# *Chapter 2*

# Modern Agriculture

As I mentioned earlier the face of agriculture has considerably changed over the previous two decades. If you were running around the farm twenty years ago you may not recognize a lot of what is going on today. As the number of farmers has dramatically decreased the average farm size has obviously grown substantially. Goal of this chapter is to bring you up to speed on current production techniques and the issues and technology facing farmers today.

The romantic picture of the working farmer in the field with a hoe has given way to the reality of air-conditioned cabs with the farmer monitoring GPS equipment, getting commodity prices on his cell phone, and coordinating the times for the custom sprayer and fertilizer spreaders to arrive.

Though open to debate some of the biggest changes as they affect the small grain farm over the last 20 years have been:

- The emergence of the very large farms
- Bioengineered Crops and Advanced Hybrids
- Technological Advancements of Equipment
- Precision Farming
- Minimum till and no-till farming methods
- Glyphosate (Roundup)

Each of these will be discussed more completely in the following sections:

# The Very Large Farms

The change with the most impact to the small farmer over the last decade has probably been the emergence of the very large farms and the technologies that have facilitated their capacities. These farms are sometimes called the BTOs-or Big Time Operators, a phrase often used as a derogatory term by many small farmers.

Much like the term "small farm", a BTO is hard to define and relative to each individuals perspective. Many farmers will define a BTO as anyone who farms more than 30% more than they do. I personally believe the term refers to an attitude more than size of operation. Although the two can go hand in hand I have had the privilege of working with several large farmers who could not have been more helpful to a small guy just getting started.

Whatever the definition these large farms continue to grow and most are here to stay. Thirty or forty years ago it was simply not possible for a single farmer or average size farm family to farm more than a few hundred acres in a season. The equipment was not large enough and grain-handling capacities did not provide the ability to move the crop fast enough. Equipment advances have made productivity strides unimaginable only twenty years ago. In May of 2003 in Dniepropetrovsk, Ukraine a new world record for drilling seed and fertilizer was established when over 1,400 acres were drilled with one tractor and one drill in twenty-four hours! The amazing part is that the record was established using commercially available equipment and under standard farming conditions.

Other advancements that have allowed farmers to expand are bioengineered crops and chemical advancements. In the past, weed management was primarily handled through walking beans, rotary hoes, cultivators, etc. all of which were time expensive operations. Now with the emergence of roundup ready beans (see bioengineered crop and roundup sections below) the manual and diesel fuel efforts for weed control have been replaced by chemical controls. Bioengineered crops with built in resistance to various pests can decrease the amount of

chemicals needed to control pests. All of this technology has combined to produce a farm that is much less labor intensive-thus allowing farmers to farm much more land in less time.

As equipment, bioengineering, and chemicals have advanced there are now corn and soybean farmers who with a handful of employees can farm in excess of forty thousand acres! According to the Illinois Dept of Agriculture, the number of farmers in Illinois decreased from over 200,000 farmers in 1950 to 76,000 by 1997. During that same timeframe, the average Illinois farm size has increased from 150 to 368 acres. While 368 acres may seem relatively small, that number includes all of the little 10 and 20-acre truck farms, hobby farms, and vegetable stand operations. Similar numbers have been observed in the other grainbelt states. In a February 1 article from the soybean digest titled "Are 1,000 acres Part-Time Work?" Danny Klinefelter presents the hypothesis that if you are farming 1,000 acres or less and do not have livestock that you are probably underemployed. He says:

> *The new "hobby farm," as some people call it, might be 1,000 acres operated by a husband and wife who have one or two off-farm jobs. While that idea doesn't sit well with many, it's a realistic picture.*

Fred Yoder, president of the national corn growers associations agrees:

> *"One of the most difficult factors for many 1,100-acre or less farmers to accept is that, unless they have livestock, they're probably underemployed. Thirty years ago, 1,000 acres was enough to support Dad, three hired men and me.*
>
> *"But with new technology, equipment and products like Roundup Ready soybeans, I can farm 1,100 acres, run an independent seed dealership and still have time to be active in commodity groups like NCGA.*
>
> *"Farmers have to understand that there's not much chance to make a living on a 1,000-acre farm without supplemental income or non-commodity crops. You can count on one hand the number of farms in our area that don't have an outside job or enterprise to go along with their farms."*

In reality what most would consider the average middle class income full time farmer has expanded from 500 or 600 acres in the 70s to over 1,200-1,300 acres today and farms of 2,000 to 4,000 acres are no longer uncommon. Farming on this large scale brings a new level of

economics. With the ability to farm 5,000 acres a farmer can make a respectable living on margins as small as $30 or $35 an acre.

Where these economics realities collide is when these two different operations meet to compete and bid for land to rent. The BTO can often simply outbid the small farmer to the point of where it isn't even worth the time for the smaller farmer to rent the land. There are however some strategies to help the small farmer in acquiring land discussed in Chapter 4. There are also techniques presented later that the small farmer can use keep costs down that are not practical for the large operators.

Many small farmers have spent the last decade attempting to fight the large farms. Though the cause may be noble the trend to large farms is something that cannot be stopped. The sooner you accept the fact that you will be operating in an environment with the large farmers the sooner you can get focused on what is required to make your farm successful.

What is really interesting is the financial situation of many large operations. Despite outward appearances the really "rich" farmers today are not the big shots farming 6,000 acres with the shiny new equipment. The ones making the money are the 55 to 65 year old farming 1,200-1,500 acres who owns 600 or 700 acres of his own and who has his equipment and land paid off. The cash flows may not be as impressive but I would rather be the guy with $600,000 revenues against $400,000 expenses than the guy with $2,000,000 revenue against $1,950,000 expenses. One can only wonder what will happen to many of these highly leveraged low margin operations when we have a real disaster year or interest rates return from the lows we have enjoyed the last decade.

## Bioengineered Crops and Advanced Hybrids

Bioengineering gets a lot of bad press and at first may seem like another intimidating concept for the small farmer. In reality bioengineered crops may turn out to be one of the hobby farmers' best friends.

A GMO (genetically modified organism) is a plant or animal that through molecular techniques has been genetically modified by the addition of a small amount of genetic material from other organisms. Genetically modified foods are foods derived from GMO crops. Currently, the GMOs on the market today as they relate to the grain farmer have primarily been given genetic traits to provide protection from pests and tolerance to herbicides. Examples of GMO field crops include Bt-potatoes, Bt-corn, Rootworm corn, Roundup Ready soybeans, Roundup Ready Corn, and Liberty Link corn.

To modify a plant into a GMO the gene to be injected is separated from a donor organism. A donor organism may consist of a fungus, a plant, or even a soil bacterium that naturally occurs in the soil.

Of all the GMOs, roundup ready beans have probably had the greatest impact on the grain farm to date. Before roundup ready beans weed control required a multi-faceted approach of spraying and manual cultivation. Because soybeans are a broadleaf plant you could safely spray a grass killer to rid a bean field of grasses. Broadleaf weeds however were required to be controlled through other methods. Some weeds could be controlled with specific herbicides or with precise chemical application using equipment like a rope-wick applicator to run just above the beans to kill those taller than the beans. Roundup ready beans are genetically modified to resist the effects of glyphosate; this means that one application of roundup will simply kill every plant in the field except the beans.

Over 70% of all beans planted in the United States are now Roundup Ready. Roundup ready corn is also being grown in the United States. Even though studies have shown the proteins produced by the corn is virtually unchanged, it is nutritionally equivalent, it has been approved by the U.S. Dept of Agriculture and the Food and Drug administration and has been approved by regulatory reviews in Canada and Japan unfortunately the European Union is still prohibiting the importation of Roundup ready grown corn. As of the time of this writing any roundup ready corn can only be used in animal feed and for domestic uses.

Not all modifications are for pest control or weed control. Some varieties of tomatoes have been engineered to have thicker skins-allowing more to arrive at the supermarket with less tissue damage and a more palatable color.

So how can all this technology help the hobby farmer? Advancements in chemical efficacy and disease free crops can simplify your insect and weed control programs. They can provide a little freedom from much of the constant monitoring required in the past. If you are going to be a part time farmer you may not be able to scout your crops every day or at least as closely as someone who has sixty or eighty hours a week to dedicate to their farm.

These chemicals advancements go hand in hand with the success of minimum-tillage and no-till operations and in large part make no-till operations feasible for more farmers. Without effective chemical control the damage caused by weeds would require traditional cultivation methods-thus negating many of the benefits of a no-till practice.

While biotechnology has been one large factor in helping the large farms to operate, the small farmer can and should also take them advantage of these advancements. Unless you are planning to sell to the higher margin organic buyers, the economics of modern bioengineered crops and chemicals make it hard to ignore.

There are several issues that you should be familiar with surrounding genetically modified (GMO) seed. Probably the most controversial is that your seed dealer will require you to sign a licensing agreement and agree to one time use of the seeds. Any unused seed must be returned to the dealer. You cannot save seed back from your harvest for replanting in future years-to do so is a violation of their patent.

Monsanto is one company who has been aggressive in prosecuting farmers who violate this agreement. Farmers from Kentucky to Canada have paid penalties in excess of $150,000 for violating their license. Monsanto maintains a toll free tip line and hires private investigators to investigate the potential “seed pirates”.

To make the whole mess worse, in the past Monsanto has sold Roundup Ready beans to Argentinean farmers who do not have to comply with U.S. Patent laws. These farmers are now saving seed and farmers in Argentina and Brazil are now able to grow soybeans at significantly reduced seed cost below that which U.S. farmers are forced to pay yet they harvest and sell their beans on the same world markets. In late 2003 Monsanto announced that they will begin collecting technology fees from foreign growers but there is much skepticism surrounding their enforcement capabilities.

Several other technological advancements are in progress that will help the farmer of the future. Roundup ready corn is now entering the commercial market and work on roundup ready wheat is progressing. Trials are being completed on a wax type of coating for corn that will allow it to be planted earlier in the season. The coating will protect the kernel until optimal germination temperature is reached at which time the coating will melt and germination can begin. Advancements such as these will allow individual farmers to successfully farm more and more ground.

The advances made in corn and soybean hybrids have played a large role in the dramatic average yield increases seen over the last several decades. Farmers used to save corn or beans for replant but since the mid century when hybridization really took off farmers buy seed from the seed company even though the price can be very expensive. Even if you did save your seed and attempted to replant it you would find that it does not produce anywhere near what the original hybrid variety did. Seed corn is grown from two parent lines, and on their own each of the parent lines will produce very low yields. The genetically combined seed from those parent lines is the hybrid that the farmer buys and plants. Though soybeans can be saved and produce reasonably well, the licensing restrictions placed on the seed companies and growers prohibit the practice.

# Technological Advancement of Equipment

On the mechanical side the advancement of farm equipment technology has been just as dramatic. In 1971 the first modern four-wheel drive tractors hit the mass market. In 1971 a state of the art John Deere 7020 had 146 horsepower and retailed for approximately $15,000. By 1993 a John Deere 8970 had 333 horsepower and was selling for a retail price of $142,000. Pioneered by Caterpillar, the rubber track system introduced on the Challenger line of tractors first introduced in 1996 has sent horsepower and prices to another level. By 2003 a top of the line Caterpillar Challenger MT865 has 500 horsepower and sold for a retail price of $245,000. Comparable models from John Deere have 450 horsepower and sell for $225,000 while International has an STX Quadtrac model with over 400 horsepower and a sticker price of $235,000.

Combine and implement prices as well have gone up dramatically. A new combine with both heads can easily eclipse $200,000. A 12-row cornhead alone will sell for more than $40,000! It is not uncommon for some large operators to have three to five of these machines. A new large planter with computer monitor and GPS systems and radar can also cost more than $100,000.

With these prices obviously outpacing inflation by a large margin there has obviously been numerous technological changes in addition to raw power. Electronic sensors and computer monitoring from front to back is standard on the newer tractors. Systems that outpace the most advanced cars are common. Automatic engine and transmission adjustments can take place 200 times a second to maximize fuel efficiency is just one example of many of the features available on the new tractors.

In the past when a farmer reached the end of the field with a planter the standard approach would be to turn would be to throttle back the tractor, raise the planter and marker, turn the tractor, drop the marker and planter and throttle up again-a total of six steps. Using macro-recording technology in the newer tractors all of these commands can be programmed into two

buttons. The first time the end of a field is approached the farmer will press the "record" button and complete all of the steps above, after completing the turn he will end the record segment. From then on whenever he approaches the headlands all that must be manually completed is to press the button that recorded the macro and complete the turn, the computer in the tractor will complete all the steps as previously recorded. Some tractors have the capability to store and record several macros at any one time. Obviously with these steps being completed literally hundreds of times a day the stress reduction for the operator alone is greatly reduced-thus allowing the farmer to work a longer day, experience less fatigue, and complete his work with increased accuracy. Another benefit to these systems is the ability to work accurately after sunset, something that can often be challenging with traditional equipment due to decreased visibility from dust and glare from field lights.

Gone are the days of spending fifteen minutes walking around the combine with a grease gun filling twenty grease zerks two or three times a day, at least for those than can afford the latest combine advancements. The combines introduced in the last year have grease distribution systems that automatically distribute the lubricant from a central mess free grease tank. Some bearings are lubed every couple hours, some as often as every ten minutes-all handled without any effort on the part of the operator and allowing the combine to keep running non-stop for more hours than any of the older machines.

As you can see, the productivity gains by the macro systems, grease distribution systems, and monitoring systems all combine to allow for a single farmer to successfully manage many more acres than was possible a just few years ago.

In the very near future complete tractor guidance will be possible. The AutoTrac system from John Deere and systems such as the Raven Systems from Precision Solutions will automatically guide the tractor down straight parallel runs or even on contoured passes. When activated, these guidance systems will record the path of a tractor through the field. As the operator completes the turn at the end of the field you simply reactivate the system and like autopilot on an airplane the tractor will follow a path exactly parallel to the first pass through the

field. All that is required of the operator is to ride along and monitor the systems and to complete the turn at the headlands.

The John Deere AutoTrac system is capable of maintaining a pass-by-pass accuracy as precise as four inches! In cases of tillage and spraying four inches will be more than adequate and depending upon the width of the equipment more accurate than is possible with a human operator. As impressive as these systems are there are some cases in which four inches may not be accurate enough. With an accuracy of plus or minus four inches there is a possibility of the guess row being off by as much as eight inches. In 15" beans or even in 30" inch corn rows 8 inches is enough of a variance to effect yield and harvesting accuracy.

There have been some new systems on the horizon that have demonstrated much improved accuracy. Using a combination of satellite guidance and land-based sensors the equipment can calculate its position with accuracy of as little as ½ an inch!

Within the next couple years we should expect to see similar systems from CaseIH and Agco as well. The 2003 Lexion combines introduced an optional feature that will utilize a sensor on the front of the grain platform to detect where the edge of the unharvested crop is and guide the combine precisely along the edge thereby maximizing machine capacity and reduce operator intervention. This allows the operator to spend less time guiding the combine and to focus more attention to monitoring and tuning the separator functions.

How do all of these advancements affect the hobby farmer? Probably not much in the short term, but as advancements like this continue to appear it will drive up the productivity and drive down the production cost for the BTOs and ultimately make them even more competitive to the smaller farmers. The cost of purchasing and maintaining these systems will likely keep them out the reach of most hobby farmers for years and years to come.

In terms of equipment the biggest challenges I see are for the medium sized farmer-those farming between 800 and 1,200 acres of row crops. The equipment being manufactured today is

so large and so expensive that it is going to be more and more difficult to justify for the mid size farmer and managing large acres with aging equipment presents its own challenges.

# Precision Farming

The term precision farming covers a variety of technologies and farming techniques from aerial photography used to get field mapping information to z-values used for measuring elevations. Purdue university department of agriculture defines precision farming as “Using the best available technologies to tailor soil and crop management to fit the specific conditions found within an agricultural field or tract."

In practice the term is most often used to describe technologies such as GPS (Global Positioning System) mapping, variable rate seeding and nutrient applications, and automated tractor guidance systems.

Systems from John Deere (Greenstar) and Agco (Fieldstar) and Case IH (AFS-Advanced Farming System) provide Satellite mapping with harvest results on the Combine. As crops are harvested the monitoring systems records the yield of a specific spot in the field based on the GPS location.

Results from this system can be taken from the combine on a memory card and placed into the computer to produce a color-coded map of the field. This information can then be used to develop a plan for nutrient management and weed control for future seasons. The same memory card that was recorded in the combine can be placed in a fertilizer spreader or planter to control variable rates of fertilizer at application time and to control variable rate seeding at planting time. The result is being able to maximize yield and minimize input costs by more densely populating the areas of the field that are capable of supporting the crop and to avoid wasting seed on areas that are not capable of producing with the higher population.

Though many of these systems will likely remain unaffordable to the hobby farmer for some time there are some precision farming tools available that are not as expensive and provide many of the benefits to the smaller farmer. One of the most common of these more economical devices is the GPS controlled light bar, these devices can be purchased for as little as a few hundred dollars. Using a 40 or 60-foot sprayer in the past necessitated either a small overlap or risking skips in application of pesticides and herbicides. The result was either wasting money on overspray or skipped areas. An inexpensive GPS light bar system can be programmed to the width any implement and will show a series of green, yellow, or red lights indicating your position relative to the last pass across the field. Depending upon the size of your farm, these systems may be able to pay for themselves relatively quickly based on fuel savings and reduced chemical usage.

## Minimum Tillage and No-Till Methodologies

Soil tillage is a very old practice that is engrained in many farmers. The last decade especially has seen the emergence of many new technologies that can reduce tillage and production time and costs with little or no detriment to yield. The emotional perception that intensive tillage was good for soil tilth is slowly giving way to the evidence that often shows just the opposite.

One of the things your will soon discover is that many of the new government programs are focused on conservation. One of the most common and easiest conservation methods is reduced tillage.

Reduced tillage is a generic term used to describe both minimum and no-till methods including strip till and ridge rill. Reduce tillage slowly started to gain popularity in the 70s when it became apparent to most farmers how much soil is lost due to fall moldboard plowing. The initial movement involved many farmers switching to spring tillage and increased use of rippers and soil savers in lieu of moldboard plows in an attempt to leave more trash on the surface over the winter to prevent soil lost to wind and water erosion.

Full tillage vs. Minimum Tillage vs. No-Till can be quite a religious matter between farmers. Terms like "recreational tillage" are tossed out as insults from those farmers preferring a no-till approach. The full tillage farmers respond by calling the no-tillers "Lazy Farmers." Both sides are adamant that their method is best and that their methods result in the best yields and both sides will often provide studies that support their positions.

No-till opponents will make claims of yield loss due to accumulation of compaction from season to season with no-till proponents will saying that freezing and thawing along with enhanced earthworm populations and undisturbed root channel due to lack of fall tillage will naturally handle the compaction. Full tillage proponents will counter that tillage reduces chemical requirements and breaks up compacted soils.

Though some farms and crops lend themselves better to no-till methods than others I fully believe no-till is the way of farming in the future. For the small farmer it will allow you to start with less horsepower and fuel expense, decreased time requirements, and less equipment. For the large farmer it will allow them to manage more land in less time.

A full discussion of the advantages of reduced tillage and techniques to implement a reduced tillage program is covered in Chapter 11.

# Glyphosate (Roundup)

Roundup has probably had more of a profound impact on agriculture than any chemical since 24-D. Roundup has changed the way we grow soybeans and will soon be changing the way many other crops are grown.

Like roundup, Glyphosphate-based herbicides all work on the same biochemical principle, they inhibit the EPSP enzyme that plants need in order to grow. Without EPSP

synthase plants are unable to produce the proteins essential for growth and they die. Almost all plants use this same enzyme, so almost all plants succumb to Roundup.

Roundup will kill any plant that relies on EPSP synthase. Plants that are resistant to Glyphosphate produce an enzyme that performs the same function as EPSP synthase but that is not inhibited by Glyphosphate. Given the amount of Glyphosphate that is sprayed on the planet every day, it is probably safe to say that Glyphosphate is not violently toxic to people or animals. Humans and animals do not have the same enzymes in their cells that plants do, just like human cells and bacteria differ enough that antibiotics kill bacteria cells but not human cells. In addition, Glyphosphate breaks down relatively quickly and within a few days becomes harmless. Even plants not immune to roundup can be safely planted without worry of residual damage.

Prior to roundup weed control was primarily accomplished with a variety of chemicals. Broadleaf weed control chemicals were applied to corn fields and grass control to bean fields. However grasses were pretty much free to grow in the corn fields and broadleaf weeds were free to grow in the corn fields. Control of the weeds that remained was primarily handled through the use of rotary hoes, cultivators, and manually walking beans.

Roundup changed all this. One of the first uses of roundup was in rope wick applicators. Farmers learned that if they ran a rope soaked in roundup just over the top of their crops the roundup would wipe off on all the plants that were taller than their corn or beans and would be killed, this however did nothing to address the problems of shorter weeds. Cultivation continued to be the best way of handing between the row weeds but short of walking beans there was no practical way of controlling weeds between the plants.

With the emergence of roundup ready beans many problems were solved for farmers. With beans that have a replacement for the EPSP synthase the entire field can simply be sprayed and all plants except the roundup resistant ones will be killed, including those between the plants.

Roundup has enabled a single farmer to farm much more ground, use a lot less chemicals, use less time, fuel, and equipment and in the end have a cleaner higher yielding crop. No-till soybean practices which required a lot of chemicals in the past and that were typically lower yielding have become economically viable thanks in large part to the benefits of Glyphosate.

Recently Monsanto has released several new formulations of Roundup. These new formulations mix better with water and are more concentrated so that you can apply less volume and get the same results. These advnaces will allow the farmer to go longer without stopping to refill the sprayer.

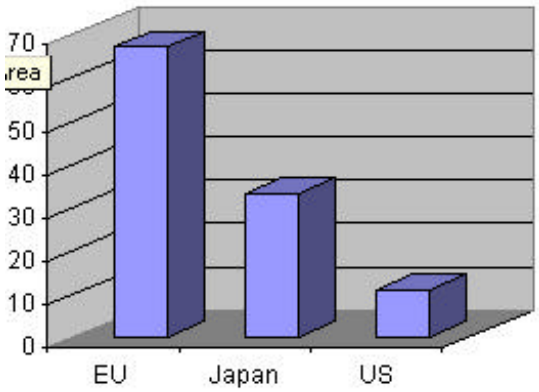
# The future of US Agriculture

The future of US agriculture is as uncertain as it has always been. There are so many global trade issues and government policy issues that are evolving that it is very hard to project potential markets even a few years out.

International competition whether it be Brazilian soybeans, Chinese corn, Canadian hogs, or Soviet wheat will no doubt keep prices in check for the foreseeable future. Though US Agriculture is often portrayed as the bad guy of agricultural trade in international media the real numbers tell a different story.

It may surprise many people to learn that the U.S. will soon no longer be the largest soybean grower in the world. In 2001 the U.S. grew 65 million tons of soybeans. That same year South American countries grew 102 million tons. Brazil alone grew 60 million tons in 2003 and is projected to surpass the U.S. and grow 67 million tons in 2004. Due to their climate the South American growers can actually harvest two crops per year. As they continue to put more and more land into production we can only expect their output to grow. According to the USDA Economic Research Service report on Brazil they say: “There are few natural limits to the future expansion of grain and oilseed production that cannot be overcome by astute planning, research, and adequate investment capital.”

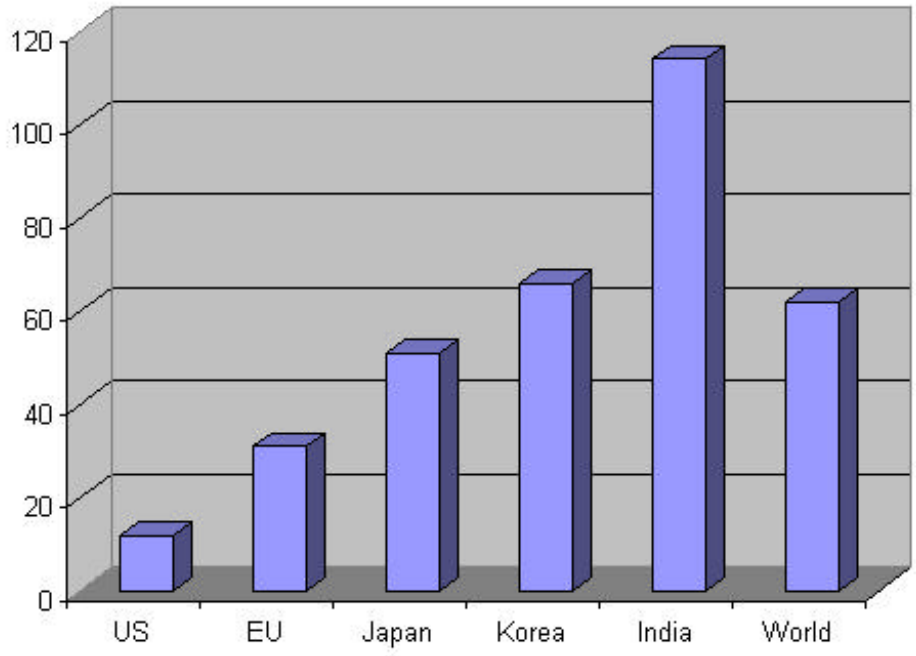
Thought the U.S. is often criticized for overspending on agricultural support as you can see from the chart below that the European Union spends more than ten times what the US does in trade distorting domestic support. Domestic supports are typically found in programs no different than those sponsored in typical US farm bills.




Agricultural Domestic Support (in Billions)

(US Dept of Agriculture 2001)

The numbers for import tariffs are almost as amazing:

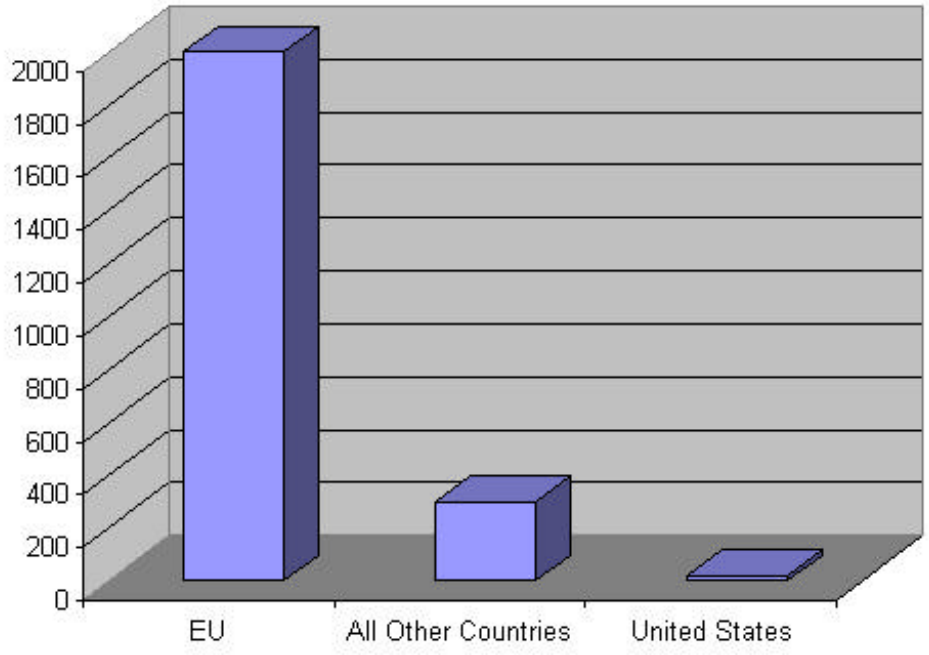



Average Maximum allowable Agricultural Tariff

(US Dept of Agriculture 2001)

As you can see, India may impose tariffs that can be ten times as high for U.S. products coming into India as the products coming from India into the United States. As a percentage the U.S. tariffs are less that one quarter of the average of the rest of the world.

Finally the most stunning numbers come from the export subsidies numbers:




Export Subsidies for Year 2000 (in millions)

(US Dept of Agriculture 2001)

As you can see from the chart above the European Union spent over two BILLION dollars on exports subsidies in the year 2000. That is more than a hundred times more than the twenty million dollars spent by the United States. All other countries combined spent only 300 Million.

Lest I paint too bleak of a picture there are some promising things in the future. More and more alternative markets and products are being created for use of Corn and Soy products. In 2001 the U.S. exported 53% of its wheat crop, 35% of its soybean crop, and 20% of its corn crop.

Carpet padding made out of soy based materials are available, combine panels for John Deere combines are being made from soy based resins and even being painted with paint made from soybean based oils. Biodiesel made from Soybean oil is being more strongly promoted and being successfully used in several government trials. Ethanol based fuel from corn continues to grow and hold promise as a potentially large market in the future.

Soybeans are a staple food for many people around the world. Tofu and soy burgers continue to make slow but steady market gains in the US. Vegetarians rely on Soy products for protein in place of meat. Baby formula for lactose intolerant infants and soymilk for lactose intolerant adults are made of soybeans.

US Soy is a company in Mattoon Illinois that is working to develop non-GMO soybean hybrids for use in food products. US Soy has developed a bean that when processed will release the enzyme that causes the bitter bean taste. These types of advancements will allow soybeans to be processed into flour for use in breads or to produce a better tasking soymilk. US Soy has been contracting with several central Illinois soybean producers who buy the seed from them and sell the crop back, US Soy will pay a 50-cent per bushel premium for growing their non-GMO hybrids. Ed Zimmer, head of sales and public relations at US Soy says they hope to produce 20 million pounds of flour per year when they get all their mills running.

Some really amazing technology is involved in "Bio-pharming". Bio farming is the growing of special use proteins in genetically altered plants. Host plants used to grow the proteins include everything from alfalfa and corn to tobacco. Once the crop is delivered to the proteins are extracted and used to make medicines. Just as with the GMO products there are many concerns. Mike Wilson of Prairie Farmer magazine said, people are concerned that "someone's prescription drug will end up in your corn flakes". There are many extremely stringent precautions required by the USDA to assure that no pharmacrops end up on the general market. Bio-pharming as an industry is in a very early stage but it is one intriguing area that in the future could be very beneficial market for farmers and the agriculture industry as a whole.

One thing that is certain is that technology and efficiencies will advance and undoubtedly get more expensive. Grain farming will continue to become less and less of a manual operation and more and more of a business and planning function.

As discussed in the next chapter in order to compete the small farmer will have to be innovative and cost conscious to survive in this rapidly evolving industry.