Triticale: A viable alternative for Iowa grain producers and livestock feeders?

The current agricultural environment presents considerable challenges for Corn Belt crop producers who have relied on a corn-soybean crop rotation for their livelihood. Pests are adapting to this production system and input costs continue to rise. While production costs continue to increase, prices for corn and soybean remain low. Large price rebounds for soybean do not appear likely in the near future because of increased competition from Argentina and Brazil. In addition, development of a large-scale animal feeding industry in Brazil could put tremendous strain on the traditional swine-corn-soybean system that has been the backbone of central Corn Belt agriculture over the last four decades.

The need and desire to remain productive and competitive in a global marketplace while sustaining our natural resource base will continue to push changes in U.S. agriculture. Adapting to the realities of the modern agriculture environment will require development of advanced cropping systems with lower costs, less risk, and less environmental impact than the traditional corn-soybean practices of the past few decades. One prospect is to add another crop to the corn-soybean rotation. The purpose of this publication is to introduce a new research initiative at Iowa State University that will assess the potential of triticale to enhance Corn Belt farming systems.

What is triticale?

Triticale (trit-ah-kay-lee) is a close relative of wheat that results from pollinating durum wheat with rye pollen, then using that cross in a breeding program to produce stable, self-replicating varieties. It is a man-made crop in that plant breeders must physically make crosses and then manipulate the resultant offspring to obtain a self-fertile plant. Once a triticale variety is stable, it will not revert back to produce rye or wheat plants. The objective behind making wheat/rye crosses is to capture the best traits of each species. Wheat yields and grain quality are better than rye. But rye has greater disease resistance and better tolerance of environmental stresses.

The first man-made hybrid of wheat and rye was produced in the late 1800's. The early attempts to cross wheat and rye produced only sterile offspring, so for many years triticale was only a scientific novelty. It was not until the 1930's that techniques for creating fertile hybrids were discovered and the name "triticale" appeared in the scientific literature. The name was created by combining *Triticum* and *Secale*, the genus names for wheat and rye. Once a fertile hybrid was produced, it became possible to create new combinations between durum wheat and rye, produce direct combinations between triticales with differing wheat and rye parents, and to intercross triticale with common wheats.

Breeding programs begun in the 1950s and 60s in Mexico, Canada, Poland and the U.S. have been successful in producing modern triticale varieties. When these programs were started, triticale plants were tall, highly sterile, late maturing, and produced shriveled grains that were unsuitable for commerce. Most of these problems have been alleviated through breeding efforts so that characteristics of modern triticales make them far superior to the varieties released in the infancy of these programs. Progress has been incremental with improvement made possible by genetic variability that scientists were able to generate in their laboratories and field nurseries. Modern triticale breeding programs concentrate on developing varieties with improved animal feed and fodder for production under diverse environmental conditions. Attempts are also being made to breed triticale varieties that are more suitable for human food use.

Intercrossing triticale and common (bread) wheat has created modern varieties that are very similar to common wheat varieties. The plants and grain of some modern triticale varieties are very difficult to distinguish from those of hard red or soft red wheat. Although similar to wheat in appearance, triticale is a significantly better choice for animal feed. Triticale is generally superior to all classes of wheat for pasture, silage, hay, and for grain used for feed. Triticales, similar to wheat, have either winter or spring growth habit, but vary significantly in plant height, tend to tiller less, and have a larger inflorescence when compared with wheat. The majority of triticale cultivars have prominent awns, however some recent releases are awnless and have increased potential for use as forage for livestock.

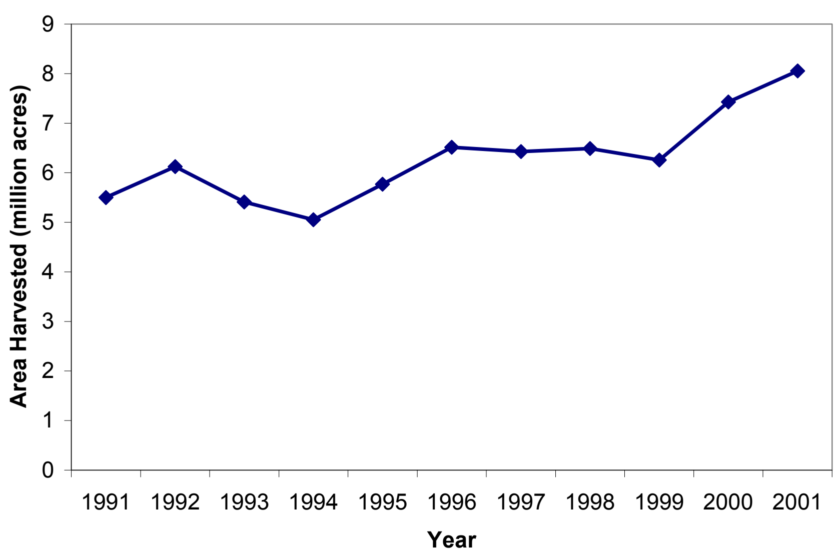
World triticale production has increased nearly 50% over the last decade (Figure 1). The United Nations Food and Agriculture Organization estimates that 8.1 million acres and 420 million bushels of triticale were produced worldwide in 2001. Major producers include China, Poland, Germany, France, and Australia.

Most triticale in the U.S. is currently grown for forage, and is not differentiated from wheat forage and other small grain forage in USDA statistical reports. The International Triticale Association estimated triticale acreage in the U.S. at 850,000 acres in 1998. Approximately 40% of estimated triticale acreage in the U.S is in the Southern Plains where it is primarily used for annual cool-season pasture. Another 25% of the acreage is grown in northern dairy states as the principal ingredient in blends with forage legumes. Much of the other 35% of U.S. triticale acreage is in major dairy areas where it is grown in pure stands for silage, and in Southeast and Intermountain West for beef pasture.

Why grow triticale as a grain crop?

Triticale has many potential benefits to offer Corn Belt crop producers and livestock feeders (Table 1). Its major strength is its versatility for use as feed, silage, grazing, cover crops, and straw. These options for use can provide economic and risk management benefits and allow shifts to alternatives that provide the highest return. When added to a rotation, triticale can increase yields of other crops in the rotation, reduce costs, improve distribution of labor and equipment use, provide better cash flow, and reduce weather risk. Additionally,

Figure 1. World triticale production, 1991-2001.
Source: United Nations – FAOSTAT.



production of triticale may provide environmental benefits such as erosion control and improved nutrient cycling. Most Corn Belt crop producers could eventually take advantage of at least one of these uses.

The major market for grains in much of the North Central U.S. is as animal feed. Research has shown that modern triticale varieties are an excellent replacement for corn as swine feed, and because of their superior lysine content, have feed values higher than other cereal grains. Feeding trials documenting similar rates of gain and feed efficiencies for pigs fed triticale-based diets and pigs fed corn-based diets indicate that triticale can replace 100% of the corn in swine diets.

Lysine is the first limiting amino acid in corn, wheat, barley, and many other cereal grains for swine. Average lysine concentration for triticale is 0.39% compared with 0.26% for corn. The superior lysine content of triticale results in an average 6% (and as great as 10%) higher feed value per bushel than corn when fed to swine. Triticale use can decrease feed costs because it can reduce soymeal requirements by up to 100 lb per ton of mixed diet for swine. Since soymeal must be purchased, swine producers that mix their own diets would benefit the most from growing triticale for swine feed.

Triticale could have an immediate impact in the production of swine in hoop buildings. One of the major ways in which management of hoop structures differs from the management of confinement facilities is the use of large amounts of bedding. Small grain straw works well as a bedding material and would add value to the crop production system.

Triticale's grain and forage potential for livestock producers is such that triticale research has replaced feed wheat research in Nebraska. The superior disease resistance of triticale compared to wheat was apparent in the eastern part of that state, where triticale had grain yields 20% higher than those of winter wheat. In Iowa State University research, winter wheat has regularly yielded between 65 and 70 Bu/A. Combined, the Nebraska and ISU data demonstrate triticale's promise in the Corn Belt.

Table 1. Benefits of triticale as a grain crop.

- Versatility as a feed grain, silage crop, pasture, cover crop, and bedding material.
- Better distribution of labor and equipment use
- Improved cash flow
- Reduced weather risk
- Lower input costs than corn and soybean
- High lysine content
- Higher feed value for swine than corn
- Reduced feed costs
- High quality straw
- Culture and management similar to wheat
- Better disease resistance, stress tolerance, and yields than wheat
- May increase subsequent corn and soybean yields when grown in rotation
- Reduced soil-borne pest problems in subsequent corn and soybean crops
- Utilizes nitrogen efficiently
- Reduced phosphorus excretion in swine manure

In addition to its high feed value, strengths of triticale include: management similar to other small grains, cold tolerance, vigorous growth, and resistance to many of the diseases and insects that affect wheat. Most cultural techniques for growing wheat can be transferred directly to triticale. Consequently, fertilization, seedbed preparation, and seeding methods used for wheat are acceptable for triticale.

Triticale may provide significant rotational benefits when grown in sequence with corn and soybean. It has been well documented over the last twenty years that corn and soybean both benefit greatly when they are grown in rotation. Corn grown on land planted to corn the previous year generally yields 10 to 15% less grain than corn rotated with other crops and soybean yields 10 to 15% more when rotated with corn rather than when grown continuously.

Most Corn Belt grain farmers exploit the rotation benefit using a corn-soybean rotation. However, significant evidence suggests that greater yields may be achieved by growing these crops only one out of every three years or more. Studies from Minnesota demonstrated that an annual rotation of corn and soybean resulted in corn yields that were 10% better, and soybean yields that were 8% better, than monoculture. However, first-year corn after five years of soybean yielded 15% better than monoculture, and first-year soybean after five-years of corn yielded 17% better than monoculture. Other results have shown a 6% decrease in soybean yield when soybean was grown in an annual corn-soybean rotation compared with 1st-year soybean after multiple years of corn. These yield improvements occurred in the absence of any major pest problems.

The rotation benefit may be even more valuable when significant soil-borne pest problems exist. Rotation is important for control of soybean cyst nematodes (*Heterodera glycines*), which have been estimated to cost U.S. soybean producers as much as $1 billion in lost revenue annually because of diminished yields. Rotation has become increasingly important for cyst nematode management because nematode races shift in response to the use of resistant cultivars. Brown stem rot and white mold in soybean and corn rootworm can also be more effectively managed with longer crop rotations that include small grains, like triticale.

Triticale appears to be an ideal crop for producers utilizing sustainable agriculture practices and organic farming techniques. Differences in N uptake and efficiency favor spring and winter triticales when compared with other small grains. Recent research also suggests that phosphorus excretion from pigs fed triticale was as much as 29% less than from pigs fed corn.

Provisions in the Federal Agricultural Improvement and Reform (FAIR) act of 1996 allow for more flexibility for producing crops such as triticale. Future agriculture policy changes may make triticale production in the Corn Belt even more desirable.

Triticale research at Iowa State University

Recognition of triticale's potential for grain producers and livestock feeders and a need for information on its culture in Iowa has resulted in a major new initiative at Iowa State University. A diverse team of scientists and educators, known as the "Crop Diversification and Crop/Livestock Integration Group" has been organized to provide research-based answers to

Table 2. Goals of the Crop Diversification and Crop/Livestock Integration Program

1) Develop agricultural systems that receive both farmer and consumer support

2) Introduce small grains into corn-soybean cropping systems as a means of increasing farmer profitability, decreasing farmer risk, reducing chemical and energy inputs, and increasing corn and soybean yields

3) Analyze the economic outcomes of including small grains in a rotation

4) Determine the feasibility of triticale for animal production in the North Central U.S.

5) Foster interaction among scientists from diverse areas of study

6) Engage crop and livestock producers in a discussion of the economic, soil quality, and environmental benefits of growing small grains in a corn-soybean rotation

questions regarding addition of triticale to crop and livestock production systems. Goals of the group include a better understanding of the agronomic performance and economic feasibility of this new crop (Table 2).

The ISU group (see Table 3) includes an economist to answer questions of profitability, risk management, and economic sustainability. An animal scientist is incorporating the use of small grains into swine feeding systems. A cropping systems specialist is investigating the agronomic and pest management aspects of extended rotation sequences. A plant breeder is analyzing and improving small grain traits that enhance their use in corn-soybean cropping systems and their acceptance in the marketplace. A soil scientist is determining soil quality benefits of extended rotations. An extension educator is providing information exchange among researchers, farmer cooperators and other farmers. An undergraduate teacher of crop management courses is taking the knowledge gained from this project into the classroom.

The research is in its infancy with the first studies planted in fall 2001. The intended ultimate outcome of this work is economically viable options for Midwestern cropping systems that improve rural and environmental sustainability. The Agronomy Endowment at Iowa State University has provided funding to the group over the next four years. These funds are being used to establish an infrastructure for attracting outside funding from state, federal, and private sources. The first research studies are being performed at Iowa State University research facilities throughout Iowa. Initial results of variety testing, feeding trials, crop rotation, and management experiments will be available in 2002 and 2003.. Experiments and demonstrations with farmer cooperators will be added in coming years as we secure funding for these activities.

Table 3. Crop Diversification and Crop/Livestock Integration Group at Iowa State University

Member	Specialty	Organization
Lance Gibson	Crop Management Research and Education	Department of Agronomy
Mark Honeyman	Swine Management Research	Departments of Animal Science and Agriculture Education and Studies
Jean-Luc Jannink	Small Grains Breeder	Department of Agronomy
Doug Karlen	Soil Quality Research	National Soil Tilth Laboratory
James Kliebenstein	Economics Research	Department of Economics
Matt Liebman	Cropping Systems Research	Department of Agronomy
Margaret Smith	Extension Educator	ISU Extension/Department of Agronomy

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