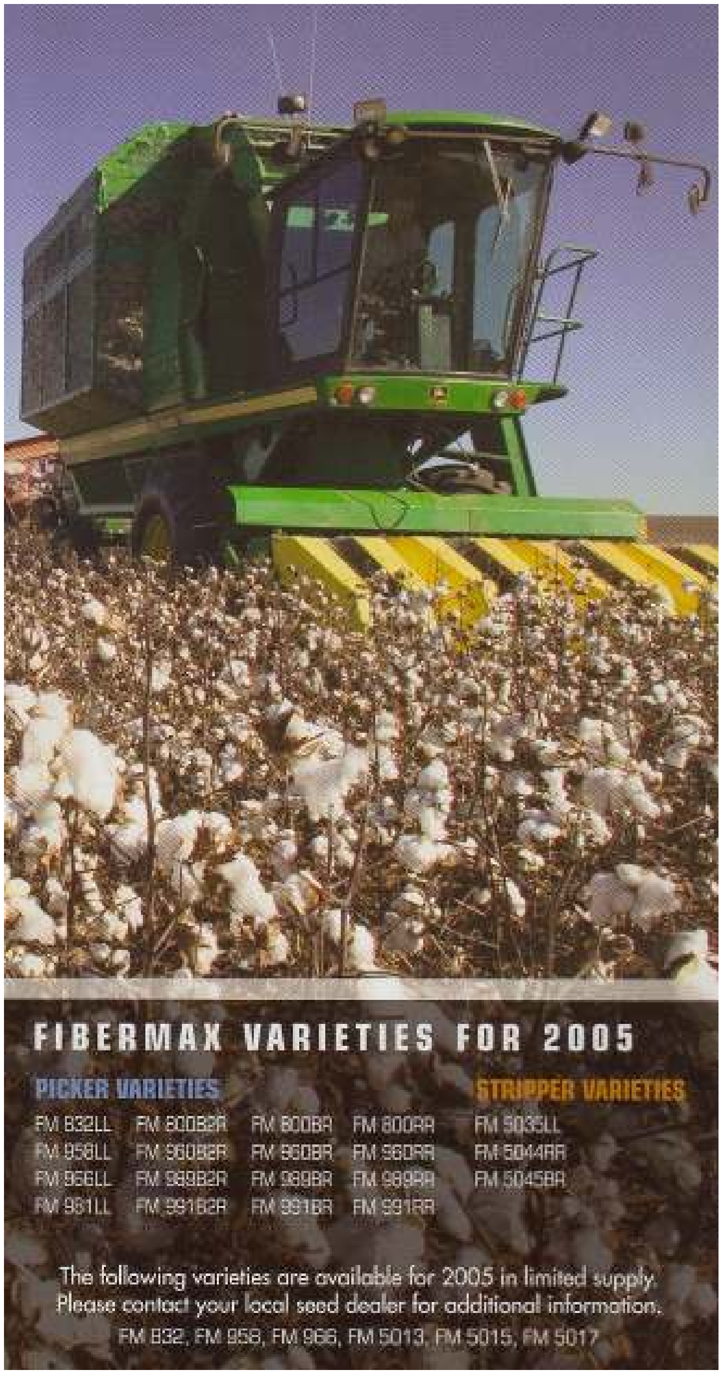


Figure 4.3: Transgenic (top) vs. conventional (bottom) Fibermax cottonseed varieties available in 2005 (2005 Fibermax Variety Guide).

Pockets of resistance

Over the last decade, biotechnology and seed companies have been diligent in their attempts to convert cotton farmers from conventional to GE seed systems. Irrigated cotton farmers, such as those in Hale Center, and farmers who devote a small percentage of their cropland to cotton, like those in Elliott, were easy converts. Irrigated farmers have more control over moisture which reduces their risk of drought and low yields. When moisture levels are controlled, high yields can be accomplished therefore justifying the higher cost of the seed. Elliott farmers, located on the periphery of true west Texas cotton country, do not irrigate but devote an average of only 15% of their cropland to cotton. By planting less cotton they mitigate their risk of a loss from the crop. They too can justify purchasing GE seed. Eighty-nine percent of the Hale Center farmers and 95% of the Elliott farmers I interviewed reported intentions of planting 100% of their cotton acres to GE seed in 2004. But for dryland farmers on the southern high plains, south of the Ogallala, GE cotton is too much of a gamble. The majority of farmers in this area save and replant conventional seed, namely Fibermax 958.

Fibermax 958 is a conventional cotton variety popular with low-input (non-irrigated) farmers in the southern high plains region. According to estimates from the Agricultural Marketing Service Cotton Program, in 2005 the conventional variety FM 958 was by far the most widely planted cottonseed variety in the state of Texas. A commanding 19.6% of Texas cotton acres were planted in FM958 in the 2005 season. Steve Verett, Executive Vice President of the cotton producer interest group Plains Cotton Growers claims, “There is no other conventional variety on the market that will yield like Fibermax 958” (personal communication, March 23, 2006). Two of the top three Texas varieties in 2005 were conventional. Both are Fibermax varieties popular for their excellent fiber quality. Cotton with better fiber quality receives a higher premium in the market. Figures 4.4 and 4.5 illustrate the top five cottonseed varieties in Texas in 2005.

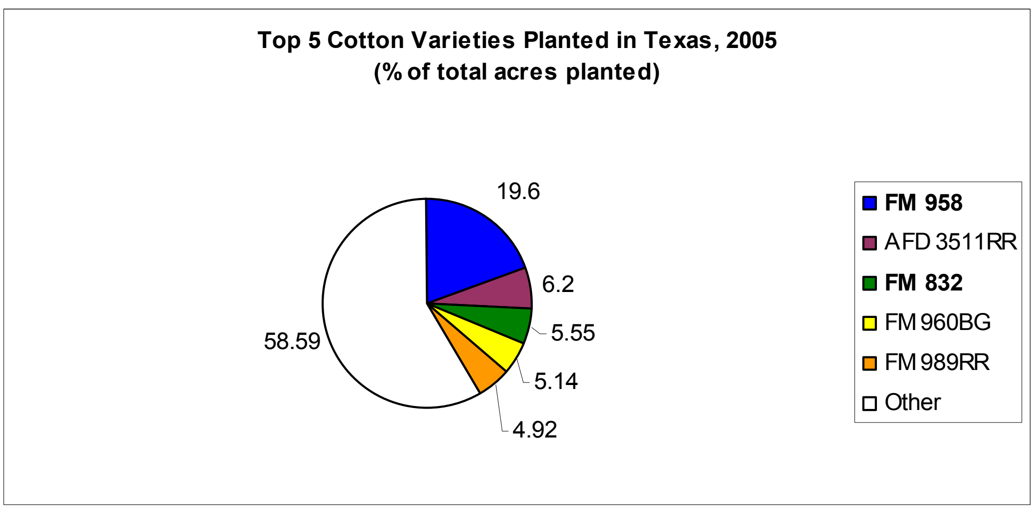


Figure 4.4: Top five cottonseed varieties planted in Texas, 2005 (Cotton Varieties Planted, 2005).

Variety	Type	Brand	GE trait/s	Type	GE trait owner	%
FM 958	conventional	BCS[1]				19.6
AFD 3511RR	transgenic	AFD[2]	RoundupReady	HT[3]	Monsanto	6.2
FM 832	conventional	BCS				5.55
FM 960BG	transgenic	BCS	Bollgard I (Bt)	IR[4]	Monsanto	5.14
FM 989RR	transgenic	BCS	RoundupReady	HT[3]	Monsanto	4.92

[1] BayerCrop Science, [2] Associated Farmers Delinting, [3] Herbicide-tolerant, [4] Insect-resistant.

Figure 4.5: Details of top five cottonseed varieties planted in Texas, 2005 (Cotton Varieties Planted, 2005).

Fibermax 958 is also available with herbicide-tolerant (HT) and insect-resistant (IR) traits but for farmers in the southern portion of northwest Texas where rainfall is scarce and groundwater irrigation is not available, GE forms of FM 958 are not cost effective (Figure 4.6). Many farmers on the southern high plains and in the Texas valley respectively save the well-liked FM 958 and FM 832 varieties to replant year after year.

Source	Variety	Description	Seed count	Seed	Tech fee	Total
Saved	FM 958	conventional	50 lb Bag	free	$0.00	$0.00
Bayer	FM 958	conventional	50 lb Bag	$77.95	$0.00	$77.95
Bayer	FM 958BG	Bollgard I (Bt)	50 lb Bag	$77.95	$34.60	$112.55
Bayer	FM 958LL	Liberty Link	50 lb Bag	$140.00	$0.00*	$140.00

* BayerCrop Science does not separate seed price from technology fee as Monsanto but charges one sum for seed containing their patented traits (LL).

Figure 4.6: Prices of Fibermax 958 varieties for 2005.

Frustrated with profit loss from farmers and gins saving and replanting popular Fibermax conventional varieties, BayerCrop Science recently announced that farmers wishing to buy certified conventional Fibermax seed (such as FM 958) must sign an agreement stating that they would not save or replant the seed. Conventional seed, unlike genetically engineered seed, is not patent protected. Amended in 1994, the 1970 Plant Variety Protection Act (PVPA) protects plant breeders' rights by stating that seed cannot be saved, sold, and/or replanted without the plant developer's permission. Section 2483 of the PVPA states,

> Every certificate of plant variety protection shall certify that the breeder has the right, during the term of the plant variety protection **[20 years],** to exclude others from selling the variety, or offering it for sale, or **reproducing it**, or importing it, or exporting it, or using it in producing a hybrid or different variety therefrom, to the extent provided by this Act. 7 U.S.C. 2483 (emphasis added).

Congress, however, granted two exemptions to the 1994 PVPA amendment. Public researchers were allowed to use protected varieties for research purposes and farmers were allowed to save protected seed to replant in their own fields (Monsanto vs. U.S. Farmers, 2005). According to the PVPA, farmers *can* save and replant conventional seed. BayerCrop Science, however, prohibits the reselling of seed not according to the PVPA but by requiring farmers to sign a contractual agreement stating that they pledge not to replant the seed. These agreements are a bit tenuous and have become highly controversial for west Texas dryland cotton farmers accustomed to cutting cost by saving their own seed. If Bayer's strategy is successful, they will increase their revenue from popular conventional varieties while limiting the control and choices of dryland cotton farmers. For instance, let us consider a farmer who has no FM 958 seed saved but would like to plant some in 2006. It is illegal according to the PVPA for the farmer to buy protected FM 958 from his neighbor. According to the provisions of the PVPA, farmers can only save seed for their own personal use. Therefore the farmer has no other choice than to buy the seed from Bayer for $78/bag. But now he is trapped. In order to buy the seed, he must sign an agreement saying that he will not replant it next year. In other words, to be lawful, the farmer can not save his conventional seed but must buy it new from Bayer each year. He must pay the price the seed company asks and can no longer plant FM 958 if the company ever decides to no longer sell the seed. He is left with no choices in a no-win situation.

Bayer has even started a campaign to convince farmers of the benefits of buying, instead of saving, conventional seed. A document on Bayer's website (last accessed March 21, 2006) entitled, 'Advantages of Using Commercial Seed,' warns farmers on the many risks of saving seed:

> Specialists again remind cotton growers this year to be conscious of the disadvantages of saving seed for next year's crop. At the top of the list of problems growers may encounter from saving seed is poor fiber quality due to genetic drift and varietal impurity. …

Fibermax varieties are grown on a large scale because of their fiber quality and profit potential. Bayer attempts to convince farmers that their saved seed is inferior to Bayer's pure, certified seed and that saving their own seed might jeopardize their yield and fiber quality:

> As good stewards, growers know the value of planting commercially sold seed. …
>
> Growers are limited in resources to ensure proper quality control when they save seed. …

In other words, only large, scientifically astute corporations are fit for proper storage of seed.

> …saving seed can be real hassle. … manufacturers make buying seed more convenient…

This argument tells farmers that they have too much to worry about to have to deal with the inconveniences of seed saving. According to Bayer, seed saving should be left to the professionals:

> Many growers may save their own seed because they feel it gives them more control. However, the risk of problems may deter cautious growers—they know they don't have much control if something goes wrong. Buying commercially sold seed comes with the backing of the company from which it was purchased.

Risk is an issue I return to in Chapter Seven. Risk alleviation programs attempt to capture otherwise unwilling markets, such as dryland farmers in northwest Texas, by lessening the economic risk of purchasing more expensive GE seed. These programs are nothing less than carrots used to lure farmers into corporate technology traps.

Corporate consolidation

Consolidation and competition in the cottonseed and chemical industries is also limiting farmers' choices in the selection of seed. In 2005, 89.2% of all U.S. cotton acreage was planted in seed from four companies: Deltapine (43.2%), Bayer CropScience Fibermax (25.3%), Monsanto/Stoneville/NexGen (13.9%), and Paymaster (6.8%). Seventeen seed companies sold cottonseed in 2005 down from 27 in 1999 (Figure 4.7). In the winter of 2005, Bayer CropScience Fibermax bought the once self-proclaimed GE-free seed outlet, Associated Farmers Delinting (AFD). Associated Farmer's Delinting was a regional cottonseed company located on the high plains of Texas in the heart of cotton country. In April of 2005 Monsanto purchased Emergent Genetics (Stoneville/NexGen) for $300 million. Accounting for 12% of American sales, Stoneville is the third largest cottonseed company in the United States (Communiqué 2005). Three companies provided over 80% of all cottonseed in the Southwest (Texas, Oklahoma, and Kansas) for the 2005 season. BayerCrop Science-Fibermax seed accounted for 53.9%, Deltapine 14.18%, and Paymaster 13.55%. Bayer CropScience Fibermax owns the patent on the Liberty Link system and developed the popular FM 958 and FM 832 varieties.

Concentration in the seed industry is reason for concern. The same companies that control germplasm are the ones "investing in nano-biotechnologies that will enable manipulation and patentable control over not just the genes but also the atom they are made of" (Mulvany 2005, 71). Control over germplasm, seeds, genes, and atoms mean control over food and subsequently life itself. "When ownership of seeds—the first link in the food chain, is tightly held by a fistful of transnational firms—the world's food supply becomes vulnerable to the whims of market maneuvers" (Communiqué 2005, 2). Consolidation in the cottonseed industry is nearly as worrisome as the concentration of control over patented genes.

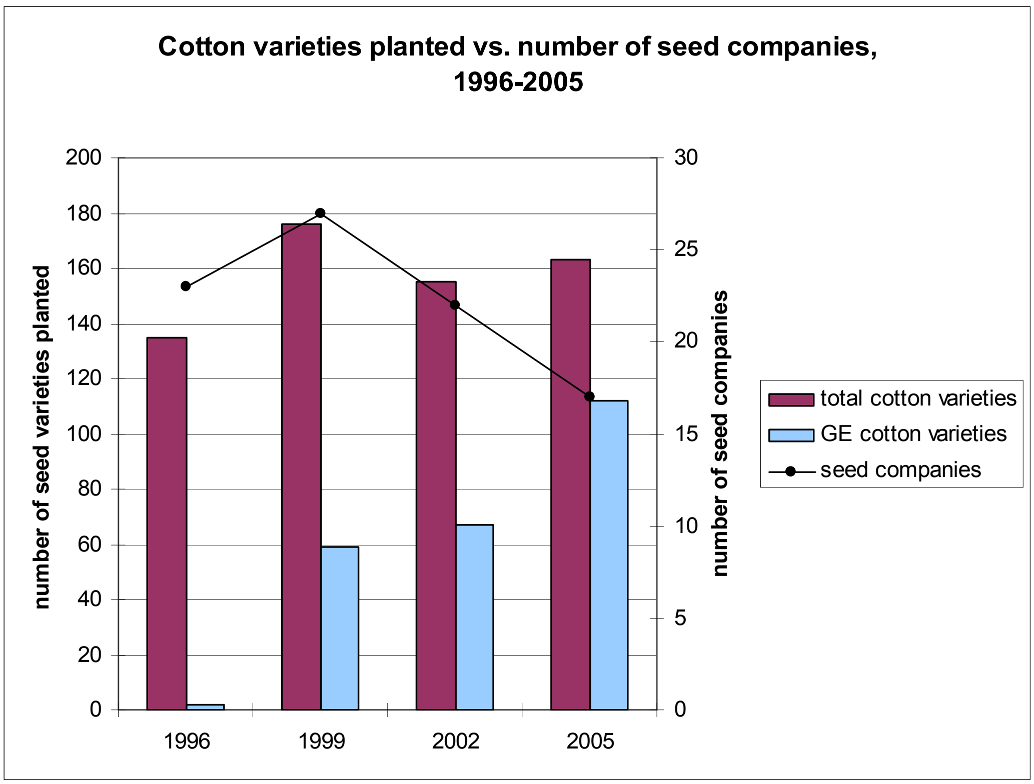


Figure 4.7: Cotton varieties planted as compared with number of seed companies (Data from Agricultural Marketing Service – Cotton Division, 1996-2005).

Monsanto is a biotechnology, seed, and chemical company based in St. Louis, Missouri. They develop and own patents on DNA sequences or traits, such as Roundup Ready and Bollgard I and II Bt technologies. Patented traits are leased by seed companies for use in their seed. In exchange, Monsanto receives a technology fee for each bag of seed sold. Through their ownership of patented traits, Monsanto controlled 63.5% of worldwide cotton plantings in 2005. Comparably, they controlled 91% of world GE soybeans and 97% of world's GE maize acreage in the same year (Communiqué 2005). Monsanto also owns seed companies such as Dekalb, Calgene, and Asgrow and produces and sells chemicals. With the 2004 purchase of Seminis, the world's largest vegetable seed business, Monsanto became the world's largest seed company. And as noted, their recent purchase of Mississipi-based Stoneville, makes them a key player in the cotton industry. Monsanto's Stoneville purchase came on the heels of failed negotiations to acquire the world's largest cottonseed provider, Deltapine and Land Company in the 1990s. Monsanto also sells pesticides and is notorious worldwide for their GE system chemical, Roundup. According to the USDA, privately owned seed companies, like Monsanto and Bayer, are sponsoring less research relative to the size of their market. As the number of seed providers decrease, so does research and the number of varieties made available (Fernandez-Cornejo and Schimmelpfennig 2004). It is troublesome that the majority of national food safety and security decisions are being made by the private sector where profit maximization, not social well-fare is the goal. "The [private biotech firms] have no motivation to fund research that holds little possibility for profits, such as research on relatively minor crops, crops grown in limited geographic areas, or crops utilized by poor people. Neither are they motivated to develop knowledge that could lead to reducing the use of expensive inputs by farmer" (Heffernan and Hendrickson 2002, 5). Only research with the potential of profitability is conducted.

The processing predicament

The way in which cotton is processed also complicates issues for those wishing to save conventional cottonseed after ginning. With the widespread use of GE cottonseed it is almost impossible for a farmer to "catch" his or her conventional cottonseed in such a way as to not have it mixed with at least some of the surrounding transgenic seed while being processed at the gin. Farmers who even unknowingly catch, delint, and plant seed that may be transgenic are doing so illegally and could be held liable for their mistake in court. Even though I am not aware of this having happened in northwest Texas, the very system works contrary to any farmer wishing to save his or her seed to grow conventional cotton. Crops such as corn and soybeans are different from cotton in that the product harvested is the seed. Farmers can selectively choose what seed they want to save in the field when harvesting. Cotton is different in that it is harvested with the cotton lint intact to the seed which must be separated at the gin.

Since cottonseed is mixed during ginning, it is logistically difficult for farmers who want to grow conventional or organic to do so without their own gin. Due to the high cost of maintaining and keeping gin equipment up to date, many gins have closed. Those that remain are located farther distances apart and are capable of processing cotton from within a larger area. Between 1900 and 1990, the number of gins operating in the United States fell by 90%, from 20,214 to 1,513 while the capacity of a typical gin has risen by a factor of 30 (Rivoli 2005). A group of organic cotton farmers on the high plains operates their own gin to process organic cotton. The Texas Organic Cotton Marketing Cooperative (TOCMC) consists of approximately 25 organic cotton farmers within a 150-mile radius of Lubbock. They successfully sell organic cotton and cottonseed to buyers around the world. According to their website, the TOCMC opposes the use of genetically engineered products and ingredients and therefore does not use GE cottonseed in their fields. The TOCMC is one example of farmers banding together to dictate their future on their own terms, not those of the biotech industry. Their situation is unique as most northwest Texas, commodity farmers find it difficult to break free from the high-yield, low-price conundrum and feel hopelessly stuck on the transgenic treadmill.

Transgenic treadmill

The most disturbing aspect of the life science industry is the confidence in which they have declared ownership of the seed—the origins of life. According to lawyer and environmental journalist, Claire Hope Cummings, "The whole point of the commercial use of the genetic engineering technology is the patents, and the social control they facilitate." She goes on to say that the reason certain crops were genetically engineered is so that "agribiochemical companies could own the seed supply and control the means and methods of food production, and profit at each link in the food chain" (Cummings 2005, 35). The loss of farmer autonomy is inversely proportionate to corporate control of our food system. As the reach of corporate control of agriculture extends across rural America, the freedom and rights of farm families diminish. A growing industrialized agricultural sector translates into fewer choices for agricultural communities and the urban consumers they serve. Once farmers are part of the corporate GE system, it is difficult for them to get out. GE seed systems are self-reinforcing. When a farmer buys and plants GE seed, he or she is permanently tied to biotechnology companies such as Monsanto or Bayer and is continuously on the transgenic treadmill. The whole system works against farmers who would like to return to conventional seed. Take for instance the following hypothetical scenario:

Farmer Brown is disgusted with the high costs of GE seed. He planted 100% of his 500 cotton acres in GE varieties between 2002 and 2004 but wants to return to conventional seed in 2005 (a realistic possibility in coming years given the drastic increases in operation costs). He has no seed saved so he must look for a conventional variety which has performed well in area field trials. There are few conventional varieties from which to choose. Only two of them were included in last year's field trials conducted by the regional agricultural research and extension service. Farmer Brown knows very little about the other three conventional varieties available and is apprehensive about having to choose one without having more information. But Farmer Brown is adamant about reducing his input costs. Most conventional varieties are older and do not compete in yield or quality with the new germplasm in GE varieties but nonetheless, Farmer Brown is committed to save and replant his seed. Farmer Brown decides on two varieties. He is worried about the risk he is taking and knows better than to put all his eggs into one basket. He chooses Fibermax 958. Even though it is rumored that Bayer will not let him save his seed, he takes the chance. It has fantastic fiber quality and yield potential and he has experience with the variety from previous years. Next he chooses AFD 2430. AFD 2430 was developed in his area and performed well in recent field trials. Unfortunately, after weeks of trying to obtain AFD seed, Farmer Brown gives up. Bayer was in the process of purchasing AFD making it difficult to buy their seed. Farmer Brown settles for

All-Tex Excess—an older, early maturing stripper variety with good stormproofness. His FM 958 seed cost $77/bag while his Excess cost him $25 per 50 pound bag—much cheaper than the stacked gene Deltapine 444RR/BG seed he planted last year at $266.55/bag. Farmer Brown was surprised to find how restricted his conventional seed choices were. The more he thinks about what the future holds, the more depressed he becomes.

The pricing pickle

The more tricks a seed has, the higher the price. When GE seeds entered the market, seed companies justified high technology fees as necessary for research and development. Farmers understood. Ten years later technology fees continue to rise. The cottonseed technology fee ranged between $40 and $125/bag in 2005. The price difference between conventional and GE cottonseed is astonishing. For the 2005 season a 50lb. bag of conventional All-Tex seed is $26 whereas DP555 BG/RR is $109.95 or $145.55/bag with Cruiser (a seed treatment) plus a $125 technology fee; a difference of $244.55/bag. Depending on seeding density and row spacing, a farmer can plant anywhere between 5 and 10 acres with one 50lb. bag of cottonseed.[6] The decision to plant transgenic cottonseed means increased inputs of over $40/acre for seed alone. That translates into $40,000 for 1,000 acres of cotton!

[6] In 2004 some seed companies started selling cottonseed by seed count instead of bag weight. One 50lb bag contains anywhere between 230,000 and 250,000 seeds.

Over 90% of farmers I surveyed agreed that GE cottonseed is overpriced. It is the technology or tech fee which brings them the most frustration. Many farmers feel as if biotech firms are being unfair and greedy with their technology fees:

> The seed costs so much and of course they've brought the cost of generic roundup down where that's not a major expense anymore like it was there for a long time. But the tech fee on this seed is just unreasonable.
>
> You know, that's just like a drug company or anything else. I think that they're entitled to the rewards but I think that they've kind of gotten out of hand on the amount that they're charging.

Few farmers have a favorable view of the integrity of biotech companies:

> Well, they're entitled to that [tech fee] because they developed it but, well, to a point. I think [Texas] A&M [University] probably developed it and they [Monsanto] stole it.

At the same time, the majority of farmers interviewed feel that it is only fair that biotechnology companies recover costs put into seed research and development:

> Well, they have a right, for so many years, to get back their investment.
>
> I can understand them wanting to get their, you know, cost back out of it. Because it takes a lot of research, a lot of time and money to get there. So, I got over it. Isn't that the way farmers are? They get mad at first then they get over it.

During one interview, a farmer showed me a long and tedious survey regarding GE seed pricing Monsanto paid him to complete. Seed companies put a great deal of research into how much farmers are willing to pay for GE seed. They charge enough to keep selling the seed but not more than what farmers could feasibly afford. If farmers cannot afford to buy seed, biotechnology and seed companies do not profit. It is in the best interest of biotech firms to set seed prices where farmers can and will buy the seed.

Most farmers are convinced that well-educated scientists are much better suited to develop and create seeds than they are. Biotechnology companies continuously reiterate their supposed expenses per hour/day/year for research and development. Farmers are taught to believe that biotech companies are wholeheartedly devoted to making farming easier and better for them. So much so that Monsanto's latest public relations campaign encourages farmers to sit back and relax as Monsanto worries about the next ten years of innovation (see Appendix B).

No going back?

For many farmers with whom I spoke, reverting to the previous seed-saving system is not an option. So although GE prices are high, farmers continue to purchase transgenic seed:

Farmer: They're charging too much for it [GE cottonseed] but I don't know what to do about it unless we go back to conventional practices like that.

Interviewer: Is that an option?

Farmer: Not for me. Maybe it is for some other people. …
I just sign them [the technology stewardship agreements] and go on. … I don't know what we can do about it. They [the GE seed prices] are just too expensive. But if you want to use their product I guess you have to do it.

Interviewer: Pay the price?

Farmer: Yeah, pay the price.

Farmers who grow GE seed pay for more than expensive seed. They are heading down a path of no return which threatens the survival of farm families and rural communities alike.

Currently, the 2007 farm bill is up in the air. The United States is being pressured by the WTO and developing countries to terminate agricultural subsidies. Eager to further access to foreign markets and to liberalize trade barriers, U.S.-based biotech companies are in a precarious position at home. Farm subsidies make it possible for farmers to invest in the latest technologies such as GE seed and chemical systems and new machinery while receiving below the cost of production prices for their crops. Without government support for American farmers, agribusinesses would suffer. Not only do large agribusiness corporations benefit from subsidy payments by way of expensive inputs but also from inexpensive outputs. American companies could not compete on a global scale if they had to pay the true costs of agricultural production in the United

States. Subsidized agriculture allows farmers to buy bags of $300 high-yielding seed whilst receiving pennies on the dollar for their commodities. Most farmers never actually finish purchasing the expensive inputs necessary for them to compete on such a large scale. They are in a continuous cycle of debt and dependency. In fact, farmers who do not keep up with technology cannot compete with their neighbors and some, as a consequence, go out of business. Agribusinesses, not farmers, benefit from this system. A recent issue of *Farm Journal* credits the political clout of farm commodity groups for escaping small across-the-board cuts in farm payments this year (January 2006). While commodity groups are indeed powerful, it is naïve to ignore the colossal influence of the agribusiness industry on farm policy. Biotech firms are just as serious about protecting their interests in the countryside as they are in Washington D.C.

This chapter has outlined how restrictions in seed availability, concentration and competition in the seed industry, and current laws regarding patents and seed use, leave farmers few options to choose from. Each season there are fewer conventional varieties from which to choose, less companies from which to buy, and more regulations dictating farmers' use of the seed. When farmers are unable to save seed, they are trapped—forced to choose from a shrinking array of dead-end options.

In today's highly competitive seed market we find that not only is it illegal for cotton farmers to save and replant GE cottonseed but now it is unlawful to save and replant certain conventional cottonseed varieties as well. Many cotton farmers are left with no choice but to purchase seed from a limited number of large multinational corporations. Biotechnology and seed companies control the availability and price of seed and dictate what farmers can do with the seed after purchase. Consolidation and concentration in the seed and agrochemical industry is extensive. According to Barker (2002, 318), "GE products are designed to create a further and more lasting dependence on the corporations that manufacture them" (Barker 2002, 318). Consolidation limits farmers' seed choice, weakens their autonomy, and increases their dependency on multinational corporations for expensive and seemingly necessary inputs.

Under current agricultural policy, the best form of short-term economic survival for commodity farmers is to increase production. Genetically engineered crops help farmers increase production not because inserted genes make GE plants higher yielding but because most germplasm used in GE varieties is not made available in conventional varieties. Farmers take out larger loans to purchase GE seed with hopes of earning more. But revenue from higher yielding GE crops rarely returns to farmers' pockets. Instead, it goes to seed companies to pay for the next year's seed. GE seeds are deceptive in that they appear to give farmers more flexibility, freedom, and choice. They appear to ease the burdens of labor in weeding and the control of insects. They appear to generate more revenue for the farmer. But GE seeds and the biotechnology and seed companies that develop them do not help farmers but rather relegate them to participation in a technology cul-de-sac.

But why should society care about hard-pressed cotton-farmers in northwest Texas? Or better yet, what is the societal value of a multitude of economically healthy and autonomous family farms scattered throughout the American landscape? First, small to mid-sized farmers are more knowledgeable of the idiosyncrasies of their land than those who manage thousands of acres. Farmers who are more familiar with their land are better able to conserve resources such as topsoil and water by farming in accordance with the rhythms of the land (Berry 1997). Secondly, more farm families translate into more people with which to support rural communities. Communities compromised of smaller and numerous family farms have more civic involvement than those supported by fewer industrial-type farms (Goldschmidt 1946). Additionally, the more freedom and autonomy farmers have in their farming businesses, the more choice consumers will have in the marketplace. The long-term costs of corporate control of the seed are far reaching. When family farms suffer, all of society suffers as a result.

Chapter 5

Toxic Treadmill

Contrary to claims made by the biotechnology industry, pesticide use in the United States has increased with the expansion of GE crops.[7] GE corn, soybeans, and cotton have led to a 122 million pound increase in total pesticide use since 1996. In cotton alone, an additional 15.7 million pounds of pesticide have been applied to American farms. Herbicide-tolerant (HT) cotton required 26.8 million pounds more herbicide than if planted in conventional varieties while insect-resistant (IR) cotton reduced insecticide use by 11 million pounds over the last decade (Benbrook 2004).

This chapter discusses HT and IR cotton in northwest Texas, the contradictions of conservation tillage, and how the development of weed and insect resistance plays into farmers' dependence upon seed and chemical corporations for new technological fixes.

Transgenic seed and pesticide use

Pesticide use in the United States has increased with the advent of GE seeds. From his analysis of USDA chemical use and crop data, Benbrook (2004) found that between 1996 and 1998 GE corn, soybean, and cotton crops reduced pesticide

[7] By pesticide I am referring to herbicide and insecticide.

use in the United States by 20.6 million pounds. However, between 1999 and 2004 pesticide use rose 143 million pounds accounting for a net increase of 122 million pounds since the adoption of GE crops in 1996 (Figure 5.1). His findings are substantiated by others, including the USDA which has shown that between pre-GE 1992 and post-GE 2002, acres of cropland treated with chemicals for weed, grass, and brush control increased over 15 million acres (U.S. Census of Agriculture 1992, 2002). Likewise, acres of cropland treated with chemicals for the control of insects went up over 3 million acres from 62.5 million acres in 1992 to 65.7 million acres in 2002 (U.S. Census of Agriculture 1992, 2002).[8] During the same time period cropland acres in the United States decreased by over 1 million acres (U.S. Census of Agriculture 1992, 2002).

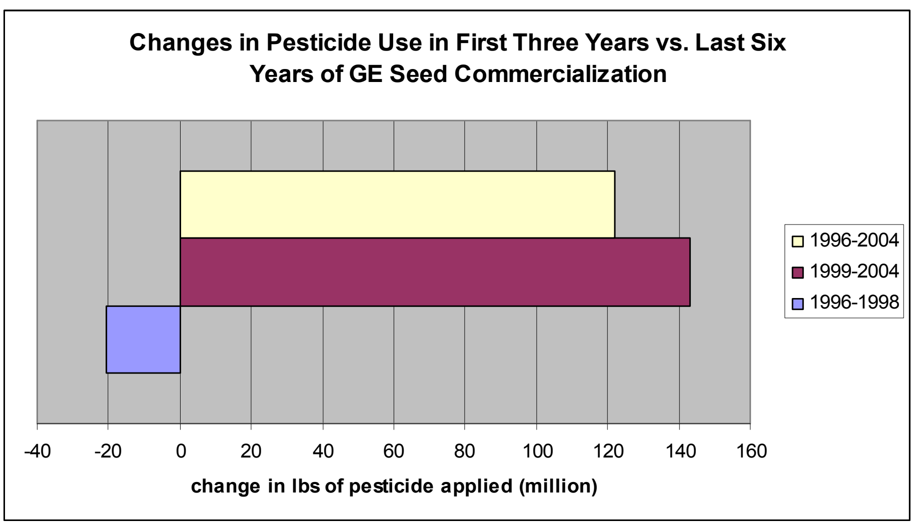


Figure 5.1: Changes in U.S. pesticide use since GE crop adoption (Data from Benbrook 2004).

[8] These estimates are for acres treated and not for volume of chemical applied.

Herbicide-tolerant (HT) cotton

Released in 1995, Bayer's BXN cotton was the first HT cotton available in the United States. BXN cotton can withstand applications of the herbicide Buctril. Buctril is expensive compared to similar chemicals and according to farmers with whom I spoke, does a poor job of controlling many of the most troublesome weed species in cotton. BXN cotton might have been the first HT crop on the market but it never gained the popularity of Monsanto's Roundup Ready HT cotton introduced a year later (Figure 5.2). BXN experienced a surge of popularity between 1998 and 2000 but reduction in the cost of glyphosate after 2000 ensured success for Roundup Ready cotton varieties over BXN. In the 1980s and 1990s many farmers used Roundup as their herbicide of choice when spot spraying cotton.

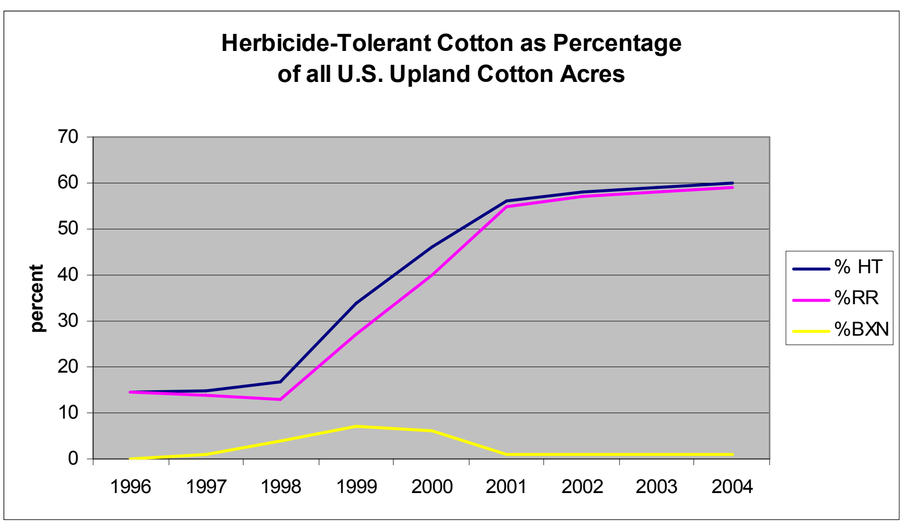


Figure 5.2: Percent of all U.S. Upland cotton in herbicide-tolerant varieties (Data from USDA-NASS and Benbrook 2004).

The quick adoption of RR cotton is due in part to farmers' familiarity with Roundup and the availability of inexpensive generic forms of the chemical after 2000.

Glyphosate [N-9(phosphonomethyl)glycine] was developed in 1974 by Monsanto. It was a popular and, at one time, very effective, non-selective herbicide used in relative moderation until the release of Roundup Ready corn, soybeans, and cotton in the late 1990s. In 2000, Monsanto's patent on the herbicide Roundup (glyphosate) expired. Competitors flooded the market with generic brands (i.e., Ratler and Glyfos). Glyphosate prices fell. As a result, sales of Roundup Ready (RR) cotton and its accompanying chemical glyphosate steadily increased (Figure 5.3). As indicated in Figure 5.3, the average amount of glyphosate applied per acre of U.S. Upland cotton increased annually since commercialization of Roundup Ready cotton in 1996. The percentage of U.S. Upland cotton acres planted in Roundup Ready varieties made a sharp increase between 1999 and 2002. Glyphosate is well-liked in relation to other herbicides despite recent studies which have shown it to be more harmful than once thought.

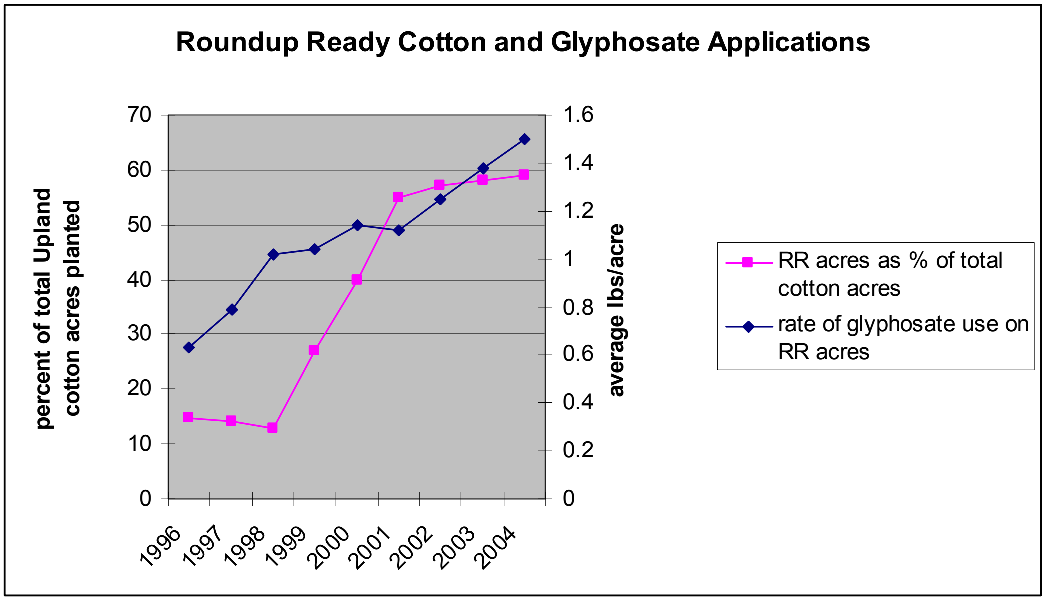


Figure 5.3: Percentage of total U.S. Upland cotton acres planted in RR varieties as compared to average glyphosate application rate per acre of RR cotton (Data from USDA-NASS and Benbrook 2004).

Glyphosate has been linked to the death of tadpoles (Relyea 2004), non-Hodgkin lymphoma (Hardell, Eriksson, and Nordstrom 2002), inhibition of steroidogenesis (Walsh *et al.* 2000) and disruption in division of human embryos (Marc *et al.* 2002). Yet, it continues to be regarded as one of the safest chemicals on the market for weed control.

Weeds are problematic in cotton fields for several reasons. First, weeds compete for a limited supply of moisture in the soil. It is very important for farmers to keep their fields "clean" because as one dryland farmer put it:

> Weeds are a major problem as far as production because we have a limited supply of moisture here.

Secondly, large weeds, such as careless weeds or tumble weeds, can pose a serious problem when it comes to harvesting as they choke up the header of the cotton harvester impeding an efficient harvest. Perhaps the largest threat of weeds in one's cotton field is how they affect a farmer's bottom line. Cotton is graded according to its quality and the price farmers receive is partly based upon the grade of their cotton. Weeds and other debris picked up during harvest lower the quality of the fiber and lower a farmer's profit. Before the availability of HT cottonseed, farmers controlled weeds with a combination of methods. Methods included pre-emergent herbicides, manual removal (hoeing), cultivation, and/or the direct application of Roundup. Farmers often designed and built equipment for direct applications practices such as spot spraying, weed wiping, and/or rope wicking themselves.

Reliance on glyphosate as the primary method of controlling weeds in cotton is problematic. Dependency on and overuse of glyphosate has caused weeds to develop higher tolerances for the chemical in some weed species, and complete resistance in others. Figure 5.4 lists biotypes or weeds with confirmed resistance to glyphosate. Six of the eight weed species have developed resistance since 2000—the same year Monsanto lost patent rights to Roundup and cheaper generic forms of the chemical became available. As result of overuse of the herbicide and subsequent developments in weed hardiness, rates of glyphosate applications have risen. In Texas they increased from an average of one application per acre in 1994 on 5% of all Upland cotton to an average of 1.3 applications per acre on over 69% of all Upland cotton in 2005 (USDA-NASS, 2005). Between 1997 and 2003 glyphosate applications on U.S. cotton acres increased by an overwhelming 753% (Bennet 2005).

Common name	Scientific name	Country	State	Year
Palmer Amaranth	*Amaranthus palmeri*	USA	Georgia	2005
Common Ragweed	*Ambrosia artemisiifolia*	USA	Arkansas	2004
			Missouri	2004
Hairy Fleabane	*Conyza bonariensis*	South Africa		2003
		Spain		2004
Horseweed	*Conyza canadensis*	USA	Delaware	2000
			Kentucky	2001
			Tennessee	2001
			Indiana	2002
			Maryland	2002
			Missouri	2002
			New Jersey	2002
			Ohio	2002
			Arkansas	2003
			Mississippi	2003
			North Carolina	2003
			Pennsylvania	2003
			California	2005
Goosegrass	*Eleusine indica*	Malaysia		1997
Italian Ryegrass	*Lolium multiflorum*	Chile		2001
		Brazil		2003
		USA	Oregon	2004
Rigid Ryegrass	*Lolium rigidum*	Australia	Victoria	1996
		Australia	New South Wales	1997
		USA	California	1998
		Australia	South Australia	2000
		South Africa		2001
Buckhorn Plantain	*Plantago lanceolata*	South Africa		2003

Figure 5.4: Biotypes with confirmed resistance to the herbicide glyphosate (Data from www.weedscience.org).

Liberty Link (LL) cottonseed was introduced in 2004 by Bayer and is resistant to the herbicide glufosinate. Trade names for glufosinate include Liberty and Ignite. Like Roundup and RR seed combinations, Bayer's Ignite "smokes weeds, not cotton." Very few of the northwest Texas cotton farmers with whom I spoke have experimented with the newly-released Liberty Link (LL) "system." The price of LL seed is comparable to RR varieties but the complementary chemical, Ignite, is too costly for most farmers to consider. Several farmers with whom I spoke used LL seed in areas where certain weeds, hard to control with glyphosate, were heaviest.

Despite increases in "over the top" herbicides such as Buctril (with BXN seed), glyphosate (with RoundupReady seed), and glufosinate (with LibertyLink seed), many farmers I interviewed continue to use pre-emergent or yellow herbicides such as Treflan or Prowl. Pre-emergent herbicides are applied to the soil to suppress new weed growth before cotton is planted. They are effective in preventing weed seed from sprouting early in the season and are relatively inexpensive in comparison to glyphosate or glufosinate. One dryland farmer gives the following rational for using pre-emergent herbicide:

> Yes, it's cheap. You can do it for 2 or 3 dollars/acre. [*Glyphosate costs 6 or 7 dollars/acre*]. You put out the yellow before and then you can usually get by with one over the top with Roundup [glyphostate]. Then you're pretty well set on weeds for the year, most of the time.

Other farmers have stopped using pre-emergents with herbicide-tolerant cotton. Those who decide against yellows often do so because they sterilize the soil. If weather prevents the establishment of a healthy stand of cotton by early summer, an alternative crop is usually planted later in the season. It is difficult to establish grain sorghum or wheat on land treated with pre-emergent herbicide.

> We are putting out Roundup instead of that [yellow herbicides] so I guess if you look at it that way then maybe we increased it [amount of herbicides used in cotton]. But Roundup doesn't add up in the soil like those yellow herbicides do.

In fact, between 1997 and 2004, yellow herbicide application on U.S. cotton acres decreased by 25% (Bennett 2005). However, to combat the development of weed resistance to glyphosate, Monsanto is now recommending that farmers use pre-emergent herbicide in *addition* to Roundup (www.weedresistancemanagement.com last accessed on March 25, 2006).

Between 1996 and 2005, Monsanto recommended glyphosate be applied to Roundup Ready cotton up until the fifth leaf stage only. At the fifth leaf stage, cotton is small and has not yet developed a canopy (Figure 5.5). In the event of early summer rain, it is common for farmers to miss the fifth leaf glyphosate application window. Farmers do not benefit from expensive Roundup Ready seed if they are not able to make an over-the-top glyphosate application before this stage. It is also difficult for farmers who grow large amounts of cotton to treat all of their cotton acres with glyphosate before the 5th leaf appears, especially during inclement weather. In the event of missing the spray window, weeds must be controlled by other methods (i.e., hooded sprayer, hoeing). Hooded sprayers have shields to protect the susceptible leaves of RR plants beyond the 5th leaf stage. Many farmers invested in hooded sprayers, priced around $10,000, in order to have more flexibility in their glyphosate applications. In the late 1990s Monsanto even paired up with the hooded sprayer manufacturer, Red Ball, to offer discounts on sprayers for customers who purchased a certain amount of Monsanto's name brand chemical, Roundup.

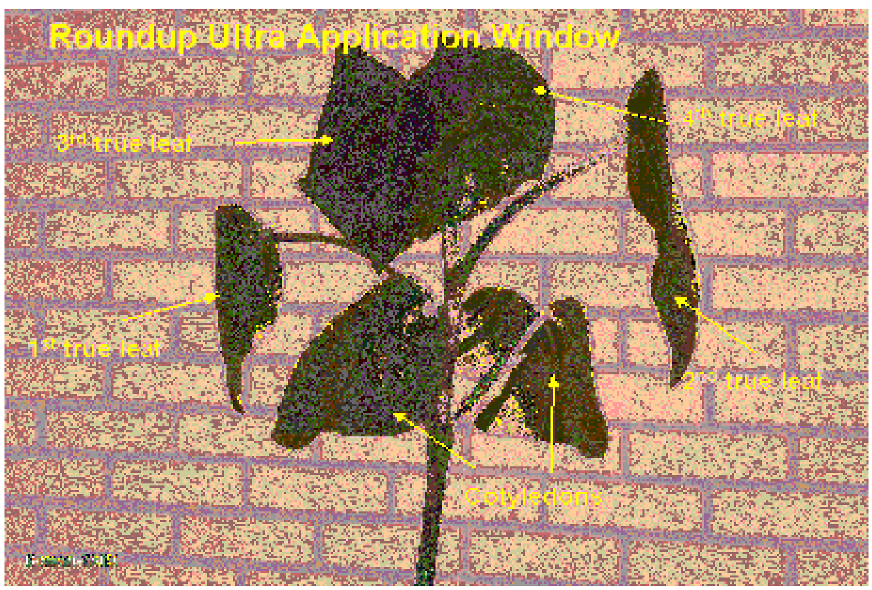


Figure 5.5: Fourth leaf stage (www.lubbock.tamu.edu/focus/Focus2002/June7/).

Currently Monsanto is working with seed companies to deliver Roundup Ready Flex (RRF) technology—cottonseed engineered to resist full-season, over-the-top glyphosate applications. Monsanto, as the Roundup Ready Flex patent holder, has agreements with eight seed companies to offer Roundup Ready Flex technology in over 30 varieties for the 2006 season (Barksdale 2005).[9] Cotton farmers are eager to try Roundup Ready Flex cotton but some agronomist and weed scientists are concerned. "Growers who delay might allow the first couple of weed flashes to emerge and compete before Roundup is applied could experience yield loss" (Barksdale 2005, BUS-15). Weed control could also suffer if spraying is delayed to accommodate "piggy-backing" or tank mixing glyphosate with insecticides and or growth regulators. And, as expected, there is a catch to the technology.

According to Monsanto, ordinary glyphosate causes leaf damage and subsequent yield loss in Roundup Ready Flex cotton. Farmers wanting to try new RRF varieties are not recommended to use any of the more economical forms of generic glyphosate as they have in the past. Instead, for best results, farmers are encouraged to use Monsanto's new and "improved" Roundup WeatherMAX and Roundup OriginalMAX "crop shield" reformulations. According to Monsanto representatives, RRF cotton is genetically different from RR cottonseed in that Monsanto added a promoter gene to the reproductive part of cotton's DNA to allow full-season over-the-top glyphosate applications. But after altering the DNA of RR cottonseed, scientist noticed that Roundup caused leaf damage to the cotton plants. "Monsanto doesn't know what caused the leaf damage" reports

[9] Deltapine, Stoneville, Bayer Fibermax, Phytogen, Beltwide Cotton Genetics, Croplan, Americot, and All-Tex.

Monsanto representative, Denver Cole, so they decided to change their Roundup formulation. After many tries and large sums of money, Monsanto developed a new and improved Roundup reformulation that does not damage RRF cotton.[10]

Regarding Monsanto's Flex glyphosate reformulation, the January 2006 issue of *Progressive Farmer* reports, "The technology to produce these formulations has been offered to other glyphosate formulators" (Barksdale 2005, BUS-15). But according to Monsanto field representatives the glyphosate reformulation technology is costly and requires a lengthy amount of time to produce. So chances are, even though other glyphosate manufactures might have been offered the reformulation, Monsanto is at least one year ahead of competitors in creating the chemical. Monsanto, having offered the formulation to other companies, appears generous while benefiting from the exclusive sale of their "cropshield" Roundup products. Monsanto's "crop shield" Roundup reformulation is also patent-pending. If they are granted the patent, those who manufacture generic glyphosate would not be able to sell the product in the future. So what does this mean for cotton farmers? Farmers who plant Roundup Ready Flex cotton in 2006 have no choice other than to purchase the more expensive Monsanto brands of Roundup over generic forms of the chemical. If Monsanto's crop-shield Roundup reformulation receives patent rights, they could recapture

[10] Monsanto reportedly spends $500 million annually on research. (www.monsanto.com last accessed March 30, 2006).

the glyphosate market lost in 2000 leaving farmers with even fewer options than before.

Insect-resistant (IR) cotton

As opposed to HT cotton, insect-resistant (IR) cotton has decreased pesticide applications for Upland cotton acres in Texas and the United States. Cotton engineered to express the bacterial toxin *Bacillus thuringiensis* has "substantially reduced insecticide use over its nine years of use resulting in a decrease of 11 million pounds of insecticide" (Benbrook 2004, Sec 35). As of 2005, two insect-resistant or Bt technology traits were available in U.S. Upland cotton varieties. The Bollgard and Bollgard II traits are both patented by Monsanto. Both are commonly referred to as Bt as they contain a soil bacteria most often utilized by organic farmers as a natural insecticide. Bollgard II was released in 2004 as insects were showing resistance to the Bt in Bollgard I cotton; a decision which is now believed to have been made in haste. Up until the recently, Monsanto has monopolized the Bt market. In 2006, however, Dow AgroSciences will release WideStrike, a similar insect-resistant technology in select varieties. VipCot by Syngenta is also nearing completion of the regulatory process and is projected to be on the market within the next several years.

In 2004, insecticide use on Bt cotton varieties amounted to an average of 0.32 lbs/acre less than insecticide applications on conventional cotton varieties

(Benbrook 2004). It is generally accepted that Bt technology, thus far, has been beneficial in terms of reducing total insecticide use in the United States. This is not to dismiss other complications of Bt technology.

Bt cotton is heralded throughout the world as a huge success. But in recent years scientists have become increasingly apprehensive about the technology. As a result of the popularity of Bt cotton, entomologists throughout the southern United States are documenting a rise in secondary pest infestations such as Lygus, thrips, stink bugs, spider mites, and fleahoppers. According to Michael Williams, a Mississippi State University entomologist, "pest status continues to change and once-minor pests are now causing major losses" (Henderson 2006, special features). Bt cotton is engineered to kill grazing bollworms, budworms and armyworms. In the first decade of Bt crops insecticide use was reduced. But today many farmers throughout the United States are finding it necessary to apply insecticides to Bt cotton to control secondary pest infestations. Ecologists are not surprised by the recent surge in secondary pests in cotton. "The adaptive capacity of nature is scarcely understood, nor do we have the capacity to begin to foresee all of the unanticipated reactions and consequences that are triggered when we significantly alter natural systems" (Kroese 2002, 26). Of all secondary insect pests, Lygus, or plant bugs, are feared the most. In 2005, Lygus species cost American cotton farmers $10.49 per acre (Henderson 2006).

Farmers who plant Bt cotton cannot be guaranteed that they will not need to spray their cotton fields with insecticide. At a recent cotton grower meeting I attended, a Monsanto representative reported, "You might have to spray if we are in a high infestation of worms." Yet, Monsanto representatives feel, "It just helps you sleep better at night with Bollgard II in the field." I am not sure if I would sleep better at night knowing I had spent $300 /bag for BII cottonseed without the assurance that the technology would prevent me from spending more money on insecticides later on in the season. Texans have been comparatively slow in adopting IR technologies. In 2005, 52% of all U.S. cotton contained Bt traits from Monsanto's Bollgard and Bollgard II products. But in 2004, Texas farmers planted only 18% of their cotton in Bt varieties (USDA-NASS 2005). A dryer climate and colder winters, prevent insects from becoming the nuisance they are in the southeast cotton region.

Insecticide use on Texas cotton has fluctuated over the last decade (Figure 5.6). The peak in usage of insecticide on Texas cotton farms in 1999 can be attributed to the Texas Boll Weevil Eradication Program (TBWEP); a democratically governed program instigated to eradicate the boll weevil. Insects are caught in pheromone traps placed throughout cotton fields to measure insect pressure. When a boll weevil presence is confirmed, host fields are sprayed with the organophosphate malathion. The bulk of eradication spraying took place in Wilbarger County between 1999 and 2001.

Hale Center farmers also participate in the TBWEP, but with less weevil pressure due to increased elevation, colder winters, and the physical barrier of the Llano Estacado caprock. Considering malathion use, insecticide use on Texas cotton farms has decreased in 2003 to less than one-quarter of what was applied in 1994 (Figure 5.7). As boll weevil numbers decreased under the TBWEP, less malathion was applied to area fields. As a result, worm pressure increased and farmers began to plant more Bt and stacked-gene cotton varieties (Figure 5.8).

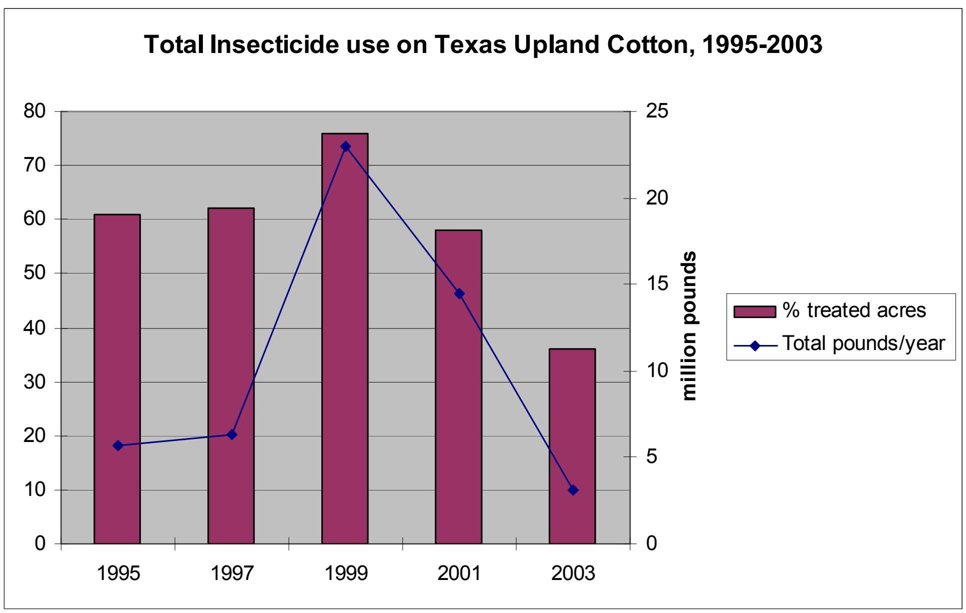


Figure 5.6: Total insecticide use on Texas Upland cotton, 1995-2003 (Data from USDA Agricultural Chemical Database).

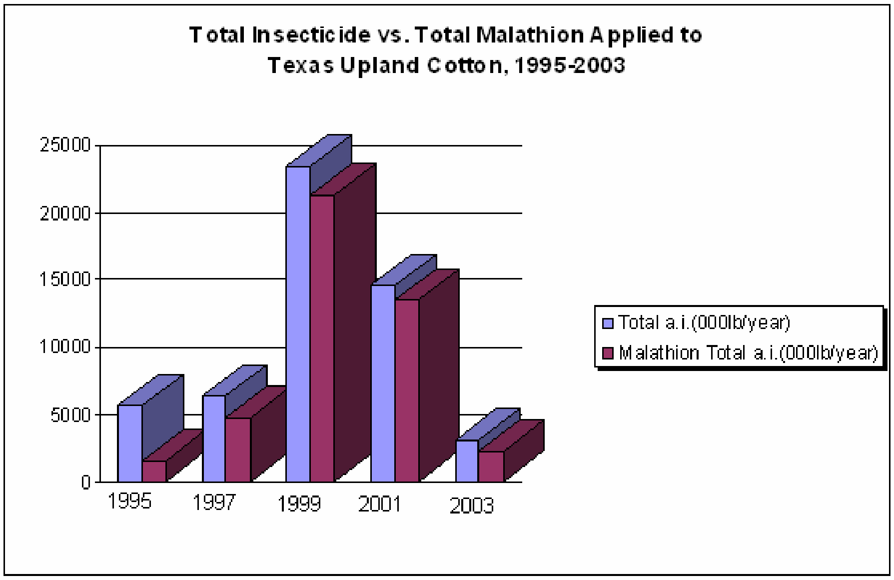


Figure 5.7: Total application of insecticide vs. total malathion applied to Texas Upland cotton (Data from USDA Agricultural Chemical Database).

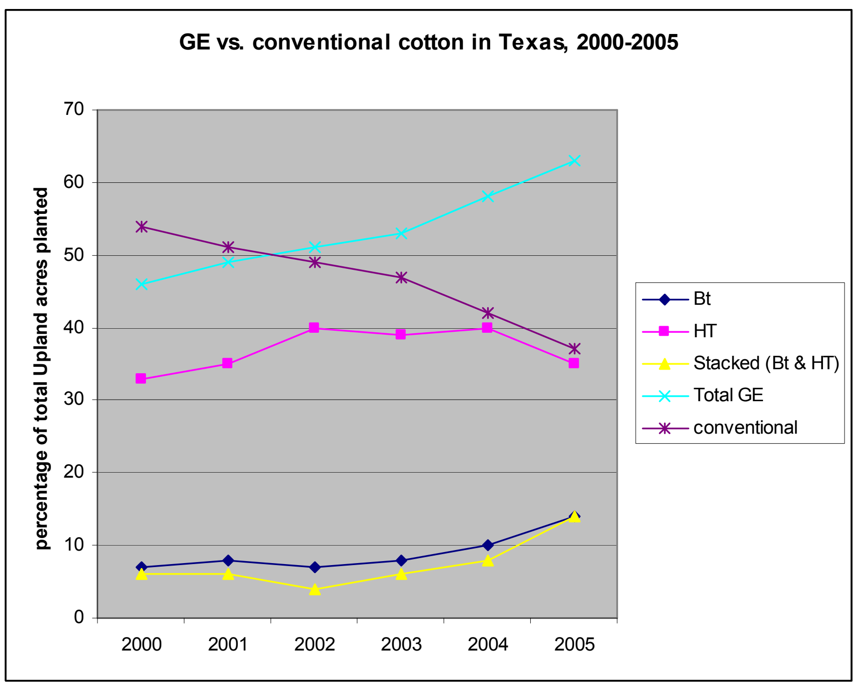


Figure 5.8: GE Upland cotton in Texas, 2000-05 (Data from USDA-NASS).

Before the Boll Weevil Eradication Program and Bt cotton, Texas farmers spent a lot of time and effort fighting insect infestations; most notably, the boll weevil. As one Elliott cotton farmer put it:

> As far as the insects are concerned, it got to be if you didn't spray a crop, you didn't make a crop in this country. Because you spray the bollweevils then when you spray the bollweevils you kill the beneficials, then the bollworm came up. It was a never-ending battle. Once you started, you had to go all the way to the end.

While Bt cotton has definitely reduced the amount of insecticide sprayed on Texas cotton acres, it is worrisome to contemplate what chemicals and GE products will be necessary to combat secondary pest infestations such as Lygus and stinkbugs, heartier worm infestations, and insect resistance to Bt cotton inevitable in the very near future.

Contradictions of conservation

The popularity of conservation tillage practices has increased with the introduction and adoption of transgenic seed. Also known as no-till, conservation tillage is an attractive form of land management for farmers who use GE seed. No-till involves leaving the soil undisturbed except during planting. Vegetation and weed control is accomplished with the use of chemical applications. Variations and other names for no-till practices include direct seeding, zero-till, slot planting, strip-till, row-till, and/or slot-till. No-till practices are complementary to GE cropping systems in that select herbicides can be applied to plants genetically engineered to resist the chemical while killing the surrounding weeds. Between 1994 and 2004, U.S. cropland in no tillage systems nearly doubled (Figure 5.9).

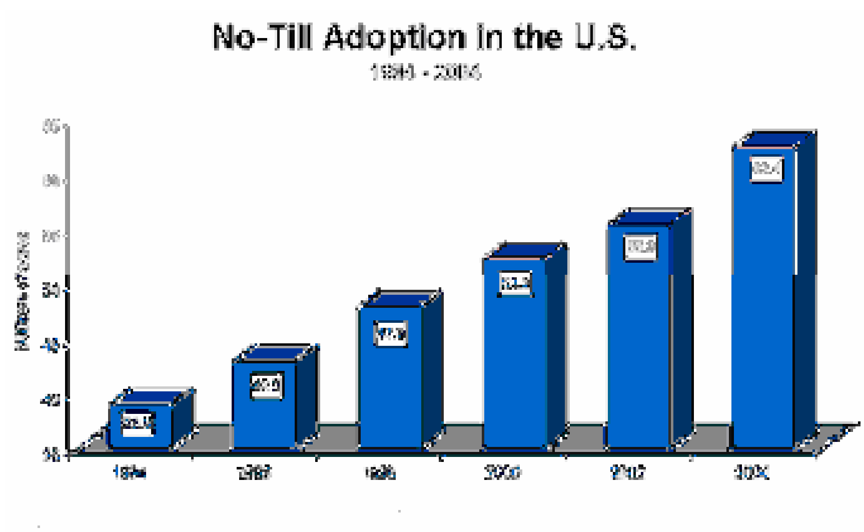


Figure 5.9: No-till adoption in the U.S., 1994-2004 (Conservation Technology Information Center 2005).

There are benefits as well as costs associated with conservation tillage farming practices. Moisture in the soil is preserved when the land is not “broken” by the plow. One farmer talked about the difference in soil compaction between soil which has been farmed conventionally and with no-till methods:

> I could go out here in these fields, well I couldn't now, and take an electric steel fence post in a row of cotton and I could take just one hand and shove it all the way to the bottom. You go out in a conventional land and you could shove it in the ground about that deep, about as deep as it's been plowed and that's about as far as you can get it into the ground.

Wind and water erosion of topsoil are greatly reduced with use of no-till groundcovers. Wind on the plains can be brutal. It does not take long for a hot south wind to sandblast a newly established cotton crop. Conventional tillage farmers must be ready at all times to "fight sand" with their tractors and rotary hoes—implements made up of large rotating spiked discs that break the surface of the soil to prevent sand atop the hardened soil pan from blowing. Sand fighting in NW Texas has always been a challenge for cotton farmers who may not have more than one rotary hoe or hired laborers available to help in multiple cotton fields. An Elliott farmer explains the benefits of no-till practices on his farm:

> The main thing [with no till] is I don't have to fight sand blowing during the spring. … When we were conventional and I was farming a lot more cotton then I am now and I didn't have an 8-row planter, still had a 4-row planter and stuff like that. And fighting sand…well Darlene plowed just like I did. She was out there on the tractor and the sand was blowing and she'd be on one place and I'd be on another place and you know and the cotton was just a year round job nearly. You know and by the time that fall got here and we started harvesting and had to take it to the gin in trailers, she'd pull the trailers and well, it was a major operation.

Labor and time spent in the field is reduced with no-till practices as farmers "go over" their land less. Fewer hours are put on farm equipment and less fuel is used since vegetation is controlled with chemical applications instead of plowing. It takes much less fuel and smaller horsepower tractors to go across a field with a spray tank of chemicals than to pull a large plow through the soil. With crude oil surpassing $70/barrel at the time of this writing, farmers unable to afford fuel with which to plow their fields are giving no-till practices serious consideration.

For farmers who manage large amounts of land, the immediate benefits of no-till out weigh the costs. Herbicides like glyphosate are much cheaper than they were even two or three years ago. Considering the high and increasing cost of fuel, it truly is more cost-effective to spray weeds with chemicals instead of plowing them. Many farmers even refer to no-till practices as chemical agriculture. Chemical companies encourage the practice and suggest that farmers use more herbicide per application on no-till land than on conventional. For example, at a recent cotton "grower" meeting at the Elliott community center, a BASF chemical company representative gave a presentation on the company's new and improved Prowl H2O pre-emergent herbicide. During his presentation he suggested that no-till farmers use 2.5-3 pints/acre of the chemical while conventional farmers should use only 2 pints/acre. In other words, BASF recommends that no-till farmers apply up to 50% more pre-emergent than farmers who plow and bed up their cotton land. In order to keep weeds under control, no-till farmers may spray their cotton fields with herbicide up to five or six times a year compared to one to three times by farmers who till the soil.

No-till farmers also invest in various types of new equipment to better suit their change in farming practices. Large tractors are often traded for smaller ones since there is less of a need for big horsepower to pull tillage equipment through the soil. Other investments might include a no-till drill and/or planter, a spray rig and maybe a hooded sprayer. Although, with the advent of Roundup Ready Flex cotton, hooded sprayers may very well become obsolete.

As conservation tillage or no-till methods grow in popularity, more farmers are experiencing problems with unwanted volunteer cotton populations. Any lint containing seed which is left in the field at harvest could sprout and grow into a new cotton plant the following season. Some farmers rotate or layout their cotton ground so cotton is only grown every two or three years while others fertilize and leave the land in cotton year after year. I have found that farmers who irrigate their cotton such as those in Hale Center are more likely to fertilize and leave the land in cotton year after year than dryland farmers in Elliott who seem to rotate cotton throughout their cropland acres. Since no-till farmers do not plow the land but spray unwanted weeds or cover crops with glyphosate (termed burndown), they often find it tricky to rid their fields of volunteer RR cotton resistant to glyphosate. Volunteer cotton can be a real nuisance explains one farmer:

> Well it comes back RR just like the first time you poured it out of the sack. That's the reason we're having so much trouble with all this volunteer cotton in the country. …. Especially on this no-till

> ground. … Like Tom's corn patch over there. It was cotton last year now there's volunteer cotton all over that corn patch and in fact I had to call my boll weevil people the other day and tell them you know, you need to put some traps out and start watching that.

Some farmers use stronger chemicals to kill the volunteer cotton while others have been forced to plow land under a no tillage system for several years. Technically, farmers with volunteer cotton problems are in violation of their Technology and Stewardship Agreement (TSA) with Monsanto for allowing second generation RR cottonseed to produce. I am unaware of any lawsuits filed against farmers battling volunteer cotton, but the legal ramifications, if implemented, are frightening.

In spite of the growing trend of no-till farming, many older farmers see no-till as alien to that which they have known all of their lives—breaking the sod. Others have tried no-till but were not convinced of its superiority to conventional tillage methods. One Elliott dryland farmer gave the following rational for not switching to no-till:

> I had a patch one year that made 60 bushel wheat. The straw was tall and the mat on the ground was…well it had a buffer of straw that deep. And I planted the cotton in there and it planted good. It was muddy when I planted and it came up and you know I looked at it and said this has got to be perfect…because you had that little old seed in there and that straw was two inches deep and your stubble was standing up there and I thought, this has got to be the way to make cotton. It made a half a bale. … It wasn't bad but you know it was one of those that should have made ¾ or a bale just if it would have been worked [plowed]. And that has made me quit doing it, to quit trying [no-till cotton].

While no-till practices are growing in popularity, Texas cotton farmers have been slow to adopt no-till practices in comparison to other cotton-growing states such as Tennessee or South Carolina. In 2003, only 15% of Texas cotton farmers used no-till methods while 83% used field cultivation in the control of weeds. In contrast, 56% of Tennessee cotton farmers and 40% in South Carolina used no-till methods in 2003 (USDA Agricultural Chemical Usage 2003 Field Crops Summary 2004). It is estimated that less than 10% of Hale Center farmers interviewed use no-till methods in cotton while a slightly higher percentage utilize no-till practices in Elliott.

In today's largely industrial agricultural system farmers can manage more land with conservation tillage practices simply because less "trips" across the land are required. As land holdings continue to consolidate, it is predicted that more acres will be farmed using HT seed and chemical systems with conservation tillage practices. Chemical use will either become more sophisticated and/or increase to control volunteer and resistant plant and weed infestations.

Adaptive resistance: Good for business

Worldwide, 305 biotypes, or weed species, have developed resistance to human-derived pesticides (www.weedscience.org). Resistance is the "inherited ability of a weed [or insect] population to survive herbicide [or insecticide] application that is normally lethal to the vast majority of individuals in that species" (Perez and

Kogan 2003, 12). Six plant biotypes have developed resistance to specific herbicides in Texas. Many Texas weeds require increased dosages of herbicide for termination, yet currently no species have been proven resistant to glyphosate. In other parts of the United States, glyphosate is ineffective in controlling horseweed, ragweed, and palmer amaranth. Mike Owen, weed scientist at Iowa State University, reports on weed resistance in *Farm Industry News* (Collins 2006, 42): "As we narrow the selective forces imposed upon a weed population to one herbicide, it's not surprising that Mother Nature will find a way to overcome it." After ten years of the exclusive use of glyphosate on RR cotton, soy, and corn, weeds have developed and continue to develop resistance to the chemical.

Resistance to Roundup has created opportunities for competing chemical companies to re-access the market lost to Roundup Ready technology and glyphosate in the mid 1990s. Today it is common to see numerous rival chemical companies aggressively promoting chemical solutions cotton farmers can mix with glyphosate to better control tolerant and resistant weeds (Figures 5.10, 5.11, and 5.12). Dupont experienced a 26% decrease staple herbicide sales between 1997 and 2003 (Bennett 2005). But today Dupont is making a comeback with Staple as they advise farmers "glyphosate-tolerant weeds make it more important than ever to add Dupont residual herbicides to your tank mix." Syngenta boasts that their Gramoxone herbicide helps farmers "manage glyphosate resistance."

Figure 5.10: DuPont advertisement #1.

Figure 5.11: DuPont advertisement #2.

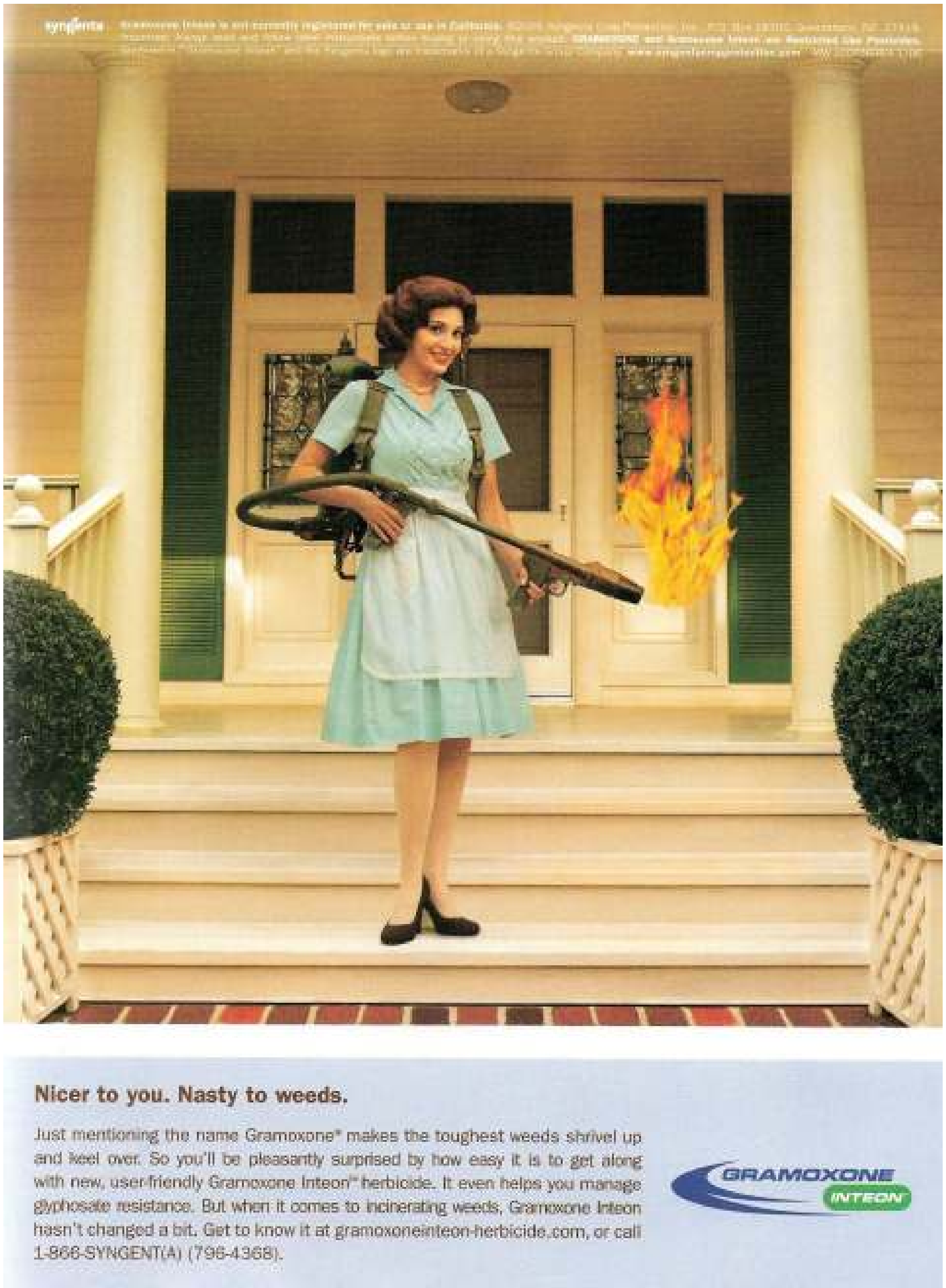


Figure 5.12: Syngenta advertisement #1.

Monsanto, as the patent owner to RR technologies in corn, soybeans, and cotton, is very concerned about the development of weed resistance to glyphosate. They should be considering “there aren’t many new herbicides coming down the pipeline” (Brooks 2006). The popularity of Roundup Ready technologies created little incentive for chemical companies to develop new chemical weed solutions. “Companies are not putting in the time, effort, and especially, the money to find new compounds” (Bennett 2005). But when glyphosate is no longer an effective form of weed control, Monsanto’s RR seeds will become useless for farmers. Monsanto is so concerned that they have launched a website with the sole purpose of educating farmers about how to prevent glyphosate resistance (www.weedresistancemanagment.com, last accessed March 29, 2006).

The key selling point of RR cotton is its convenience in chemical use. All farmers have to do is spray their cotton with Roundup to control weeds. Farmers bought RR cottonseed and used record amounts of glyphosate. But with glyphosate resistance on the horizon, Monsanto is scrambling to protect the efficacy of RR technologies, even if it means recommending chemicals and methods other than Roundup for weed control. Monsanto’s weed resistance website now recommends that farmers adhere to the following “tips” for preventing glyphosate resistance:

1. Start with clean fields and control weeds early.
2. Use Roundup Ready technology as the foundation of your weed management program.
3. **Add other herbicides and cultural practices** where appropriate as part of the Roundup Ready System.
4. Use the right herbicide rate at the right time.
5. Control weeds throughout the season and reduce the weed seed bank.

It is ironic that just ten years after the introduction of RR cotton Monsanto is recommending that farmers revert to the very herbicides and cultural practices (i.e. hoeing) they set out to replace.

Most farmers are very aware of their relationship with seed and chemical companies but find it hard to envision any other way of farming successfully. Many cut costs by purchasing generic chemicals but cannot fathom (or physically endure) going back to the pre-genetic revolution days of chopping all their cotton acres by hand. I remember asking one farmer if he felt weeds were getting harder to kill than in previous years. He responded:

> I think so. Maybe some weeds are worse than others. Russian thistle is worse than others. Careless weeds or pigweeds are showing some resistance. I don’t think it’s bad yet but I think it will continue to get worse.

Then what would you do? I asked.

> They’ll come up with a different one. And if they don’t, we’re in trouble. We’d have to go back to that old way and we don’t want to do that.

Considering the lack of conventional cottonseed varieties available, "going back" to the old ways of cultivating and removing weeds by hand might not be an option. What then does the future hold?

Weed and insect resistance is inevitable with the continued use of pesticides. Large chemical companies such as Monsanto, Dupont, BASF, and Syngenta understand that the natural environment will adapt, and over time, survive the application of novel chemical concoctions. Seed and chemical oligopolies count on the evolution of plants and insects while farmers desperately rely on a privatized science to keep them ahead of the curve. Capitalism feeds on the creation of new markets for products that society thinks it needs. Just as weed and insect control is "built in" to transgenic plants, the inevitability of environmental resistance locks one into the GE package. Technological change keeps corporations in power and farmers under their control. According to Kloppenburg and Burrows (2001, 109), "biotechnology for the foreseeable future will continue to be dominated by and respond principally to the needs of industry." Just as the mechanical cotton harvester, irrigation, and synthetic fertilizer allowed cotton production to be profitable, so too does GE seed and chemical packages. Previous technologies in cotton were different in that most of the newfound profitability from the technology returned to the farmer. But over the years, as technology advances replace the cumbersome ingredients in cotton production, returns go to the 'industry of inputs,' not farmers. They have become serfs on their own land.

In conclusion, increased glyphosate applications have made weed resistance a reality in many parts of the United States. In order to control weeds with tolerance to glyphosate, farmers either increase their rate of application or add new chemicals to their tank mixes. Chemical corporations respond to chemical resistance by developing and marketing supplementary chemical concoctions to combat the increased tolerance of weeds and insects. In other words, the environment in its struggle to fight chemical submission actually creates a perpetually evolving chemical market from which seed/chemical agribusinesses thrive. Farmers dependent upon these companies do not. They are ever more reliant on "crop protection" corporations to create new and more sophisticated chemicals to control unwanted pests inevitable in the industrial farming systems in which they are entrenched. So not only have GE cropping systems caused chemical usage to increase, but they have tightened the belt and cranked up the speed on the toxic treadmill forcing farmers into chemical solitude.

Chapter 6

Chemical Solitude

The widespread use of herbicide-tolerant (HT) cottonseed has upset the structure and vitality of rural cotton-growing communities throughout northwest Texas. Over the last ten years, HT cottonseed has transformed weed control practices from a predominantly collective, manual, and social activity to one of chemical solitude. As a result, the recently ubiquitous "hoe hand" is all but extinct (Figure 6.1). Before HT cotton, it was common to see groups of laborers hoeing weeds in cotton fields from June through early autumn. This is not true today. As previously discussed, HT cottonseed allows farmers to spray their cotton fields with the requisite herbicide to kill weeds once removed by hand. The chemical kills weeds, not cotton genetically engineered to resist the herbicide. Today most farmers no longer need hoe hands but control weeds themselves with large spray tanks and tractors or hire aerial crop sprayers to apply the chemicals from an airplane.

The change in cotton farmers' cultural practices from manual to chemical control of weeds has affected local human and ecological communities in several ways. First, HT seeds are convenient for farmers in that they significantly reduce the need for hired labor. HT cotton reduces the management duties of farmers by eliminating the need to oversee workers during busy summer months.

Figure 6.1: Hired laborers or “hoe hands” chopping weeds in a Hale County cotton field (Photo by author July 2003).

But with convenience comes consequence. Free from the constraints of weeding labor, individual farmers are able to mange more acres of cotton. In this regard, HT cotton promotes monocropping and further facilitates the consolidation of farm land. Thirdly, the transition from manual to chemical weed control has replaced a largely Hispanic and migrant labor force. As a result, small, rural communities with cotton-based economies have suffered. A smaller workforce translates into less money in the local economy. Businesses close. School systems loose enrollment and funding. Unemployment increases. Social welfare systems are strained. All the while regional industries restructure to absorb the surplus of a low-wage, low-skilled labor pool.

The convenience factor

The primary reason NW Texas cotton farmers grow HT cotton is convenience. When surveyed, the majority of farmers in both Hale Center and Elliott agreed that while HT cotton is not necessarily cheaper than hired labor, it is desirable in that it is easier, less time consuming, and requires less labor to manage. Due to its labor-saving qualities, it is useful to compare HT cotton with previous labor-saving technologies in cotton production such as the tractor and mechanical cotton harvester.

Laborious cotton

HT cotton is the latest in a long line of innovations which have reduced human labor requirements and further industrialized agricultural systems throughout the world. Historically, cotton was one of the most labor-intensive crops a farmer could grow. In the early 1900s, one acre of cotton required 133 man-hours of labor. Seemingly time and labor-intensive vegetables such as tomatoes (114 acre-man-hours) and snap beans (131 acre-man-hours) required less labor than cotton (Welch and Miley 1945). Tractors reduced cotton man-hours by 25% (Stephens 1931) and mechanical cotton harvesters by 63% (Welch and Miley 1945).

Farmers on the Texas plains adopted tractors quickly compared to smaller farms in the plantation south. Tractors replaced mules and horses and reduced the labor and time involved in cultivating, listing, planting, and plowing cotton land enabling more of the northwest Texas land to be busted and put into cotton. But tractors also tied farmers to the off-farm economy. During the Great Depression, many farmers unable to buy fuel reported leaving their tractors parked in the barn or under a shade tree.

Despite over 200 patents for mechanical cotton harvesters on file in the United States Patent Office by early 1900s, the adoption of the mechanical cotton harvester (prelude to the modern-day cotton stripper and cotton pickers) did not take place in some parts of the plantation south until as late as the 1960s. Adoption of the cotton harvester was cost effective in the Texas panhandle where labor was in short supply (especially during WWII) and the exceedingly flat topography of the region was conducive to large farms and mechanization. In fact, cotton farmers on the high plains were designing and building sled mechanisms to aid in the harvesting task as early as 1914 (Fleisig 1965). Adoption of the mechanical cotton harvester was considerably slower in the antebellum south where sharecropping systems predominated after the abolishment of slavery. Hard-pressed sharecroppers or tenants could not afford to buy mechanical cotton harvesters and under the rent system southern land owners had no incentive to purchase them. So, "rather than labor costs or technical complexity, it was the structure of the economy" which reduced the chances for widespread adoption of the cotton harvester in the plantation south (Fleisig 1965, 706).

Prior to adoption of the cotton harvester, many worried about the social and economic implications of mechanization. Following the Great Depression, the Agricultural Adjustment Administration adopted policies to inhibit mechanization and restrict farm labor displacement. Prominent Mississippi newspapers advocated the "junking" of mechanical cotton harvesters as "antisocial instruments economically detrimental to the people" (Welch and Miley 1945, 941). Many felt that the "immediate resultant economic and social dislocations and changes [of mechanization] may be painful unless off-farm employment is available" (Welch and Miley 1945, 942). Years later Peterson and Kislev (1986) argued that contrary to popular belief, the mechanized cotton harvester did not displace labor but rather replaced an already disappearing labor force pulled into higher paying off-farm jobs. Others, however, continue to purport that labor was, in fact, displaced. One effect of previous mechanization technologies is for certain. Reduction in labor requirements brought about by mechanization lowered the cost of production therefore sending cotton production into marginal areas. Increases in cotton production created surpluses which triggered the plummeting of cotton prices. To recover from low prices, farmers planted more cotton. While the mechanical cotton harvester replaced hand picking of the crop, laborers were still needed to rid the cotton fields of weeds.

Migrant immigrants have historically shouldered the burden of cotton labor in the southern high plains. The first settlers to the area were Anglo, not Hispanic. Labor shortages during WWII spurred the initiation of the Bracero Program. Instituted in 1942, the joint agreement between Mexico and the United States facilitated the movement of agricultural workers from Mexico to American fields, predominately Texas and California. It is believed that more than 5 million Mexican workers came to the United States to work between 1942 and the termination of the program in 1964 which arguably coincided with the development of the mechanical cotton harvester. Texas went from harvesting 25% of its cotton by machine in 1956 to 78% by 1962. Thousands of workers illegally remained in the United States and continued working in agricultural labor. Over the years, the ethnic composition of NW Texas was transformed as subsequent generations of braceros remained on the high plains. Chain migration from Mexico and the Rio Grande Valley supplied a constant source of labor to weeding in the cotton fields even after mechanization of the harvest.

Herbicide-tolerant cotton is different than mechanization that it does not decrease production costs. Biotechnology and seed companies have carefully priced HT containing cottonseed to be competitive with the labor costs of manual weed removal. Farmers repeatedly attribute adoption of HT technology to convenience not a reduction in the costs of production. As one farmer said, "It ain't any cheaper but it sure is easier." As opposed to mechanization of the cotton harvester, the introduction of HT technologies has not caused cotton production to move into marginal lands. In fact acres in cotton production in the United States have decreased since peaking in 1995 (Figure 6.2). Acres in cotton have also stayed relatively constant in the study community counties of Elliott and Hale Center between 1995 and 2005 (Figure 6.3). Numerous factors such as weather patterns, rock-bottom cotton prices (Figure 6.4), increasing global production in countries such as China and India, and an overall increase in yields (Figure 6.5), have caused cotton acres to remain relatively stable on the national level (Figure 6.6) all the while overall production has increased. Genetically engineered seeds have contributed to an increase in U.S. cotton yields (from selective pairing of traits and germplasm as discussed in Chapter Four) (Figure 6.5), but as yields increase, the price farmers receive for their cotton decreases (Figure 6.4).

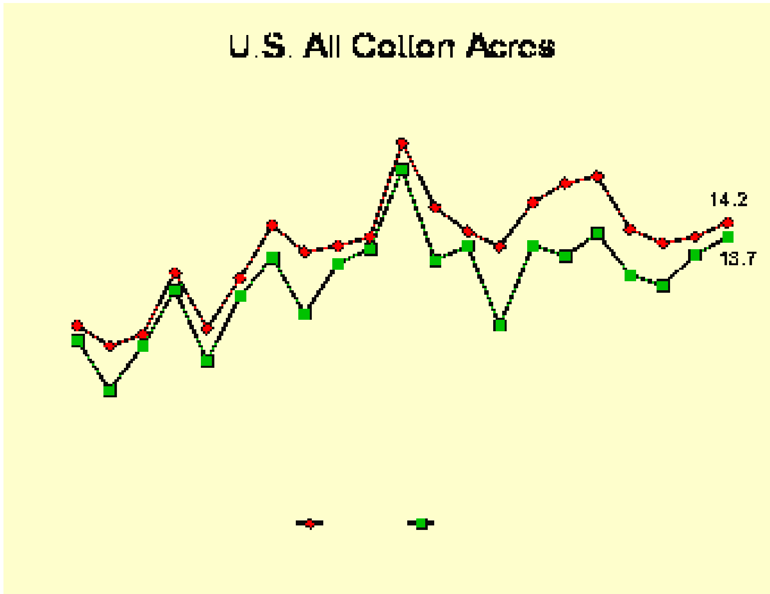


Figure 6.2: Change in U.S, cotton acres, 1985-2005.

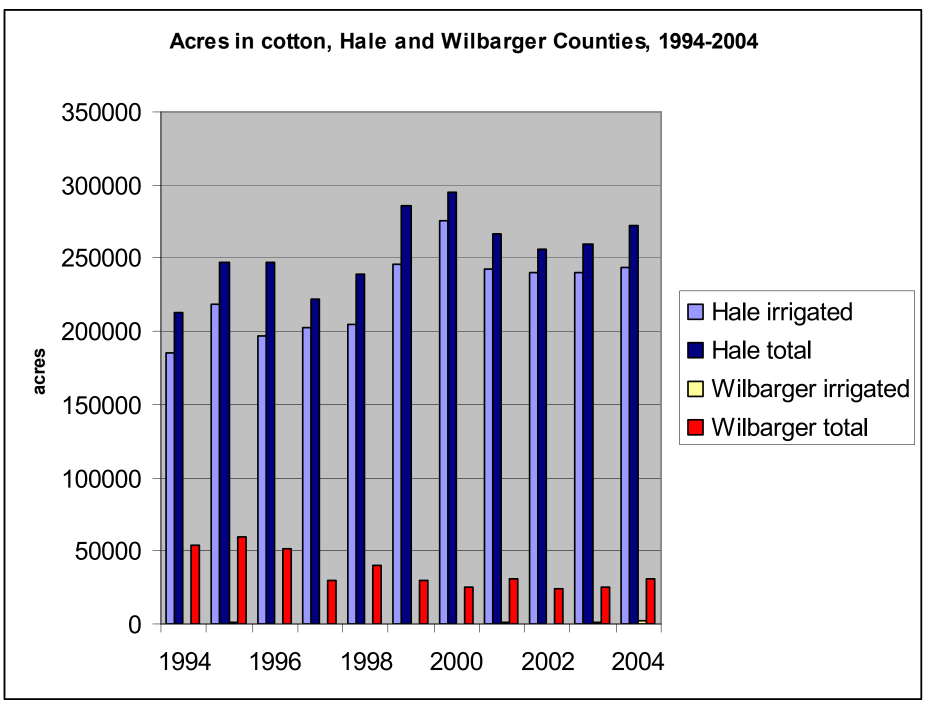


Figure 6.3: Acres in cotton, Hale and Wilbarger Counties, 1994-2004 (USDA-NASS).

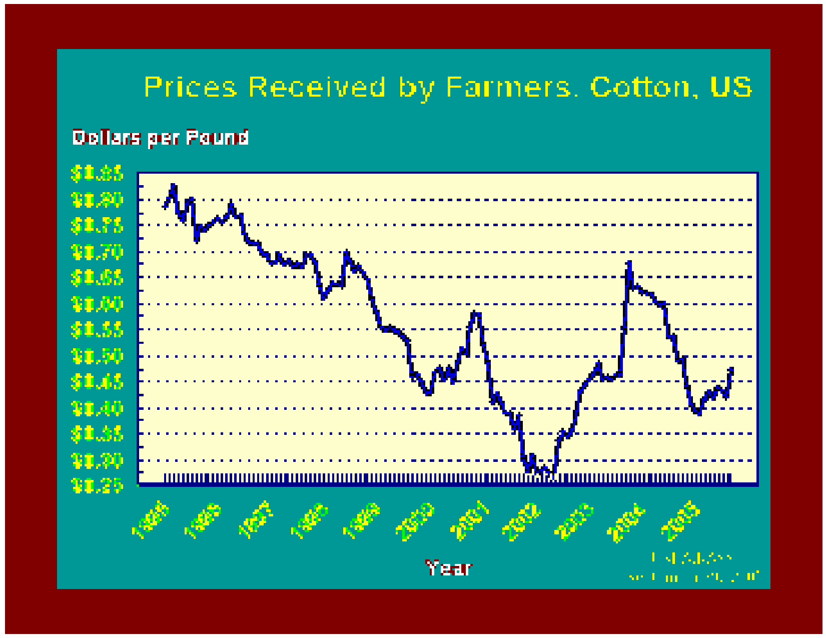


Figure 6.4: Decrease in cotton prices received by U.S. farmers, 1995-2005.

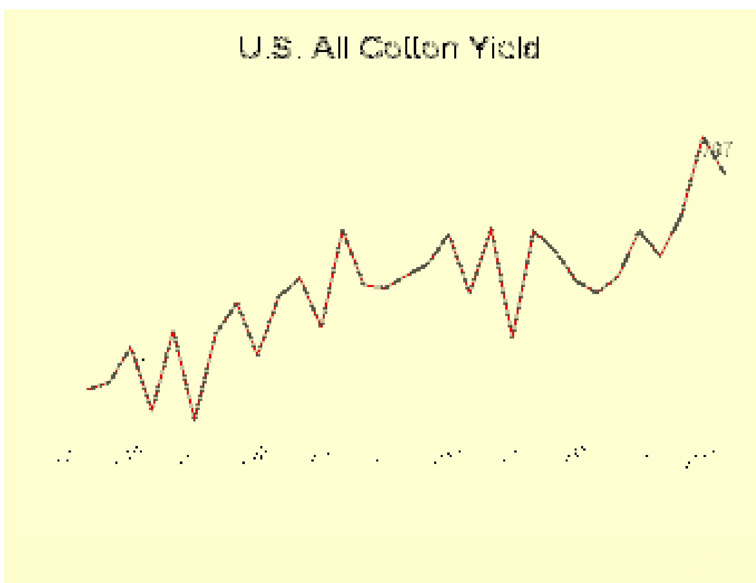


Figure 6.5: Increase in U.S. cotton yield, 1975-2005.

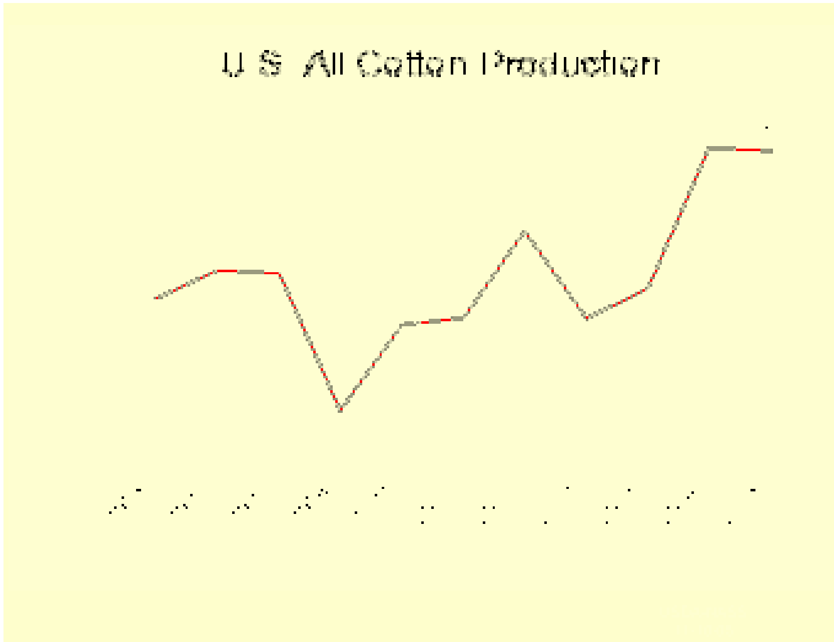


Figure 6.6: Increase in U.S. cotton production, 1995-2005.

More cotton, fewer farmers

Genetically engineered cotton has contributed to fewer northwest Texas cotton farmers who devote more acres to cotton. Since 1987, the number of farms in Hale and Wilbarger counties producing cotton has decreased while average acres per farm devoted to cotton have increased (Figures 6.7 and 6.8). In the study area, it is clear that GE cotton contributes to larger cotton farms or monocultures, and land consolidation trends. Labor-saving and yield-enhancing technologies such as synthetic fertilizers, pesticides, and mechanization helped create a less diverse agricultural system in the United States. Fewer farmers have been farming more land with less diversity since the 1950s.

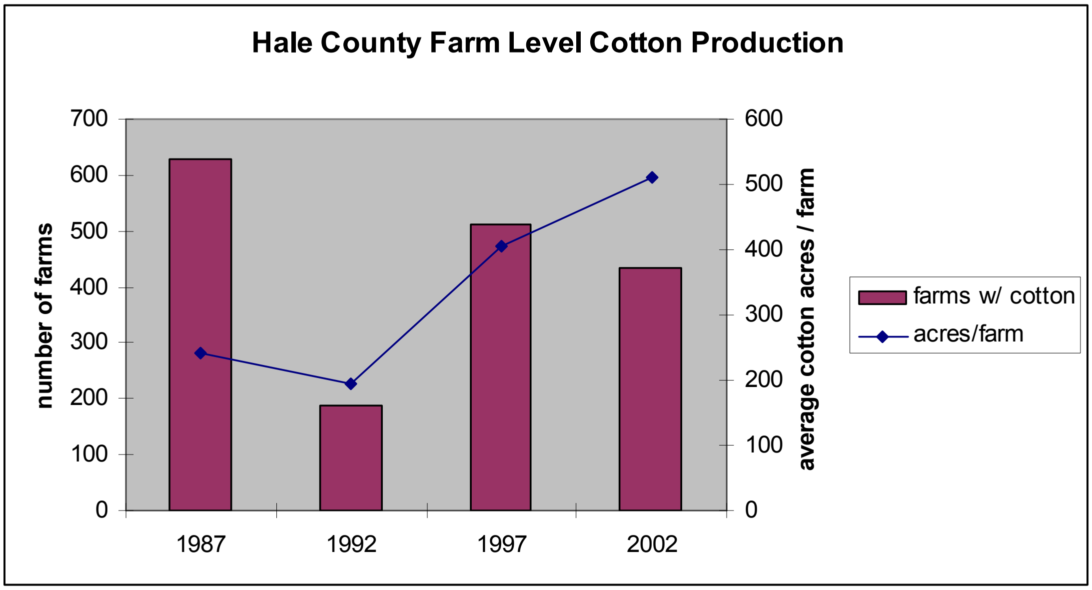


Figure 6.7: Change in number of farms growing cotton vs. acres per farm in cotton for Hale County, 1987-2002 (USDA-NASS).

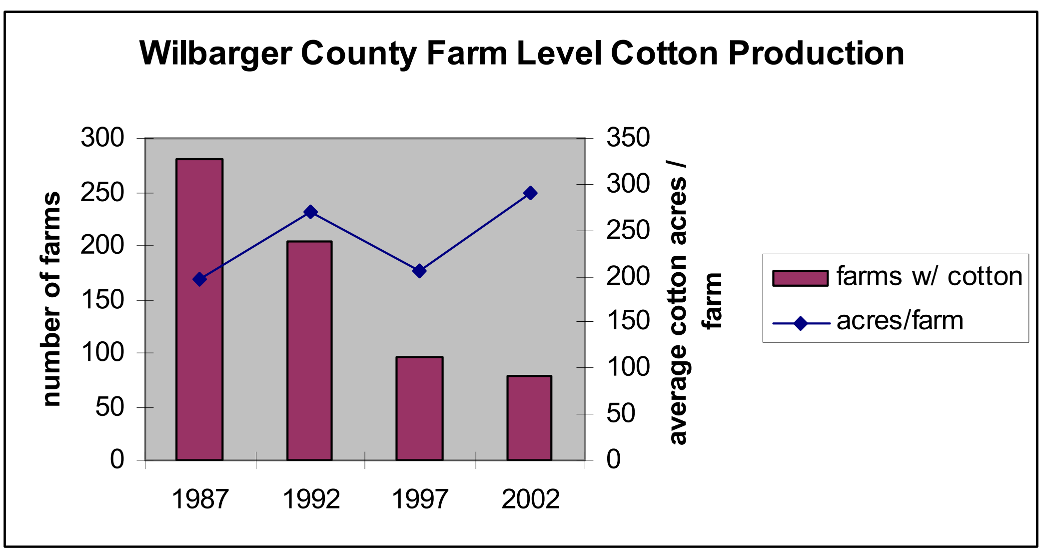


Figure 7.8: Change in farms growing cotton vs. acres per farm in cotton for Wilbarger County, 1987-2002 (USDA-NASS).

Monocultures of key commodities such as corn, cotton, wheat and rice have created "the perfect conditions for plant-feeding insects and other organisms to become pests" (Steinbrecher 2001, 83). Transgenic crops are tailored to 'solve' the problems of monocropping, which they themselves contributed to.

In 1945, scientists from the Mississippi Agricultural Experiment Station wrote, "With the advent of a successful cotton picking machine, the only serious bottleneck to complete mechanization of cotton production will be that of properly thinning and weeding the cotton" (Welch and Miley, 945). Precision planters of the 1950s and 1960s made thinning cotton obsolete but up until recently, ridding fields of hardy and water-competing weeds was a never-ending chore for cotton farmers. HT cottonseed has successfully pushed cotton production through the last 'bottleneck' of mechanization. But at what costs?

One of the first responses I received to the question, what do you think about Roundup Ready cotton, was, "It's a miracle!" Summers in Texas are extremely hot with temperatures sometimes remaining over 100°F for weeks on end. With HT cotton, farmers are able to spray package herbicides on their cotton fields from the cab of an air-conditioned tractor once or twice a season to control weeds. It is no longer necessary to walk up and down each row of cotton two or three times each summer to chop out weeds or supervise large crews of usually migrant labor to do the same. Roundup has successfully replaced labor at a time when it was reportedly "difficult" to keep. One farmer commented on the stresses of managing hoeing crews:

> I tried to eliminate cotton choppers. By doing that you spray Roundup and you don't have to fool with people. It's not any cheaper, but you don't have to put up with the hassle.

One farmer, in particular, told me how it took the whole day for him to manage hoe hands working across the 2,500 acres of cotton he farmed. Depending on weeding pressure and weather conditions, one person can remove weeds from anywhere between one to five acres/day. Sometimes large cotton farmers could have up to five crews working across various fields at any given time. Another farmer, however, was not sure if their operation benefited from HT seeds:

> We got so much work to do. I don't know whether it saves time or not. We're always busy.

By the 1980s cotton farms on the Texas plains were too large for farm families to "hoe" or manually remove all the unwanted weeds themselves. In Elliott farmers grow less cotton than farmers in Hale Center, so some weeding labor is absorbed by the farm family unit supplemented with hired laborers when needed. One middle-aged farmer's wife recalls her memories of chopping cotton:

> I'm glad to say that I've chopped cotton but I will not miss it! I can remember that the last two or three times that I chopped, I was chopping way off down in there and it was really bad weeds and I almost passed out before I got back home. But, there's a feeling of satisfaction of getting those weeds and looking back at that clean field. That's kind of fun but I just remember getting so hot and

> how hard it was and then having to go through that sand. That sand is hard.

Many farmers, especially in Hale Center, reported an increasing minimum wage, a more pronounced involvement of farm worker labor unions, and the high cost of worker's compensation as problematic labor issues which make it increasingly difficult to efficiently use "hoe hands" for weed control. In 1938 cotton chopping paid 38 cents/hour. Today farmers are required to pay $0.50-1.00/hour/person over minimum wage for unemployment benefit costs. One Hale Center farmer told of a situation where he hired a group of labors to hand spray weeds. After several days of work it rained and was too wet to get into the fields to work. One of the workers filed unemployment causing the farmer's unemployment tax to increase. He reportedly had to go through arbitration to settle the case. Many farmers reported frustrations in the hiring and management of laborers. "They want to work 2 or 3 days then get on unemployment." The Texas Rural Legal Aid has done much to protect the rights of migrant farm workers. Farmers, as employers, are required to provide access to clean water, shade, and toilet facilities for seasonal workers. In most cases though, it is very difficult for farmers to ensure that such facilities are available in each of their cotton fields—some of which are miles apart. Fearful of litigation, farmers are finding it much easier to grown HT cotton than to deal with the hassles of labor. One farmer expressed:

> Before we had Roundup [Ready] cotton we had to cultivate it then we had to get cotton choppers which was no big problem. They came into this country in droves. You could hire them anywhere—anytime. But then it got to where you couldn't find them, and you couldn't find good ones. And then it got to where liability got to be an issue you know because there's always someone getting hurt.

Few farmers mentioned a shortage of labor, but rather stated the quality of labor and liability as key problems. During interviews some farmers repeated stories about others taken to court for not providing additional work after the chopping was finished. Perhaps their greatest fear, I found, was litigation in the event of an injury. According to one Elliott farmer:

> Oh yeah, it's a whole lot easier and now with generic [glyphosate] I don't guess it's any more expensive than hiring cotton chopping crews and you don't have the physical liabilities with this frivolous lawsuits and stuff like that. I'm almost afraid to have someone work on the farm. … I think it could happen here. I've never really had any problems with cotton choppers. I've hired some large crews that come up from south Texas and we didn't have any problem you know but now the people sue and the way people are you never know if someone might deliberately hurt themselves someway. You know? That's the reason I carry a tremendous umbrella liability policy, for situations like that.

Regarding liability and hoe hands, another Elliott farmer commented:

> We didn't see it [lawsuits] as bad here as they [plains cotton farmers] did, but it was coming.

In the end, HT cotton has eased the burden on farmers who either had to remove weeds themselves or manage large crews of workers throughout the hot summer months to do the same. One farmer's wife noted how GE cotton was less stressful for her husband in the short term but she worried about the future implications of the technology:

> Before Mike was always worrying about when the cotton choppers were going get here and how much it was going to cost to get the cotton chopped this year and you know, all of that stuff. Uh, and how much the cotton was going to be damaged and now he doesn't have to worry about that. … So, in the short run it seems like a good deal but you know, for the long-term it might not be but you know, once something like that gets out of the box, can you ever put it back in?

Some farmers use HT seed technology as a safety net. I know of one Elliott farmer who planted more expensive Roundup Ready cottonseed but instead of spraying the cotton with glyphosate manually removed the weeds himself with a hoe (Figure 6.9). Weed pressure often depends on rainfall. Unable to predict if early season weeds will be a problem, some farmers plant HT cotton 'just in case.' Sometimes low weed pressure does not justify the expense of spraying the cotton with herbicide. If a farmer has a small amount of cotton, it is possible for him to chop the weeds himself therefore internalizing the cost of weed removal. As cotton acreage increases, however, outside forms of labor or chemical control is necessitated.

Figure 6.9: Farmer hoeing weeds (Photo by author July 2003).

Regardless of the number of acres devoted to the crop, cotton is much more labor intensive than wheat, sorghum, or corn. Despite labor-saving technologies, growing cotton, especially for irrigated farmers, is a full time job.

> I've cut back the last couple of years and I'm not farming as much cotton. It just seems like it's a little bit easier to grow wheat or milo. I think because it's easier to harvest. You hire somebody to come in and harvest it. And even if you have a good stripper and a module builder, it still takes two people. … I'm just getting too old for cotton.

Texas farmers are getting older and farming more acres than ever. The average age of farmers is on the rise and has been for quite some time. Currently the average age of a Texas farmer is 57. The average age of retirement in the

United States is 63 (United States Department of Labor 2005). Over 50% of the farmers surveyed in the study were over the age of 60. Farm size in Texas has risen as well. The average Texas farm has grown from 160 acres in the 1950s to over 700 acres in 2002.

Herbicide-tolerant technologies ease the labor burdens of cotton production and therefore make it possible for farmers to devote more acreage to the once labor intensive cash crop. From slavery to the cotton gin, sharecropping, tractors, the Bracero Program, and the mechanical cotton harvester, society has been diligent in its pursuit to reduce the labor constraints of cotton. Herbicide-tolerant cotton was developed as a solution to problems created by previous labor-saving and yield-enhancing agricultural technologies of the Green Revolution. By transforming cotton DNA to withstand herbicide applications, multinational biotechnology companies have consumed the economic benefits of labor—redistributing income from the hands of rural workers and communities to the pockets of corporate CEOs and stockholders. While HT cotton may not be the primary cause of land consolidation and increased monocropping (as many facets of industrial agriculture are responsible), it dramatically alters the means of production whereby consolidation and the management of larger acres of land is made more attractive and feasible. Farmers unable or unwilling to keep up with the scale increasing pace of industrial farming, are forced off of the land. In Hale Center and Elliott, HT cotton has made it easier to farm larger amounts of land needed to bring in a profit. But, as Altieri (2000, 90) argues, "as the large-scale landscape homogenization with transgenic crops proceeds, environmental impacts will probably be substantial and it is expected that such massive deployment will exacerbate the ecological problems already associated with monoculture agriculture." Unfortunately, "like all of industrial agriculture, biotechnology promotes the idea that the goal of agriculture is to control, simplify, and homogenize, without concern for nature" (Mander 2002, 18), or, I might add, the economic and social sustainability of agriculture-based communities throughout rural America.

Social sustainability?

Over the past five to ten years, rural communities in northwest Texas have seen many changes due to HT cotton and the loss of hoeing jobs. Hale Center, more than Elliott, is experiencing the social and economic ramifications of HT cotton adoption. The most obvious effect has been the loss of local businesses such as grocery stores, mechanic shops, and restaurants. Numerous informants told me of businesses which have closed since fewer migrants were coming to and residing in the community. What has hurt the Hale Center community the most is the drop in enrollment in the local school system. In Texas, attendance numbers are taken in the middle of October to determine the amount of state funding a school district will receive for the year. Between 100 and 150 estimated students were lost in the late 1990s as a result of RR cotton and the lack of hoeing jobs in the area. This amounts to a significant loss of school funding when the state contributes approximately $1,000/child/year.[11] The school system is reportedly recovering yet the loss of migrant laborers and their school-aged children has been hard on this rural school system which has come to depend on a certain amount of state funding each year.

The local economy has suffered less in Elliott. Since Elliott farmers grow less cotton than Hale Center farmers, fewer migrant laborers came to stay in the area. Many of the laborers come from local towns and those that migrated to work in the cotton fields or at the Elliott gin were less likely to bring their families. The only business in Elliott is the Elliott Producers Cooperative Gin. According to the Elliott gin manager, transgenic seed actually brings in less income than conventional seed for the cooperative. In years past, the gin would receive $1 for every $20/bag seed sold or roughly 5%. Some transgenic seed costs almost $300/bag yet the gin as a dealer only receives $1-2/bag. Dealers are responsible for more paperwork in the ordering and delivering of seed but receive a smaller percentage of the total cost of the seed.[12]

Over the years, the ethnic composition of NW Texas has been transformed by the influence of Mexican and Latin American migrant workers. Beginning in

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[11] Personal communication with former Hale Center Independent School District superintendent on January 25, 2005

[12] Personal communication with Elliott Producers Cooperative Gin manager on March 7, 2005

the early 1940s, Bracero Program workers made rural cotton-growing communities of the Texas plains their home away from home. Chain migration, or those following the lead of friends and family, from Mexico and the Rio Grande Valley supplied a constant source of labor to weeding in the cotton fields even after mechanization of the harvest. In the 1960s 'Operation Wetback' set out with the ambitious task of removing illegal immigrants from the United States. However, willing workers were needed in the cotton and vegetable fields of northwest Texas. In 1986 the United States government conceded and gave legal status to immigrants working and living in the United States prior to 1982. Today, 48% of Hale County and 57% of the Hale Center is Hispanic (Figure 6.10). Up until recently migrant laborers have performed the majority of weeding labor in area cotton fields. Hale County unemployment data indicates a surge in unemployment with the introduction of the first HT cotton varieties in 1995 (Figure 6.11). Between 1995 and 2000 unemployment was at a high in the county. Another peak occurred between 2000 and 2005. The percentage of persons unemployed in Hale County is significantly higher than 1995 pre-HT cotton estimates.

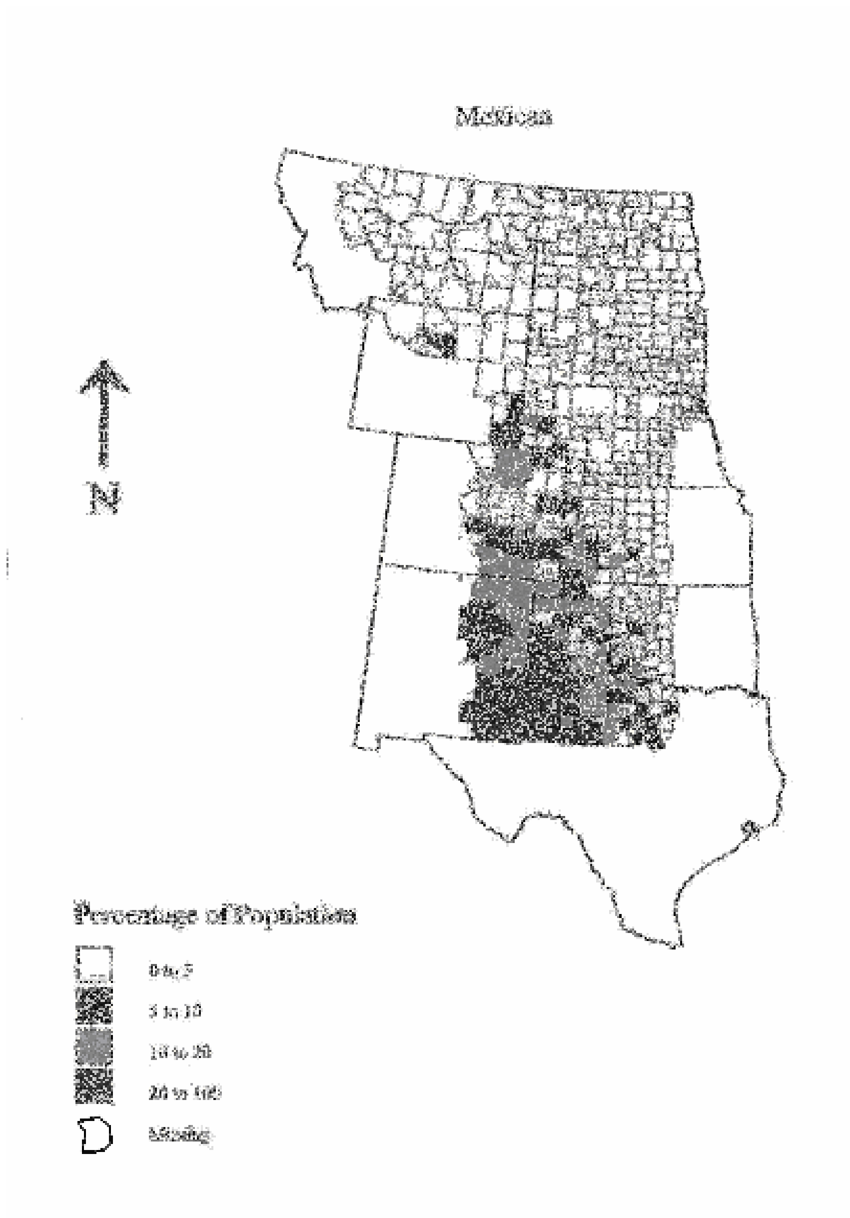

Figure 6.10: Percentage of Great Plains's population of Mexican origin, 1990 (Baker, Gutmann, and Pullum 1999).

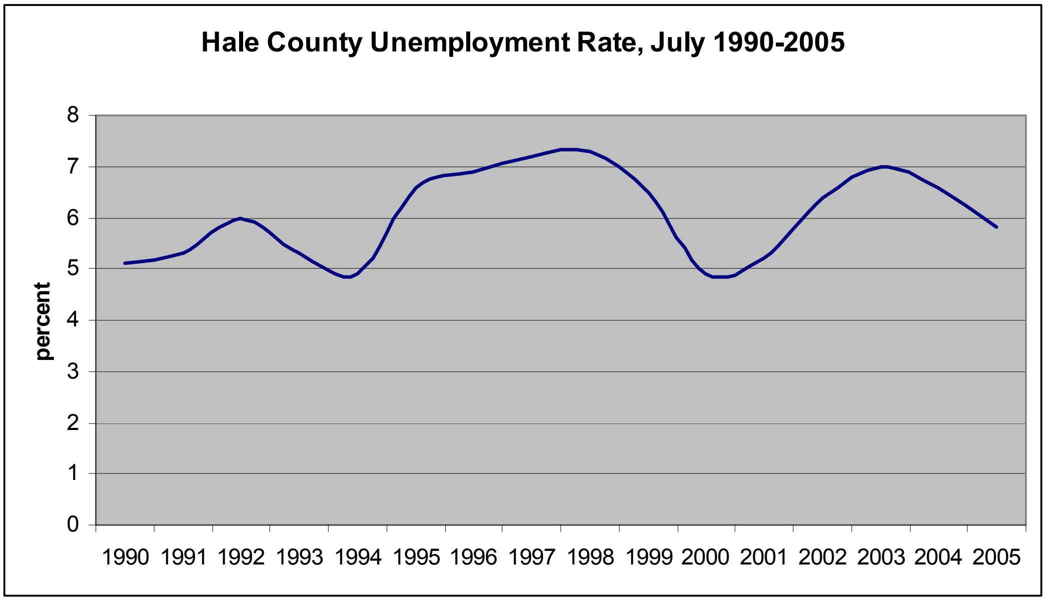

Figure 6.11: Hale County unemployment rates, 1990-2005 (USDL-Bureau of Labor Statistics 2005).

The construction of Interstate 27 from Lubbock through Hale County has spurred much agricultural and industrial growth in the area. It is postulated that some weeding jobs lost to HT cotton were replaced by similar low-wage employment in industries along the I-27 corridor. Excel beef packing employs close to 2,000 people. Meat-packing and processing is ranked as one of the most dangerous and accident-prone professions in the United States. A Wal-Mart distribution center was built in Plainview in 1986. Azteca, a corn processing plant was constructed in 1990. In 2001, Hale County entered the Boll Weevil Eradication Program which employs over 200 summer workers to monitor insects in each of the county's cotton fields. The Formby State Jail and Wheeler

Substance Abuse Felony Punishment Center and employee training center was also recently constructed on the periphery of Plainview.

So what does this mean for the workers and citizens of Hale Center? From interviews, it was obvious to people of Hale Center that the loss of weeding labor has affected the vitality of their town. Statistics show that unemployment rates increased with the introduction and adoption of HT technologies. And although unemployment rates have since dropped, perhaps from the variety of other industries in the region, businesses in Hale Center remain closed. For example, The Owl's Nest is the only place in town for lunch. In the past there were three or four restaurants. Not only has the loss of hired farm laborers been detrimental to the community but so too has the loss of farmers and farm families.

In this chapter I have argued that in the study communities HT cotton lessens the management burdens of farmers and thereby contributes to the practice of monocropping, supports the consolidation of land, and has restructured, in particular, the Hale Center community by dramatically reducing the demand for cotton-related laborers. By reducing and even eliminating the amount of labor required to manually remove weeds, HT cotton is less labor intensive. Reducing labor requirements allows fewer farmers to manage more acres of cotton. "Farmers are on a treadmill in which the downward pressure on prices they receive—and/or the upward pressure on input needed for production—force them to adopt new technologies and to increase the scale of production in an attempt to stay in business" (Magdoff, Foster, and Buttel 2000, 12). Farmers who adopt HT cotton are at an advantage over those who do not in terms of convenience and time devoted to labor management. Even though the cost of HT seed is comparable with the cost of labor for weed removal, farmers who grow HT cotton can more easily take on the responsibilities of more acreage. Fewer cotton farmers and fewer laborers translate into trouble for rural communities struggling to survive.

Chapter 7

Risky Business

Cotton farming is a gamble. One farmer with whom I recently spoke joked about the certainty of a Las Vegas slot-machine over a cotton crop. The unpredictability of weather, diminishing groundwater reserves, increasing costs of inputs and below parity cotton prices make cotton production incredibly risky. Disgusted with the growing complexity, high cost, and low return of the crop, one 30ish farmer told me he would rather burn a stack of one-hundred dollar bills than put in yet another cotton crop. Genetically engineered cotton has contributed to the already insurmountable risk of cotton production. On the surface, governmental and corporate risk alleviation programs appear to be cotton farmers' saving grace. But upon closer scrutiny, many of these programs lock in place an industrialized agricultural system and provide little if no room for more sustainable alternatives. This chapter looks at three categories of risk exacerbated by the advent of GE cotton: environmental, health, and socioeconomic. How farmers mitigate and deal with the added risks of transgenic cotton is addressed within each of the sections. The chapter ends by debunking some of the claims made by government and corporate risk mitigation campaigns to reveal how incentive and insurance programs encourage and support otherwise impractical and unsustainable farming practices.

Transgenic risk

The risks of GE cotton are not always immediately apparent but are externalized over time and across space. From discussions with farmers and their families, three categories of risk arose.

Environmental risk

Several key environmental hazards of GE cotton have surfaced within this study. Interview and secondary data point to an increase in chemical use, incentives to monocrop, the development of weed and insect resistance, and a rise in secondary pest pressures as a result of GE cotton. Each of these trends contributes to the growing dependency of farmers on agrochemical and biotechnology companies. When technological fixes are no longer effective, farmers look to agribusinesses to patch problems caused by previous technologies. Under this system, farmers become stuck on the technology treadmill.

As detailed in chapter 6, herbicide applications on U.S. cotton have risen considerably since farmers began planting herbicide-tolerant (HT) cotton in the mid 1990s. Increased herbicide use, especially of glyphosate, has resulted in more tolerant weed species. Likewise, hardier weeds require higher application rates of pesticides. Farmers interviewed within the study use a variety of management techniques to deal with increased weed tolerances. Some increase the concentration rate and frequency of chemical applications. Others use pre-emergent yellow herbicides, widely popular before HT cotton. Some are forced to add new chemicals to their weed-fighting "arsenal." I spoke to several farmers who rigorously rotate their wheat and cotton crops. Crop rotation is a time honored technique of preventing weed infestations. Because farmers in Elliott manage predominately non-irrigated land they have more opportunities to employ crop rotation schedules. Farmers in Elliott tend to grow significantly more wheat than cotton making it difficult to rotate all of their acreage each year. Hale Center farmers are less likely to rotate other crops with cotton. Corn demands more water than cotton and irrigated wheat or grain sorghum does not equal the return of irrigated cotton. Many Hale Center farmers feel that cotton gives them the highest rate of return on irrigated land and therefore leave pivots in cotton for a number of years. This is one way that GE cotton contributes to the monocropping of cotton. The ease of GE cotton makes it easier to manage, and continue to manage, more acres of cotton.

Texas farmers can learn from the experiences of traditional cotton belt states where weed resistance is a genuine problem. In managing glyphosate resistance, cotton farmers in states such as Georgia, North Carolina, and Mississippi use stronger and more powerful chemicals. In these areas it is especially apparent how technology begets technology. Agrochemical companies aggressively market pesticides to tank mix with the no longer effective glyphosate. Competing biotechnology firms advocate their seed/chemical system as superior to others. For example Bayer promotes its Liberty Link system as more effective on morning glory species than Monsanto's Roundup Ready system. Dupont advocates their chemical when "Roundup clocks out." But just as Rachel Carson so passionately argued over forty years ago, "the chemical war can not be won" (1962, 8). If northwest Texas cotton farmers, like those in the Southeastern United States, rely too heavily upon glyphosate as their primary method of weed control, weed resistance to the chemical is inevitable.

Bt cotton has reduced the amount of insecticide applied to Texas cotton fields but not without consequence. Insect resistance and secondary pest succession are the result of dependence on Bt cotton technology. Many argue that Bt technology is a useful tool. I contend, however, that while Bt cotton may require less insecticide in the short-term (that is unless farmers must use pesticide to control secondary pests which is increasingly common), the long-term effects of dependence on transgenic systems undermine the agency and freedom of farmers to make sustainable land management decisions. To illustrate, let us return to Farmer Brown:

In 2005, Farmer Brown decided to plant 200 acres of cotton in a variety containing Bollgard II, Monsanto's latest Bt technology. This is his third year to use Bt technology in cotton. Farmer Brown's county is in the Boll Weevil Eradication Program (BWEP) so his cotton fields were sprayed with malathion in efforts to eradicate the boll weevil. Malathion use has also helped him keep his worm problems under control. Now the boll weevil is no longer a problem for Farmer Brown or his neighbors. The BWEP really worked. But the last year or two he has noticed more worms eating his cotton. Monsanto says that their Bt cotton is just the thing he needs. Worms that eat Bt cotton will not damage his cotton but die upon ingesting the plant. Even though Bt cotton is more expensive, Farmer Brown gladly plants it knowing that he will not have to spray his cotton with an insecticide to kill the worms. But this year Farmer Brown notices a different problem. Stink bugs are eating his cotton. Bt cotton is great for worms but does nothing for stink bugs, a once insignificant secondary pest. To save his cotton from the stink bugs, Farmer Brown treated it with insecticide. This was an expensive year for Farmer Brown. Not only did he have to pay $15/acre for the BWEP, more expensive Bt cotton, but then he had to pay to have insecticide sprayed on his cotton anyway. Farmer Brown is depressed. President Bush just announced that due to WTO compliance, he will receive less support from the government to subsidize his cotton crop in the coming year. It was a dry year making it very expensive to pump irrigation water from the aquifer. Farmer Brown has spent well over $300/acre on his cotton crop thus far and this morning the price of cotton dropped to below 40 cents/pound. Fearful he will not be able to repay the bank for this year's operating loan, Farmer Brown decides that now might not be the best time to repair the roof on his barn. He drives past the hardware store on his way home. The roof repairs will have to wait.

Using this scenario as an example, we can see how Bt cotton can potentially be harmful to the environment (via increased use of pesticides), Farmer Brown's economic survival (via increased seed and chemical costs), and the social welfare of his community (via inability to support local businesses).

Health risks

Health concerns also increase with the use of GE cotton and accompanying farming practices. Farm families in the study had two particular areas of concern: the health implications of agricultural pesticides and the safety of foods containing GE ingredients.

Chemical poisoning from polluted well water, and/or direct exposure, are suspect as cause for disease. One farmer's wife who has been employed in the health care industry for a number of years, worries if farm pesticides have contributed to the abnormally high incidence of Alzheimer's in their community. She too expressed concern about cancer, infertility, and multiple sclerosis, all of which to her seem to be increasing in frequency. The Center for Disease Control (CDC) and Texas Department of Health and Human Services have not identified abnormal clustering of any of the aforementioned conditions in Hale or Wilbarger Counties. Although cancer data from the Texas Department of Health and

Human Services indicate above average rates of incidence for stomach and lymphatic cancer in Wilbarger County. This is disturbing given that Roundup or glyphosate has recently been linked to higher incidences of Non-hodgkins lymphoma (Hardell *et al*. 2000).

The majority of farm families use water from personal wells for household uses such as drinking and cooking. The safety of drinking water from private wells is not regulated, and according to the Environmental Protection Agency (EPA), is the responsibility of the land owner. Underground water in agricultural areas is notably high in nitrates. Synthetic nitrogen or anhydrous ammonia is used extensively in cotton, corn, and wheat production. Since the 1950s, the use of synthetic fertilizer and chemical pesticides has steadily increased. Many farm families mistakenly assume their ground water is as safe as it was 50 or 60 years ago. Before my husband and I were married, we had the well water from the farm house where we were going to live tested at a local environmental testing lab. He had been drinking water from the well for over ten years and felt that it was safe. The results were shocking. Nitrate levels were five times the EPA's 10ppm threshold for human consumption. According to the informational sheet on nitrates from the North Texas Chemical Consultants Laboratory,

> In adults, excess nitrates can cause illness and in severe cases death. However, the most serious threat is to infants. Infants have bacteria in their digestive system that converts nitrate to nitrite. The nitrites attack the hemoglobin which interferes with the capability of it to release oxygen. Because of low oxygen, mild

> symptoms of asphyxiation (suffocation) appear. This is why it is often called "blue baby syndrome", due to the blue color that forms in the lips and extremities. If methemablobenimia (blue baby syndrome) is not dealt with immediately, the infant could die.

Today we purchase our drinking water in town but many farm families continue to drink from their wells. Older people, especially, perceive their water to be safe since they have been drinking it for decades. The lab could not test for specific pesticides so we are unaware of the chemical content of our well water.

Farm families living in rural areas are also at increased risk of direct exposure to pesticides. Many farmers are certified applicators who buy and apply farm chemicals to their crops thereby increasing their risk for exposure during mixing and application. People who live in rural areas are also in frequent contact with pesticide residue when chemicals are applied by air. Spray planes apply pesticides to area fields without warning, putting local residents at risk. In several oral history interviews, older farmers told stories about dusting cotton with chemical powders by hand; without gloves! One farmer mentioned how the ends of his fingers would turn black and eventually his fingernails would fall off from handling the chemical.

Many find it hard to believe that processed food items contain GE cottonseed oil. Scientists have repeatedly assured me that very little DNA is in cottonseed oil therefore discrediting concerns over the consumption of foreign DNA combinations as with corn and soybeans. Whole cottonseed and cottonseed meal, however, is widely fed to beef and dairy cattle. It was apparent in household interviews with farm families that women were more concerned about the health risks of eating GE foods than men. Women too, were more likely to think that they should be given a choice, that GE foods should be labeled. Some of the men were opposed to labeling fearing that the costs of testing and labeling would trickle down and eventually come out of their pocketbooks. Others felt that food labeling was trivial since for them, there was no difference between conventional and GE crops other than the way that the seed "performs" in the field.

Socioeconomic

Farmers who use GE seeds take on additional socioeconomic risks. First, cotton farmers are feeling pressure to increase their umbrella liability policies to include chemical drift provisions. Farm liability insurance protects farmers from lawsuits or loss in the event of a farm accident. The more cotton farmers spray herbicides to control weeds, the more they entertain the possibility of damaging neighboring crops, trees, or gardens. One dryland cotton farmer speaks from a bad experience:

> It is very easy for these chemicals to drift, even though you're being careful. You see, they will drift sometimes with you not knowing it.

This particular farmer lost money when his neighbor's chemical accidentally drifted and damaged his crop. The suspected farmer did not have chemical drift liability insurance and when confronted did not feel the damage was his fault. The farmer with the damaged crop simply had to absorb the loss.

It is hard to determine much less prove who is responsible for chemical drift damage. Many Elliott farmers reported damage from the chemical 2,4-D on their cotton in the summer of 2005. In Wilbarger County there is a May cutoff date for 2,4-D applications since the chemical is lethal to cotton. Under the right weather conditions, chemical can drift for miles. While it was rumored who was to blame, the chemical damage was light and in efforts to prevent conflict no one spoke up or pushed the issue. According to Dr. Randy Boman, cotton extension specialist in Lubbock, TX, chemical drift accidents in cotton are becoming evermore frequent. All upland cotton varieties look alike as small plants despite their genetic makeup. Herbicide-tolerant cotton looks the same as conventional cotton. Many times commercial chemical applicators spray conventional or Liberty Link cotton with glyphosate killing the whole field. Likewise, the chemical glufosinate which is to be used with Liberty Link seed might be mistakenly applied to Roundup Ready cotton. Chemical drift and misapplications of system chemicals can cause a great amount of conflict between neighboring farmers and is by no means conducive to community cohesion. In areas where cotton is the major crop, some farmers choose to plant RR cotton simply to avoid chemical drift damage to their crops, as a preventative or proactive measure. Crop damage from chemical drift can significantly affect a farmer's yield (Figures 7.1). Accurate farm records and liability insurance policies including chemical drift become even more of a necessity with the introduction of new GE packages.

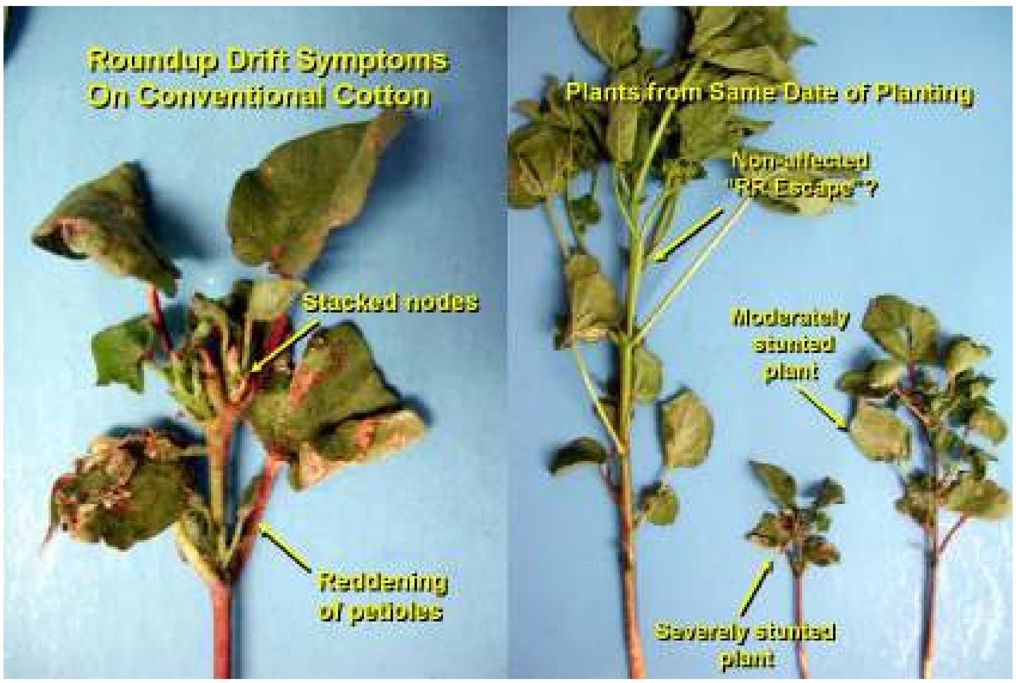

Figure 7.1: Roundup drift symptoms on conventional cotton (Photo from Western Region Cotton Resource CD).

Not only do farmers absorb the costs and liabilities of chemical use/misuse, but they too are charged with the responsibility of using GE technologies according to the terms dictated by corporations holding trait patents such as Monsanto. Technology/stewardship agreements (TSAs) put farmers at risk by reducing a farmer's ability to make management decisions and forcing those who use patented products to comply with corporate regulations. I would guess that most farmers have not read Monsanto's TSA as they would need a microscope to read the fine print (Appendix C). According to the 2006 Monsanto TSA, those who buy and plant GE seed agree to:

> 1. "**Cooperate and comply**" with Monsanto's Insect Resistance Management (IRM) programs,
>
> 2. "**read and follow** applicable sections of the Technology User Guide (TUG),"
>
> 3. "**pay** all technology fees due to Monsanto,"
>
> 4. "**allow** Monsanto to review the Farm Service Agency crop reporting information on any land farmed by Grower including Summary/Acreage History Report, Form 578 and corresponding aerial photographs, Risk Management Agency claim documentation, and dealer/retailer invoices for seed and chemical transactions" and
>
> 5. "**allow** Monsanto to examine and copy any records and receipts that could be relevant to Grower's performance of this Agreement."

Therefore, farmers who plant seed with Monsanto's patented technology agree to release their personal farming records to Monsanto as evidence to be used against them in the event of a conflict. But farmers who agree to Monsanto's terms also forfeit their right to file a case against Monsanto. Cotton-related claims contain a binding arbitration provision meaning that "any claim or action made or asserted by a cotton Grower against Monsanto…..must be resolved by binding arbitration." Cotton farmers are singled out and not permitted, by the terms of

Monsanto's TSA, to challenge Monsanto in a court of law. Futhermore, farmers agree to not discuss any part of the arbitration process. "The arbitration proceedings and results are to remain confidential and are not to be disclosed without written agreement of all parties, except to the extent necessary to effectuate the decision or award of the arbitrator(s) or as otherwise required by law" (Monsanto TSA 2006, 2). If farmers are somehow mistreated by the biotech corporation, they must remain quiet and relinquish all rights to release information regarding the litigation.

Farmers who plant Bt cotton also agree to specific management practices outlined by Monsanto. As part of Monsanto's TSA, farmers are responsible for planting and managing refuge areas of non-Bt crops around Bt crops as specified by Monsanto's Technology User Guide (TUG) and Insect Resistance Management (IRM) Guide. Refuge areas are believed to help prevent or delay insect resistance to Bt engineered within corn and cotton plants. According to Monsanto's 2006 TUG, "a refuge is simply a block of the relevant crop that does not contain a Bt technology for the control of the insect pests which are controlled by the planted technology(ies)" (2006 TUG, 2). The EPA has recently joined forces with NASA to develop a hyperspectral camera used to distinguish Bt plants from non-Bt plant refuges from 8,000 feet above the ground (Farm Journal, Summer 2005, 48). What is striking about this technology is that the U.S. government is enforcing the implementation and upkeep of refuge areas for the benefit of corporations such as Monsanto. Risk is externalized from biotech companies to farmers who are now being held responsible for the development of insect resistance. In other words, it is the fault of farmers if insects develop resistance to Bt crops. According to Monsanto's 2006 Insect Resistance Management (IRM) agreement:

> To preserve the benefits and insect protection of this technology, Insect Resistance Management (IRM) must be part of the long-term and short-term planning by the seed industry and growers alike. The EPA has mandated an IRM program and the continued availability of this product depends on everyone to do their part. Insect Resistance Management is a requirement when planting Bollgard with Roundup Ready cotton, Bollgard cotton, Bollgard II cotton, or Bollgard II with Roundup Ready cotton.
>
> Failure to follow IRM guidelines and properly plant a refuge may result in the revocation of the Grower's Monsanto Technology Agreement and result in loss of access to Bollgard and/or Bollgard II cotton technology. Please do your part to ensure that Bollgard and Bollgard II cotton technology are preserved by fully coopering in refuge management.

I am worried for farmers who do not comply with Monsanto's exact refuge area requirements. Those who do not follow refuge area rules as outlined in Monsanto's TSA and TUG could be held liable for the development of insect resistance to Bt traits. Therefore, technology developed by a public institution and supported by the tax dollars of U.S. citizens such as NASA's hyperspectral camera, could conceivably be used as proof in Monsanto's prosecution of American farmers.

Unable to bear the additional burdens of GE seed, some farmers have found ways of transferring their added risk to their landlords.

> What I've done is gone back and asked the landlord he wants to pay this year for the additional cost [of Bollgard] seed. Roundup Ready seed is $70 [a bag] and I am willing to pay for that if I'm willing to plant Roundup Ready cotton. But if it's $130 / bag for the Bollgard seed, and if I'm saving it from worms, if that's part of what we're doing, then I think the landlord should pay this portion or difference between $70 and the $130. So he should pay a fourth of the extra $60 in seed. [on quarter cropshare system where landlord pays ¼ the cost and gets ¼ the profit].

Some of the costs are passed on to the landowner but ultimately farmers remain the ones liable to the terms of Monsanto's TSA, Technology Use Guide (TUG), and the Insect Resistance Management (IRM) Guide. Relegating risk to landlords may work for farmers who rent some of their cotton land but for those who own all of their land or are in the process of buying land, there is nowhere else to pass the burden of cost.

Even though it has not been an issue to date, farmers who grow GE cotton take market risks. For example, in recent years corn farmers have spent a great deal of money growing certain types of GE corn to later find no market or buyers for the harvested seed. The same could be true for cotton. Most think of cotton as a fiber and dismiss it as irrelevant in any discussion regarding fears over the safety of GE food. But cotton is a fiber, food, and feed. Cottonseed is high in energy, protein, fiber, and phosphorus. It is coveted as a feed supplement for lactating dairy cattle. Last year's record cotton crop sent over 8 million tons of cottonseed onto the feed market. Cottonseed generally represents 15% of a grower's income from cotton. One acre of cotton produces $300 of lint and $50 of cottonseed. One 480 pound bale of cotton lint produces 780 pounds of cottonseed. (Farm Journal, Summer 2005, special features page). Cottonseed from the Elliott Producers Cooperative Gin is sold to the Oklahoma City Cottonseed Mill for processing into oil, meal, feed, and byproducts where ConAgra is the leading buyer of cottonseed oil (personal communication, 2004). With 20% annual growth in the organic food sector, it is conceivable to envision a time in the not so distant future when large players in the food industry such as ConAgra will request organic, and therefore non-GE, cottonseed oil.

Lastly, GE cotton contains added risk in that farmers must secure extra credit to purchase more expensive GE seed and chemical packages. The added costs of inputs can put farmers further in debt and/or out of business if the high price of GE seeds is not recovered by higher yields. For many irrigated farmers, input costs can be as high as several hundred dollars per acre. Some have reported that they must make at least three bales of cotton per acre to break even. Dryland farmers are elated if they raise one bale per acre. For irrigated and dryland farmers alike, management decisions are made in pursuit of economic survival. As one farmer put it:

> To me all of it comes back down to cost though. … My thinking is that with dryland cotton, you've got to look at the dollar. You can't dump a whole lot of money into a dryland crop hoping that it'll rain and that you'll make something. If you have irrigation you can control some of that but where we are you gotta think about that upfront…or at least I do.

Risk alleviation programs do much to obscure the wider socioeconomic costs of cotton production.

Debunking risk alleviation

Two types of risk alleviation programs are available to northwest cotton farmers: government subsidized crop insurance policies and corporate sponsored sales incentives. In each program, the hidden costs amount to more than the benefits provided.

Cotton farmers who participate in the USDA farm program, and thereby receive government farm subsidies, are required to follow certain rules. One of the stipulations of the farm program states that farmers purchase crop insurance on commodity crops. Premiums are based on the amount of coverage provided in the event of loss. Crop insurance is sold by private insurance companies but subsidized by the USDA under the auspice of the Risk Management Agency (RMA). Farmers pay approximately 50% of their crop insurance premiums while the federal government pays for the remainder. In other words, American tax payers are paying half of farmers crop insurance policies required, by law, by the

U.S. government. Only approved commodity crops such as cotton, wheat, corn, soybeans, and rice are eligible for crop insurance subsidies. In this way, taxpayers support an industrialized system of agriculture where farmers are encouraged to grow only a handful of crops. Likewise, farmers are limited in the crops they can grow by the USDA and county offices of the USDA's Farm Service Agency (FSA). In Wilbarger County, for instance, farmers who grow vegetables such as black-eyed peas or watermelons are deprived of participating in the current farm program. Even if a farmer plants the majority of his land it commodity crops such as cotton and wheat but decides to plant a nitrogen building crop such as black-eyed peas on 200 acres, he forfeits his participation in the farm program.

The second type of risk alleviation program available to northwest Texas cotton farmers is corporate-sponsored sales incentive programs such as Monsanto's Roundup Rewards Program and Deltapine's Replant Program. Seed companies such as Deltapine help alleviate the risk of inclement spring weather and entice farmers to purchase their seed with a seed replant program. If a farmer buys and plants Deltapine seed and looses his cotton crop to bad weather early in the season, Deltapine will supply the seed for replanting at no cost. Monsanto also offers an "insurance" program to cover the costs of technology fees on a replant in the case of loss if farmers purchase Monsanto seed and Roundup (not generic) for their whole crop. Those who can afford to purchase Monsanto's patented seed and Roundup qualify for the incentive by buying a variation of Monsanto's Roundup for application on all aspects of their entire cotton crop for the season. Farmers who buy Monsanto's most expensive glyphosate (Roundup WeatherMax) or their basic glyphosate (Roundup Original Max) for $57 and $26 dollars per gallon respectively, as compared to a generic glyphosate for approximately $11/gallon, enjoy the worry-free benefit of Monsanto's rainfast, replant, and crop destruct warranty program. "Roundup Rewards offers added protection and reduced risk program elements for your farming operation so you can farm with confidence when you use Monsanto technologies and agricultural herbicides" (www.monsanto.com). If farmers use the Monsanto product on ALL of their cotton acreage, they are privy to a refund of their technology fees in the event of a replant, or the cost of the chemical in the event of rain within several hours of spraying. According to Monsanto:

> Roundup Rewards stands behind your seed trait and herbicide purchases with an enviable package of paybacks. Your technology investment is supported by such benefits as: seed trait refunds for adverse situations, herbicide rainfast warranties, weed control respray programs, and support from local Monsanto experts who offer advice and service. (www.monsanto.com)

In reality, very few farmers can afford to pay for such peace of mind after paying triple or quadruple the price of conventional seed.

Additionally, in the spring of 2006, Monsanto/Stoneville introduced a minimum yield incentive program specifically for farmers of northwest Texas experiencing extended drought conditions. An abnormally dry fall 2005 and winter/spring of 2006 caused farmers to seriously reconsider planting cotton and how much they could afford to spend on cottonseed if they do decide to plant cotton. The 2004 and 2005 cotton seasons were record years in terms of yield and overall production. But in addition to the drought, fuel and fertilizer costs have significantly increased over the last year. Many experts are reporting that "it's going to be a hard to make a profit growing cotton this year" (Leidner 2006, special features page); especially in parched Texas where the majority of the 2006 wheat crop is in poor to very poor condition. Monsanto realized that they had nothing to loose. If drought conditions continue, cotton acreage will drastically decrease. In efforts to sell cottonseed, Monsanto introduced a minimum yield incentive program. According to Monsanto, Texas dryland farmers in Elliott who buy and plant cottonseed with Monsanto technology (RR, RRFlex, and/or Bollgard I/II products) are guaranteed a refund on their technology fees if their cotton does not produce at least 150lbs/acre. That is approximately 1/3 bale of cotton per acre. If farmers purchase Monsanto's Stoneville cottonseed they are promised a full refund on the cost of the cottonseed in addition to the technology fees given 150 lbs/acre yields are not met. The program helps Monsanto sell cottonseed by ensuring farmers a refund if a minimum yield is not met. Without the program, Monsanto would sell considerably less seed. There are many variables to consider though and most farmers know that at least in Elliott, it's going to be pretty difficult to make a profit off of 1/3 bale/acre cotton.

Farmers take on more risk with the adoption of GE cotton. Because weeds are controlled with chemicals, farmers find themselves needing liability insurance with chemical drift clauses to protect themselves in the event of accidental drift. They also endure more economic risk. GE seeds are more expensive and for farmers who take out loans to put their crop in, more credit is required to pay for more expensive seed. Also, by planting GE cotton, farmers are legally bound to lengthy and tedious technology or stewardship agreements. In the end, more risk is externalized from the corporation to the farmer who is left in many instances, literally, holding the bag.

Chapter 8

Discussion

After only one decade of use, genetically engineered cotton has taken away more options for northwest Texas farmers and rural communities than biotech companies promised it would provide. Transgenic technologies initially made cotton production easier and appear to have very few immediate or perceived costs. But consequentially, the true costs of these technologies have put Texas farmers and farming communities at greater risk than had they not adopted them in the first place. Farm families and rural communities are at risk from biotechnology corporations and genetically engineered seeds in that they limit and control farmers' choices in seed, increase their dependency on agribusinesses, especially agribiotechnology and chemical corporations, increase the use of pesticides, encourage monoculture practices, further the consolidation of land, and reduce the number of cotton-related jobs in rural areas. In short, genetically engineered cotton, however convenient, threatens the long-term viability of the American family farm and the rural communities they support. This chapter takes a critical look at the findings of this research to discuss the theoretical implications they entail.

In pursuit of the seed: Power and perception the GE campaign

Two discourses have shaped the introduction and adoption of genetic engineering technologies; faith in science and technology, and the construction of food scarcity. From interviews and interactions with cotton farmers in northwest Texas, I learned that today's farmers rely on the 'science' of agribusinesses more than their own knowledge or that of public research and extension institutions. They trust that corporations will come to the rescue when previous technologies fail or are no longer effective. Even so, most farmers question the motives of biotechnology and seed corporations and are frustrated with the lack of power they have in their dealings with them. Biotechnology firms "defend their interests by suggesting that the technology will help to feed the earth's growing population" (Heffernan 1999, 1). But in reality, biotechnology companies are not concerned with social equality, food security, or rural sustainability but are interested in creating a class of farmers who have no choice than to purchase their technologies year after year.

Economic interests such as these are central to this study. In this section I have chosen to situate the study's findings within the work of geographer Noel Castree and rural sociologist Jack Kloppenburg to illustrate how GE technologies have been used to further commodify and gain control over the seed.

In his pivotal text, *First the Seed,* Kloppenburg (1988, 2004) identifies two methods agribusinesses use to transform seed into commodities. The first route to commodification, according to Kloppenburg, is technical. The second is social. Shiva (1997, 49) concurs, "The biotechnology revolution robs the seed of its fertility and self-regenerative capabilities in two major ways: through technical means and through property rights." Seed naturally resists commodification. When harvested at the end of its lifecycle it retains the potential to reproduce the following year. Technical solutions to commodification, such as hybridization, alter the seed to prevent it from reproducing. Hybrid seed does not reproduce as successfully the second year as it does the first. Farmers must buy it new each year. In this regard, scientific feats provide technical solutions to market problems, not farmer problems. "Hybridization has proved to be an eminently effective technological solution to the biological barrier that historically had prevented more than a minimum of private investment in crop improvement" (Kloppenburg 2004, 11). Crops such as cotton, however, do not lend themselves to hybridization. Therefore industry pursued a second route to commodification, the push for passage of laws such as the Plant Variety Protection Act and patents on living organisms. These laws protect and hence privatize the intellectual property rights of seed breeders, scientists, and the corporations in which they are employed. Plant protection regulations are socially constructed mechanisms that create markets by legally necessitating the annual purchase of seed.

In 2003, Castree reviewed how the commodification of nature has been addressed in contemporary literature. He identified six principal elements of commodification in Marxist writings on nature. Two of Castree's analyzes of commodification are of particular relevance to this study: privatization and displacement. I use these two issues of commodification along with Kloppenburg's (2004) two types of seed commodification (technical and social) to frame the following discussion of the key findings of this study.

Privatization

Castree (2003, 279) defines privatization as "the assignation of legal title to a named individual, group, or institution." At the core, privatization is about power and control. So, for this study, one would want to know how has cottonseed been privatized via genetic engineering. And more importantly, how has its privatization affected northwest cotton farmers and their communities?

The ability of seeds to naturally reproduce themselves has been seen as one of the last barriers of capital accumulation within the agricultural sector (Kloppenburg 1988, 2004). Life Science corporations such as Bayer and Monsanto have used a variety of approaches to privatize or gain control of cottonseed. Privatization of seed via genetic engineering was accomplished simultaneously with social and technical methods. Genome mapping and the identification and isolation of 'useful' genes were taking place as litigation was being enacted to legalize the patenting of 'unique' life forms. Even though GE cottonseed comes back true, farmers are required to sign agreements stating that they will not save and replant the seed.

This study reveals additional ways in which biotechnology and seed corporations are privatizing or attempting to gain control over the seed. Chapter Four outlines how seed and biotech companies such as Monsanto and Bayer have slowly reduced the number of conventional cottonseed varieties available to farmers. This conscious reduction in availability of conventional seed varieties is an indirect method of privatization. In short order, conventional cottonseed varieties will not be available in the marketplace. Industry responds to farmers' complaints about the lack of conventional varieties by stating that there is not an adequate market for the seed. In other words, industry does not want to produce less profitable seed that competes with its own, more profitable GE seed.

The consolidation of seed and biotechnology companies also limits farmers' choice in seed. Since "biotechnology is such a capital intensive research enterprise, most small firms soon become marginalized" (Heffernan 1999, 7). Fewer companies from which to buy seeds and traits translate into fewer seed choices and less autonomy for farmers. As previously indicated, large biotech and seed companies are actively consuming smaller, locally-owned and regional cottonseed companies such as AFD located on the high plains of Texas. Consolidation in the seed and biotech industry is another way to force seed privatization upon farmers.

Farmers who save and replant conventional cottonseed are pressured to give up their seed-saving ways and convert to transgenic seed systems. It is not that Monsanto is holding a gun to farmers' heads forcing them to plant genetically engineered seed, but that biotech companies are actively creating an environment it which it is very difficult to do otherwise. Seed and biotech companies strategically coordinate which germplasm will be matched with which traits in the anticipation of profit. The latest and highest yielding germplasm is made available in trait-containing varieties only, not conventional varieties. This maneuver of market control is technically achieved and again limits farmers' choice in seed. Insofar, "When one producer adopts a new technology, others are forced to follow suit if they are to survive in the marketplace" (Schmink and Wood 1987, 42). In their efforts to keep up with their neighbor and survive foreclosure, cotton farmers have no other choice than to select transgenic varieties containing germplasm with the most potential for high yield and short-term profit.

The nature of GE technologies encourages wholesale conversion to the ways of the majority. The bulk of northwest cotton farmers plant GE cotton. Levidow (2001) writes extensively on the problems of coexistence between GE and non-GE seed, namely in regards to corn. This concept comes into play in regards to GE cotton as well, but a bit differently. Ginning, or the process by which cotton lint is separated from the cottonseed, complicates seed saving. Farmers who save and delint seed after ginning risk having it contaminated by GE seed. Although I have been told that it is the delinter's responsibility to check for contamination, farmers ultimately bear the burden of litigation. Farmers who plant conventional cotton also chance chemical drift damage. The risk of having their crops damaged by glyphosate drift persuades some farmers to throw in the towel and plant Roundup Ready seed instead of conventional to avoid chemical damage.

Biotech and seed companies have instigated a litany of additional social maneuvers to maintain and strengthen their control of seed. The first of these is seed and chemical pricing. GE cottonseed is competitively priced with the cost of previous forms of weed removal and insect control. Also, in efforts to access untapped markets, GE seed is more expensive in the United States than in developing countries such as Brazil or India. This type of preferential pricing is also practiced between regions within the United States. Mississippi cotton farmers pay more for certain types of GE cottonseed than do Texas cotton farmers. Additionally, stacked-gene varieties (containing HT *and* IR traits) are priced competitively with single trait varieties. Therefore, farmers often purchase stacked gene varieties over single trait ones 'just in case' without taking too much of an added economic risk. From a corporate perspective, the more experience a farmer has with their technology, the more likely they are to use it again. Or, the more farmers use and become invested within the farming practices required of the technology, the more difficult it is for them to change.

As discussed in Chapter Seven, risk alleviation programs such as corporate-sponsored replant and minimum yield incentives are constructed to give farmers who plant GE seed an advantage over those who plant conventional cottonseed. But farmers are required to uphold all-or-nothing terms of the agreement in order to cash in on the rewards of the program. For example, farmers must purchase and use Roundup products on all of their cotton acres in order to qualify for reimbursement of their technology fees. The added cost of the seed and chemical required to qualify for the program many times negates the benefits of participation. The primary goal, after all, is to sell more seed, not protect the well-being of farmers and their communities. While these programs do alleviate risk, they do so primarily for those farmers with the capital to purchase name-brand products.

One of the most significant findings of this study illuminates the latest, but surely not last, attempt to commodify the seed. Frustrated with the loss of potential income of their popular conventional type FM 958 seed, Bayer Fibermax implemented a new campaign to convince farmers of the inferiority of saved seed. When farmers purchase certified FM 958 seed, Bayer requires them to sign an agreement stating they will not save or replant the seed. There is no legal premise for such exclusion of rights. Under the Plant Variety Protection Act, farmers are granted the right to save seed for their own use. Nor is conventional FM 958 protected under patent law as it does not contain a patented trait. So now scare tactics and unsubstantiated ad hoc agreements are being used to manipulate farmers and profit from seed.

After ten years of predominately indirect strategies to push seed privatization, Monsanto has recently returned to technical forms of control. Roundup Ready Flex cottonseed offers farmers flexibility of full-season over-the-top Roundup applications to control weeds. RR Flex seed has been genetically altered, according to Monsanto, to withstand their brand-name, reformulated Roundup herbicides only. In efforts to recover from their 1999 loss of patent rights to glyphosate, Monsanto revamped their strategy to generate revenue by offering a seed and chemical combination that they alone control. Unfortunately, Roundup Ready Flex, out of the pipeline after nearly a decade, enters the market at an inopportune time. Weed resistance to glyphosate is spreading and Monsanto is concerned. Perhaps the development of weed resistance is something Castree (2003) would refer to as "incomplete commoditization" when "nature puts barriers in the way of complete commodification" (Castree 2003, 288). Or simply put, when nature fights back. Regrettably, farmers are responding to increased weed tolerance and resistance with higher application rates of glyphosate and/or the use of different herbicides. Generic glyphosate is cheap and therefore is the easiest means of controlling weeds. RR Flex cotton will further accelerate weed tolerance and resistance in northwest Texas. Monsanto may profit from RR Flex cotton and their reformulated glyphosaste concoction in the short-term but the long-term effects of Roundup Ready technologies and the subsequent overuse of glyphosate threaten the health of human and ecological communities throughout the world. Furthermore, farmers, not Monsanto, will be forced to deal with the everyday consequences of weed resistance in their fields.

Displacement

According to Castree (2003, 282) displacement is "about something appearing, phenomenally, as something other than itself." How is the face of GE cotton different from the processes and implications behind its development? Basically, when we talk about displacement we are really concerned with hidden costs or externalities. What are the true costs of widespread GE cotton production in northwest Texas? As discussed at length in previous chapters, GE cotton, on the surface, appears to be advantageous for farmers and farming communities of northwest Texas in several ways. HT cotton especially, is convenient in that it greatly reduces the labor and management requirements of weeding cotton fields. But as illustrated in Chapter Six, the reduction in labor requirements facilitates the consolidation of land and reduction in weeding jobs available in rural communities. Land consolidation allows fewer farmers to manage more acres. Less cotton-related jobs translates into less workers and families in cotton-growing communities. As seen in the Hale Center example, fewer families are left to support rural businesses, churches, and schools.

GE cotton also appears to be higher yielding than conventional cotton. But as outlined within Chapter Four, increased yields are more likely the result of high-yielding germplasm in GE varieties rather than the direct result of herbicide tolerant or insect resistant traits. Profits from high yields are required to pay for more expensive GE seed. On the contrary, researchers such as Dr. Randy Boman have shown in NW Texas field trials that many times less expensive conventional varieties net more profit per acre than GE varieties. But the more farmers purchase GE seed, the fewer conventional varieties there are from which to choose. Farmers choose and plant GE seed in efforts to remain competitive with their neighbors, but all the while, they are actively engaged in reducing their own future alternatives. But what are they to do? Either way, they loose.

Biotechnology companies also claim that GE cotton requires less pesticide and therefore is beneficial to the environment and farmer health and safety. Yes, GE cotton did initially reduce the amount of herbicide and insecticide needed for the control of weeds and insects. But, as Benbrook (2004) in particular indicates, the overall use of pesticide on U.S. cotton acres has increased between 1995 and 2004. Weeds have developed increased tolerances and in some cases complete resistance to system herbicides such as glyphosate. Today farmers actually use more herbicide to control weeds than they did previous to HT technologies. Insect populations too have responded to the use of GE cotton. Resistance to Bt cotton and alterations of insect populations in response to Bt cotton have caused secondary pests not controlled by Bt cotton to become a problem requiring yet another chemical control.

When farmers agree to plant GE cotton, they also agree to a set of corporate legalities which violate their rights as citizens and criminalize otherwise customary practices such as saving seed. Hidden within the small print of TSAs, and TUGs, cotton farmers sign away their right to a court of law. They forfeit the right to speak freely of situations in which they were wronged or violated by biotechnology companies. They give companies such as Monsanto the authority to inspect and copy their personal receipts and records. They allow corporate representatives to come onto their property for inspection. In these regards "those who are exploited become the criminals, those who exploit require protection" (Shiva 1997, 56). The displaced costs and long-term effects of GE cotton adoption are many and in these ways threaten the very premise of agriculture the world over.

Patching Green problems with Gene problems

According to Worster (1993), the Great Plains have been transformed by Green Revolution technologies. As a result, agriculture on the Great Plains consists of monocultures, a dependency on inputs (fossil fuels, synthetic fertilizers, and chemicals), susceptibility to disease, predation, pests, and disaster, system instability, short-term risks for profit, and dependency on capital and expertise that farmers can not provide. Genetic engineering technologies do not solve these problems but "patch and reinforce a system whose characteristic attributes—monoculture, chemical intensity, genetic uniformity—are widely regarded as unsustainable" (Kloppenburg 2004, 316).

Beginning in the 1940s and 1950s, hybrid seed, pesticides, and synthetic fertilizers made it easier for farmers to grow larger amounts of key commodity crops for which there was an external market or demand. Farmers planted higher-yielding hybrid seeds in hopes of increasing their economic returns. But large plantings of hybrid seed necessitated more pesticide to protect the monocrop from insect pests and diseases that were not problematic when farmers planted a diversity of crops and plant varieties. This study shows that GE cotton expands monocultures and contributes to their problems. Due to its reduced labor requirements, GE cotton supports monocropping in that it is easier for farmers to devote and manage more acres of cotton than before. GE monocultures are also more susceptible to pests, disease, and disaster. Bt cotton may avert bollworms but with secondary succession once minor pests are becoming problematic.

As with previous industrial-type farming methods, GE crops value short-term profit over long-term sustainability. Seed with higher yield potential requires more fertilizer and irrigation with which to profit. More nutrients and water are taken from the land and more are required for the land to produce the following year. Exploitation of the land is a "rational short-term solution to the market-oriented production that drains capital from the producer" (Schmink and Wood 1987, 46). Farmers who grow GE crops, invest more capital into their crops and are therefore required to make more in the short-term to make a profit. Farmers find it difficult to nurture the health of their soil in such a competitive market system where they either keep up with technology or get out of the business altogether.

One of the most detrimental aspects of the earlier Green Revolution was the creation of a system whereby farmers became dependent upon external sources of horsepower, (animal to machines), fuel (feed to oil), fertilizer (on-farm waste to petroleum), pest control (crop rotation, diversity, and natural methods to pesticides), irrigation methods (hand or wind powered to oil), credit (trade to cash system), and seed (locally-adapted and saved to hybrid). Like Green Revolution technologies "biotechnology increases the reliance of farmers on purchased inputs" (Kloppenburg 2004, 283). As indicated in this study, genetically engineered cotton has not solved or made better the Green Revolution induced predicament of plains agriculture. Today's farmers are more, not less, dependent upon agribusinesses and corporations for their agricultural inputs. They have fewer choices and less autonomy in their farming practices than they did just ten years ago. Just as the Green Revolution "destroyed diverse agricultural systems adapted to the diverse ecosystems of the planet" (Shiva 1997, 107), the Gene

Revolution attempts to further capitalize natural inputs to ensure that agriculture is profitable for those with the power and means of control.

Chapter 9

Conclusions

When I started this project several years ago I was not sure what I would find. I was shocked to learn that so many of my friends and family in Elliott grow genetically engineered cotton and I simply wanted to better understand how this came to be and what it meant for my community.

I have found that after only ten years of availability, GE cotton has become central to northwest Texas cotton production and has created an insulating and self-perpetuating culture of dependency which has marginalized traditional and more sustainable ways of farming and endangered the long-term survival of farm families and the rural communities they sustain. It has taken me a long time to reach this conclusion. Despite doubts along the way, and the possibility that some may disagree with me, I stand firm. Genetically engineered cotton may appear to be beneficial for its convenience, but the hidden costs of its long-term production undermines the sustainability of farm families and communities in rural northwest Texas.

This project has been a learning experience in many ways but more than anything it has helped me better understand the dire situation of American commodity farmers. Even though I grew up on a farm and am actively involved in farming on a day-to-day basis, I found it difficult to comprehend, much less articulate, our predicament. It is most definitely convoluted and full of contradictions. Unable to make a living off the amount of land our parents farmed, we must either find off-farm employment or compete with our neighbors to buy more land. In order to manage and pay for more land, we invest in expensive labor-saving technologies such as newer farm equipment and GE seeds. But as overall production and yields increase, the price we receive for our commodities decreases—reinforcing the cycle and necessitating more investments to pay for previous ones. Most farmers have no other choice than to manage for short-term survival. This system isn't fair. It isn't sustainable and it doesn't work.

This study takes a critical look at farmer's experiences with GE cotton to reveal the larger costs of its production in northwest Texas. It illustrates how GE cotton encourages monocultures and the consolidation of land, increases farmers reliance on agribusinesses for inputs, reduces the autonomy of independently minded farmers through the reduction of seed choice, increases the use of pesticides, and reduces the number of cotton-related jobs in rural areas—which has a social and economic ripple effect throughout the community. In these ways, GE cotton facilitates increased corporate control over seed and the farmers, at the same time it undercuts the sustainable livelihoods that make cotton farming a way of life in northwest Texas.

Most farmers are fully aware of the technology trap in which they are caught. Others have yet to come to this realization and fervently await each new techno-fix to take birth from the industry pipeline. But for most, there is frustration with a system and little hope in what the future holds. During one of my first interviews, a middle-aged farmer confided:

> Farming just isn't any fun anymore. It used to be. I really enjoyed everything about it. But now it's just depressing.

Another farmer lamented:

> I just want to make a living at it [farming], that's all. I don't think that's too much to ask. Is it?

Faced with the rising complexity and expenses of farming, most farmers have lost all hope that their sons and daughters will return to the family farm:

> There ain't goin' to be no more farmers. It's all going to be run by corporations. The family farm is going to … I think … well… They've been saying for a long time that it's on its way out but I think it's going out faster than it used to be. Nobody is coming back because there is no money. The only way any of us did it was because our daddies and granddaddies farmed. Well, like me and Bill, and Bob, and Fred and Gary now. If our parents weren't in it, we wouldn't be in it no way. I don't care how bad you wanted to be a farmer. You can't do it. I don't know if we'll see it, but eventually we'll all be gone.

If the trend towards industrialization and corporate control over agriculture continues at the current trajectory it will not be long before the family farm as we know it will be a thing of the past.

Contextualizing change

As part of the Great Plains culture, northwest Texas was once an expansive sea of grass frequented by migratory forms of life. The land resisted settlement. But those who persevered through the hardships of extreme weather, drought, and isolation developed an independent, weathered, and no-nonsense resolve still characteristic of the region today. Geographically speaking, northwest Texas is an ideal region for agricultural industrialization. The vast and expansive plains are flat, free of trees and rocks, topped with prized topsoil, and positioned over the world's largest underground water reserve, the Ogallala aquifer. Additionally, few people and a surplus of natural resources (land and water) fostered early agricultural innovation in the region. Tractors, the mechanical cotton harvester, irrigation technology, hybrid seed, and cotton ginning equipment have all been perfected on the northwest plains of Texas. An abundance of grain and cotton, ample space, a developed interstate highway system and railroads, and a source of low-wage labor (Braceros and, later, migrant laborers) supported the creation of the area's agricultural empire. Yet the Ogallala has been the ace in the hole—literally and figuratively—drawing agribusinesses into the area to provide inputs for farmers and manufacturing centers to process and distribute the abundant agricultural commodities subsidized by the aquifer.

Not long ago a farmer could support his family on 160 acres. There were at least four farm families to every section of land. But farms have grown larger with each new agricultural innovation. Today the average size of a farm in Texas is over 700 acres. Rural communities struggle with the reality of fewer farm families to support local businesses. Most young people move to good paying jobs in urban centers, not small towns. Few outsiders see northwest Texas as a place worthy of inhabiting. Upon crossing the area (even by air), most find it to be hot, flat, windy, and utterly uninteresting. Those that have remained are a unique and dying breed of rural people notably individualistic, plain-spoken, and industrious.

The Plains farmers of today survive out of the same determination and ingenuity of their ancestors yet their plight is more complicated and urgent than ever. The 'underground rain' of the Ogallala aquifer was once thought to be infinite. But even with the use of highly efficient irrigation methods, some fear that it will be depleted within the next 10-20 years. Seed, chemical, machine and fuel prices are on the rise with little hope of a corresponding increase in the price farmers receive for the crops they grow. Environmental historian Donald Worster (1979, 239) tells us, "the Great Plains cannot be pushed and pushed to feed that world's growing appetite for wheat without collapsing at last into a sterile desert." The same is true of the production of cotton. Brooks and Emel (1995, 2000) believe the region to be shifting between an "impoverished" and "endangered" zone. They trace agricultural forces that have brought the region to endangerment and conclude that the "only obvious solution is to discontinue or greatly reduce irrigated agriculture and industrialized beef finishing" (2000, 4). Others such as Popper and Popper (1987, 1999) have gone as far as to suggest that the region return to a "Buffalo Commons." Our situation seems overwhelmingly dismal at times, especially given the discouraging findings of this study. But nonetheless, hope for the future of family farms and rural communities does exist.

Sustaining rural communities in northwest Texas and beyond

My key concern has been with the sustainability of family farms and rural communities. The bulk of this study challenges the proposed benefits of GE cotton adoption. But it is unproductive to be critical of the status quo if one is not willing to discuss alternatives. I hope this study can contribute to a more sustainable future for the cotton farmers and families of northwest Texas, and I would like to end with some suggestions.

In recent years, opposition to an industrialized agricultural system has grown. Consumers are not afraid to challenge the omnipotence of corporate science or the inevitability and superiority of industrial technologies. Many consumers understand the environmental and social benefits of local food systems and are willing to pay a premium for regional food that was grown without the use of pesticides or GE seeds. In fact, demand for natural and organic food is growing faster than domestic sources that supply the market.

But cotton farmers in northwest Texas are commodity farmers. They grow large amounts of commodity crops for a market which dictates the price. Many refer to this class of farmers as the "agriculture of the middle."[13] These farmers operate independent family farms which have traditionally constituted the heart of American agriculture. But now, "midsized farms are the most vulnerable in today's polarized markets, since they are too small to compete in the highly consolidated commodity markets and too large and commoditized to sell in the direct markets" (Kirschenmann 2004, Kirschenmann *et al*. 2006). What options exist for these kinds of farmers?

According to Kirschenmann (2004), midsized farms are in the position to provide larger quantities of natural, organic, and specialty items through mid-tier value chains. "Mid-tier value chains are strategic alliances between independent (often cooperative) food production, processing, and distribution/retailing enterprises that seek to create and retain more value on the front end of the chain, and often operate at a regional level" (2004, 3). Examples include regional grass-fed beef cooperatives, organic cotton cooperatives, and farmer-owned grain mills. It is imperative that farmers and consumers, not corporations, control mid-tier value chains. As Guthman (2004) has shown in her work on the California organic industry, where there is demand, there is privitization. Farmers must loosen their ties to agribusiness as "The imperatives of capitalism necessitate

[13] As proposed by Fred Kirschenmann, Steve Stevenson, Fred Buttel, Tom Lyson, and Mike Duffy in their white paper for the Agriculture of the Middle Project www.agofthemiddle.org.

ongoing attacks and outrages against sustainable, democratic, egalitarian relationships within human communities" (McCarthy 2002, 1298). Any solution to the "predicament of the Plains" must value the economic, environmental, and social aspects of community. Berry tells us, "to be healthy, land-based communities will need to add value to local products, they will need to supply local demand, and they will need to be reasonably self-sufficient in food, energy, pleasure, and other basic requirements" (Berry 2002, 203).

These ideas are realistic but the path to implement them will not be easy. As I have mentioned repeatedly, commodity farmers, such as those in northwest Texas, are stuck in a production cycle that ties them to technological fixes and government support to survive. What will it take for farmers to be able to risk change? First, commodity farmers will need incentives and government assistance to transition to alternative types of farming. Given the corporate interest in the current system of production, this type of change will be difficult but not impossible. Consumers must continue to demand that their food be produced by family farms using environmentally and socially sound methods. "People increasingly will want to have relationships as part of their purchasing experience" (Kirschenmann 2004, 2). Relationship building between consumers and farmers is fundamental to farmer and community-centered forms of "new agrarianism" (Freyfogle 2001) and "civic agriculture" (Lyson 2004). Berry tells us "For good farming to last, it must occur in a good farming community–that is, a neighborhood of people who know each other, who understand their mutual dependences, and who place a proper value on good farming" (Berry 2002, 189). GE cotton does not promote good farming or ensure a future for rural communities of northwest Texas.

On March 3, 2005 the World Trade Organization (WTO) upheld its 2004 ruling in favor of Brazil stating that U.S. agricultural support programs for cotton were trade-distorting and in violation of WTO rules. In the early months of George Bush's second term as president he proposed budget cuts of $5.7 billion from agriculture, conservation, nutrition, and risk management programs of the USDA. Under the proposed budget cuts, a hypothetical farm would loose $7,700.[14] U.S. and world cotton production records were shattered in 2004 and 2005 and as a result world cotton prices fell 24 percent between 2004 and 2005. Fuel and fertilizer costs continue to go up as crude oil rose to over $70/barrel in early 2006. Northwest Texas is an extended drought and experts are predicting farmers could loose significant sums of money on cotton in 2006.

It is spring and farmers in northwest Texas are waiting for rain to prepare their fields for planting. Sitting around the table at the gin or hanging out at the co-op, you can bet that the drought and speculation over this year's cotton crop is the topic of conversation. It is so dry that many non-irrigated farmers do not intend on planting cotton. Regardless if they do or not, one thing is for sure—

[14] As stated by Mark Halverson, minority staff director on the U.S. Senate Committee on Agriculture, Nutrition, and Forestry (Southwest Farm Press, March 10, 2005, p. 12).

farmers are slowly getting squeezed out of our nation's food and fiber production system. Those that survive are no longer individually minded farmers, but mass producers; serfs on the land indebted to King Cotton and his court of gene giants. This is not the type of future I envision for my family or my community. Change, and hopefully some rain, is on the horizon.

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Appendices

Appendix A

Monsanto's Customer Visit Program Advertisement

Customer Visit Program Helps Monsanto Listen and Respond to Farmers' Needs

At a Glance

- *Monsanto is focused solely on agriculture and making farmers successful.*
- *As part of this commitment, Monsanto hosts a Customer Visit program that supports the company's objective of listening and responding to customer needs.*
- *More than 3,000 farmers visit Monsanto in St. Louis each year to learn about the new product development process and provide feedback to company management.*
- *Farmers say the visits are very informative and provide them with a better understanding of what Monsanto is doing to help make them more successful.*

As a company focused solely on agriculture, Monsanto helps farmers be more successful. That means not only developing new products designed to improve efficiency and increase profitability for farmers, but also listening to their needs.

One of the ways the company does that is through its Customer Visit Program, which brings more than 3,000 farmers a year to Monsanto's research facilities and corporate headquarters in St. Louis to learn about the company's new product pipeline and to provide feedback to Monsanto management.

"Hopefully, the benefit for growers is an understanding that Monsanto's goal is to bring improved seed and trait and technologies to the marketplace, so they can do their jobs better," says Jim Zimmer, U.S. Director of Marketing for Monsanto. "We recognize that our success and that of our customers is mutually linked."

Research and Development

Small groups of farmers from across the country are flown or bused in to take part in the Customer Visit Program, which starts with a tour of the Monsanto research facilities in Chesterfield, Missouri, just outside of St. Louis. On the tour, growers see how the new product development process works, and they get an up-close look at some of the latest research projects under way. Current focus areas include:

- Drought and cold tolerance
- Agronomic pest resistance
- Food nutritional enhancements
- Improved animal feed nutrition

Farmers say the visit is a great opportunity to see what really goes on in the research and development process, and they say they come back with a whole new appreciation for Monsanto and what the company is doing for them.

On average, it takes eight to 10 years and an investment of $50 million to $100 million to develop and introduce a new product.

"Monsanto's goal is to bring improved technology to the market place. We recognize that our success and that of our customers is mutually linked."

Jim Zimmer, U.S. Director of Marketing for Monsanto

"It's very impressive," says Kelly Toelke, who, along with her husband, Robert, owns a custom seed dealership in New Haven, Missouri. "You hear a lot about biotech, but it really makes a difference when you see it up close and the mechanics of it are explained in detail. It's amazing the research Monsanto is doing, and seeing firsthand what's going on really makes you aware of how committed Monsanto is to making farmers more productive."

Grower Opinions Matter

Following the Chesterfield tour, growers spend the afternoon at Monsanto's corporate headquarters in St. Louis for a free-flowing discussion between the growers and Monsanto management representatives. The exact subjects discussed vary, based on the information the growers want to know and the questions they ask, which may include pricing, stacked traits, weed management, approach to foreign markets and the best ways to utilize Monsanto's technology.

"The feedback we get from growers is invaluable," explains Zimmer. "These visits provide a unique chance to listen and respond to our customers' needs."

"Everyone I've spoken to agrees these visits are well worth their time," says Toelke. "We learned a lot about what's in the research pipeline, but, even more important, this tour made us realize that Monsanto's on our side."

Roundup Ready® Alfalfa is one of the new technologies developed at Monsanto's Chesterfield research facilities.

Always follow grain marketing and insect resistance management requirements, and read and follow pesticide label directions.

Special Sponsored Page from Monsanto

Focused on agriculture.
Committed to the future of farming.

MONSANTO
imagine

Appendix B

Monsanto's Commitment to Agriculture Advertisement

As you plan the next year,
we are researching the next ten.
Monsanto is 100 percent dedicated to the next generation of innovation — to delivering the technology that will help you more efficiently grow crops as well as your bottom line.
At Monsanto, we are entirely committed to agriculture's future. And yours.
MONSANTO
imagine

Appendix C

2006 Monsanto Technology/Stewardship Agreement

2006 MONSANTO TECHNOLOGY/STEWARDSHIP AGREEMENT

(Limited Use License)

PLEASE MAIL THE SIGNED 2006 MONSANTO TECHNOLOGY/STEWARDSHIP AGREEMENT TO: Grower Licensing, Monsanto, 622 Emerson Road, Suite 150, St. Louis, MO 63141

GROWER INFORMATION (please print)

Please complete this section with your business information. To sign this Agreement you must be the operator/grower for all fields that will grow plants from Seed you obtain containing Monsanto Technologies (defined below). You represent that you have full authority to and do hereby bind to this Agreement yourself, all entities for which you obtain Seed, all individuals and entities having an ownership interest in any entities for which you obtain Seed, and that Monsanto Company has not barred any of these individuals or entities from obtaining this limited-use license. Your name must be filled in and must match the signature below.

Full Grower's Name (First/Middle/Last) Dr. Mr. Mrs. Ms. Suffix (Jr. Sr. II, III, etc.) Farm Business Name

Business Address (as listed with the FSA) Business City

State Zip Area Code Business Phone Fax

E-mail Address

PRIMARY SEED SUPPLIER

Business Name

Area Code Phone City State Zip

THIS SPACE FOR MONSANTO OFFICE USE ONLY, PLEASE LEAVE THIS SECTION BLANK:

Lic. #: Batch #: Date:

This Monsanto Technology/Stewardship Agreement is entered into between you (Grower) and Monsanto Company (Monsanto) and consists of the terms on this page and on the second page.

This Monsanto Technology/Stewardship Agreement grants Grower a limited license to use Roundup Ready® soybeans, YieldGard® Corn Borer corn, YieldGard® Rootworm corn, YieldGard® Rootworm with Roundup Ready® Corn 2, YieldGard® Plus corn, YieldGard® Plus with Roundup Ready® Corn 2, Roundup Ready® Corn 2, YieldGard® Corn Borer with Roundup Ready® Corn 2, Roundup Ready® cotton, Bollgard® cotton, Bollgard® with Roundup Ready® Cotton, Bollgard II® cotton, Bollgard II® with Roundup Ready® Cotton, Roundup Ready® Flex Cotton, Bollgard II® with Roundup Ready Flex Cotton, Roundup Ready® sugarbeets, Roundup Ready® Canola, and Roundup Ready® Alfalfa (Monsanto Technologies). This Agreement also contains Grower's stewardship responsibilities and requirements associated with the Monsanto Technologies.

GENERAL TERMS:

Grower's rights may not be transferred to anyone else without the written consent of Monsanto. If Grower's rights are transferred with Monsanto's consent or by operation of law, this Agreement is binding on the person or entity receiving the transferred rights. If any provision of this Agreement is determined to be void or unenforceable, the remaining provisions shall remain in full force and effect.

Grower acknowledges that Grower has received a copy of Monsanto's Technology Use Guide (TUG). To obtain additional copies of the TUG, contact Monsanto at 1-800-768-6387 or go to Farmsource.com. Once effective, this agreement will remain in effect until either Grower or Monsanto chooses to terminate the Agreement. Information regarding new and existing Monsanto Technologies and any new terms will be mailed to you each year. Continuing use of Monsanto Technologies after receipt of any new terms constitutes Grower's agreement to be bound by the new terms. If any provision of this Agreement is determined to be void or unenforceable, the remaining provisions shall remain in full force and effect.

GROWER RECEIVES FROM MONSANTO COMPANY:

- A limited use license to purchase and plant seed containing Monsanto Technologies ("Seed") and apply Roundup agricultural herbicides and other authorized non-selective herbicides over the top of Roundup Ready crops. Monsanto retains ownership of the Monsanto Technologies including the genes (for example, the Roundup Ready gene) and the gene technologies. Grower receives the right to use the Monsanto Technologies subject to the conditions specified in this Agreement and for spring canola in a separate use agreement.
- Monsanto Technologies are protected under U.S. patent law. Monsanto licenses the Grower, under applicable patents owned or licensed by Monsanto, to use Monsanto Technologies subject to the conditions listed in this Agreement. This license does not authorize Grower to plant Seed in the United States that has been purchased in another country or plant Seed in another country that has been purchased in the United States. Grower is not authorized to transfer Seed to anyone outside of the U.S.
- Enrollment for participation in Roundup Rewards℠ program.
- A limited use license to prepare and apply on glyphosate-tolerant soybean, cotton, alfalfa, or Canola crops (or have others prepare and apply) tank mixes of, or sequentially apply (or have others sequentially apply), Roundup agricultural herbicides or other glyphosate herbicides labeled for use on those crops with quizalofop, clethodim, sethoxydim, fluazifop, and/or fenoxaprop to control volunteer Roundup Ready corn in Grower's crops for the 2006 growing season. However, neither Grower nor a third party may utilize any type of co-pack or premix of glyphosate plus one or more of the above-identified active ingredients in the preparation of a tank mix.

PLEASE MAIL THE SIGNED 2006 MONSANTO TECHNOLOGY/STEWARDSHIP AGREEMENT TO: Grower Licensing, Monsanto, 622 Emerson Road, Suite 150, St. Louis, MO 63141. This Monsanto Technology/Stewardship Agreement becomes effective if and when Monsanto issues the Grower a license number from Monsanto's home office in St. Louis, Missouri. Monsanto does not authorize seed dealers or seed retailers to issue a license of any kind for Monsanto Technologies.

UNITED STATES PATENTS:

The licensed U.S. patents includes for YieldGard® Corn Borer corn – [illegible]

ALWAYS READ AND FOLLOW PESTICIDE LABEL DIRECTIONS. [illegible]

Page 1 of 2

GROWER AGREES:

- To direct grain produced from corn containing the YieldGard Rootworm trait and stacks that include the Roundup Ready Corn 2 and/or YieldGard Rootworm traits to appropriate markets as necessary.
- If growing Roundup Ready alfalfa: to comply with the Seed and Feed Use Agreement, which is incorporated and part of this Agreement; to direct any product produced from a Roundup Ready alfalfa crop or seed, including hay and hay products, only to those countries where regulatory approvals have been granted, and not to plant Roundup Ready alfalfa for the production of sprouts. Refer to the Technology Use Guide for additional information.
- To accept and continue the obligations of this Monsanto Technology Stewardship Agreement on any new land purchased or leased by Grower that has Seed planted on it by a previous owner or possessor of the land; and to notify in writing purchasers or lessees of land owned by Grower that has Seed planted on it that the Monsanto Technology is subject to this Monsanto Technology Stewardship Agreement and they must have or obtain their own Monsanto Technology Stewardship Agreement.
- To implement an Insect Resistance Management program as specified in the applicable Bollgard/Bollgard II cotton and YieldGard corn sections of the most recent Technology Use Guide (TUG) and Insect Resistance Management (IRM) guides and to cooperate and comply with Insect Resistance Management programs.
- To use Seed containing Monsanto Technologies solely for planting a single commercial crop. Not to save any crop produced from Seed for planting and not to supply Seed produced from Seed to anyone for planting other than to a Monsanto licensed seed company.
- Not to transfer any Seed containing patented Monsanto Technologies to any other person or entity for planting.
- To plant Seed for Seed production, if and only if, Grower has entered into a valid, written Seed production agreement with a Seed company that is licensed by Monsanto to produce Seed. Grower must either physically deliver to that licensed Seed company or must sell or use as commodity grain all of the Seed produced pursuant to a Seed production agreement. Grower shall not plant any seed Grower has produced or use or to allow others to use Seed containing patented Monsanto Technologies for crop breeding, research, or generation of herbicide registration data.
- To use on Roundup Ready crops only a labeled Roundup® agricultural herbicide or other authorized non-selective herbicide which could not be used in the absence of the Roundup Ready gene (see TUG for details on authorized non-selective products). Use of any selective herbicide labeled for the same crop without the Roundup Ready gene is not restricted by this Agreement. MONSANTO DOES NOT MAKE ANY REPRESENTATIONS, WARRANTIES OR RECOMMENDATIONS CONCERNING THE USE OF PRODUCTS MANUFACTURED OR MARKETED BY OTHER COMPANIES WHICH ARE LABELED FOR USE IN ROUNDUP READY CROPS. MONSANTO SPECIFICALLY DISCLAIMS ALL RESPONSIBILITY FOR THE USE OF THESE PRODUCTS IN ROUNDUP READY CROPS. ALL QUESTIONS AND COMPLAINTS ARISING FROM THE USE OF PRODUCTS MANUFACTURED OR MARKETED BY OTHER COMPANIES SHOULD BE DIRECTED TO THOSE COMPANIES.
- To read and follow the applicable sections of the TUG, which is incorporated into and is a part of this Agreement, for specific requirements relating to the terms of this Agreement, and to abide by and be bound by the terms of the TUG as it may be amended from time to time.
- To acquire Seed containing these Monsanto Technologies only from a seed company with technology license(s) from Monsanto or from a licensed company's authorized dealer.
- To pay all technology fees due to Monsanto that are a part of, associated with or collected with the Seed purchase price or that are invoiced for the seed.
- Upon written request, to allow Monsanto to review the Farm Service Agency crop reporting information on any land farmed by Grower including Summary Acreage History Report, form 578 and corresponding aerial photographs, Risk Management Agency claims documentation, and dealer/retailer invoices for seed and chemical transactions.
- To allow Monsanto to examine and copy any records and receipts that could be relevant to Grower's performance of this Agreement.

GROWER UNDERSTANDS:

- Commodity Marketing: Grain/commodities harvested from YieldGard Plus corn, YieldGard Plus with Roundup Ready Corn 2, YieldGard Rootworm with Roundup Ready Corn 2, YieldGard Corn Borer with Roundup Ready Corn 2, Roundup Ready Canola, and YieldGard Rootworm corn are approved for U.S. food and feed use but not yet approved in certain export markets where approval is not certain to be received before the end of 2006. As a result, Grower must direct these grain/commodities to the following approved market options: feeding on farm, use in domestic feed lots, elevators that agree to accept the grain, or other approved uses in domestic markets only. Go to www.[illegible].com for a list of Grain Handlers' positions on accepting transgenic corn. The American Seed Trade Association web site (www.amseed.org) includes a list of grain handlers' positions on accepting transgenic corn. You must complete and send to Monsanto a Market Choices® Grain Marketing Communication Plan. For additional information on grain market options or to obtain additional forms, call 1-800-768-6387.
- Regulatory approvals: Monsanto Technologies may only be used where the products have been approved for use by all required governmental agencies. For example, some Monsanto Technologies are not approved in all states. Check with your Monsanto representative if you have questions about the approval status in your state.
- Insect Resistance Management (IRM): When planting any YieldGard or Bollgard product, Grower must implement an IRM program including planting a non-Bt refuge according to the size and distance guidelines specified in the Bollgard cotton and YieldGard corn sections of the most recent Monsanto Technology Use Guide including any supplemental amendments (collectively "TUG") and the crop specific IRM guides. Grower may lose Grower's limited use license to use these products if Grower fails to follow the IRM program required by this Agreement.
- Crop Stewardship & Specialty Crops: Refer to the section on Coexistence and Identity Preservation in the TUG for information on crop stewardship and considerations for production of identity preserved crops.

MONSANTO'S REMEDIES:

If Grower breaches this Agreement, in addition to Monsanto's other remedies, Grower's limited-use license will terminate immediately. Thereafter, Monsanto will not accept any application for a new Monsanto Technology Stewardship Agreement unless Monsanto provides in writing an authorization specifically naming Grower. Any such purported agreement that does not contain Monsanto's express authorization (whether a license number has been issued or not) is void. Injunction, Infringement and Contract Damages. If Grower is found by any court to have infringed one or more of the U.S. patents listed below, Grower agrees that Monsanto will be entitled to a permanent injunction enjoining Grower from making, using, selling, or offering for sale Seed and patent infringement damages to the full extent authorized by 35 U.S.C. § 271 et seq. Grower will also be liable for all breach of contract damages. If Grower is found by any court to have infringed one or more of the U.S. patents listed below or otherwise to have breached this agreement, Grower agrees to pay Monsanto and the licensed Monsanto Technology provider(s) their attorneys' fees and costs.

Grower accepts the terms of the following NOTICE REQUIREMENT, LIMITED WARRANTY AND DISCLAIMER OF WARRANTY AND EXCLUSIVE LIMITED REMEDY by signing this Agreement and/or opening a bag of Seed containing Monsanto Technology. If Grower does not agree to be bound by the conditions of purchase or use, Grower agrees to return the unopened bags to Grower's seed dealer.

NOTICE REQUIREMENT:

As a condition precedent to Grower or any other person with an interest in Grower's crop asserting any claim, action, or dispute against Monsanto and/or any seller of Seed containing Monsanto Technologies regarding performance or non-performance of Monsanto Technologies or the Seed in which it is contained, Grower must provide Monsanto a written, prompt, and timely notice (regarding performance or non-performance of the Monsanto Technologies) and to the seller of any Seed (regarding performance or non-performance of the Seed) within sufficient time to allow an in-field inspection of the crop(s) about which any controversy, claim, action, or dispute is being asserted. The notice will be timely only if it is delivered 15 days or less after the Grower first observes the issue(s) regarding performance or non-performance of the Monsanto Technology and/or the Seed in which it is contained. The notice shall include a statement setting forth the nature of the claim, name of the Monsanto Technology, and Seed hybrid or variety.

LIMITED WARRANTY AND DISCLAIMER OF WARRANTIES:

Monsanto warrants that the Monsanto Technologies licensed hereunder will perform as set forth in the TUG when used in accordance with directions. This warranty applies only to Monsanto Technologies contained in planting Seed that has been purchased from Monsanto and seed companies licensed by Monsanto or the seed company's authorized dealers or distributors. EXCEPT FOR THE EXPRESS WARRANTIES IN THE LIMITED WARRANTY SET FORTH ABOVE, MONSANTO MAKES NO OTHER WARRANTIES OF ANY KIND, AND DISCLAIMS ALL OTHER WARRANTIES, WHETHER ORAL OR WRITTEN, EXPRESS OR IMPLIED INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE.

GROWER'S EXCLUSIVE LIMITED REMEDY:

THE EXCLUSIVE REMEDY OF THE GROWER AND THE LIMIT OF THE LIABILITY OF MONSANTO OR ANY SELLER FOR ANY AND ALL LOSSES, INJURY OR DAMAGES RESULTING FROM THE USE OR HANDLING OF SEED CONTAINING MONSANTO TECHNOLOGY (INCLUDING CLAIMS BASED IN CONTRACT, NEGLIGENCE, PRODUCT LIABILITY, STRICT LIABILITY, TORT, OR OTHERWISE) SHALL BE THE PRICE PAID BY THE GROWER FOR THE QUANTITY OF THE SEED INVOLVED OR, AT THE ELECTION OF MONSANTO OR THE SEED SELLER, THE REPLACEMENT OF THE SEED. IN NO EVENT SHALL MONSANTO OR ANY SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL, SPECIAL, OR PUNITIVE DAMAGES.

Thank you for choosing our advanced technologies. We look forward to working with you in the future. If you have any questions regarding the Monsanto Technologies or this license, please call the Monsanto Customer Relations Center at 1-800-ROUNDUP.

GOVERNING LAW: This Agreement and the parties' relationship shall be governed by the laws of the State of Missouri and the United States (without regard to the choice of law rules).

BINDING ARBITRATION FOR COTTON-RELATED CLAIMS MADE BY GROWER: Any claim or action made or asserted by a cotton Grower (or any other person claiming an interest in the Grower's cotton crop) against Monsanto or any seller of cotton Seed containing Monsanto Technology arising out of and/or in connection with this Agreement or the sale or performance of the cotton Seed containing Monsanto Technology other than claims arising under the patent laws of the United States must be resolved by binding arbitration. The parties acknowledge that the transaction involves interstate commerce. The parties agree that arbitration shall be conducted pursuant to the provisions of the Federal Arbitration Act, 9 U.S.C. Sec 1 et seq. and administered under the Commercial Dispute Resolution Procedures established by the American Arbitration Association ("AAA"). The term "seller" as used throughout this Agreement refers to all parties involved in the production, development, distribution, and/or sale of the Seed containing Monsanto Technology. In the event that a claim is not amicably resolved within 30 days of Monsanto's receipt of the Grower's notice required pursuant to this Agreement any party may initiate arbitration. The arbitration shall be heard in the capital city of the state of Grower's residence or in any other place as the parties decide by mutual agreement. When a demand for arbitration is filed by a party, the Grower and Monsanto/sellers shall each immediately pay one half of the AAA filing fee. In addition, Grower and Monsanto/sellers shall each pay one half of AAA's administrative and arbitrator fees as those fees are incurred. The arbitrator(s) shall have the power to apportion the ultimate responsibility for all AAA fees in the final award. The arbitration proceedings and results are to remain confidential and are not to be disclosed without the written agreement of all parties, except to the extent necessary to effectuate the decision or award of the arbitrator(s) or as otherwise required by law.

FORUM SELECTION FOR NON-COTTON-RELATED CLAIMS MADE BY GROWER AND ALL OTHER CLAIMS: THE PARTIES CONSENT TO THE SOLE AND EXCLUSIVE JURISDICTION AND VENUE OF THE U.S. DISTRICT COURT FOR THE EASTERN DISTRICT OF MISSOURI, EASTERN DIVISION, AND THE CIRCUIT COURT OF THE COUNTY OF ST. LOUIS, MISSOURI, (ANY LAWSUIT MUST BE FILED IN ST. LOUIS, MO) FOR ALL CLAIMS AND DISPUTES ARISING OUT OF OR CONNECTED IN ANY WAY WITH THIS AGREEMENT AND THE USE OF THE SEED OR THE MONSANTO TECHNOLOGIES, EXCEPT FOR COTTON-RELATED CLAIMS MADE BY GROWER.

THIS AGREEMENT CONTAINS A BINDING ARBITRATION PROVISION FOR COTTON RELATED CLAIMS PURSUANT TO THE PROVISIONS OF THE FEDERAL ARBITRATION ACT, 9 U.S.C. §1 ET SEQ., WHICH MAY BE ENFORCED BY THE PARTIES.

GROWER SIGNATURE & DATE REQUIRED

____ ________________

Name Date

Page 2 of 2

Appendix D

Monsanto Roundup with Cropshield Advertisement


Choose New* Roundup® CROPSHIELD™ Formulas**.
Proven crop safe in more than 1,600 side-by-side comparisons.
Now the Roundup® agricultural herbicides you trust are available with new CROPSHIELD Formulas. These formulas can dramatically reduce your worry about cotton leaf injury in Roundup Ready® Flex cotton and control weeds the way you expect from Roundup agricultural brands. Why risk crop injury? Insist on Roundup CROPSHIELD Formulas with the starburst symbol for Roundup Ready Flex cotton and all Roundup Ready crops.
Ask your retailer for it today.
Roundup with CROPSHIELD™ FORMULA