

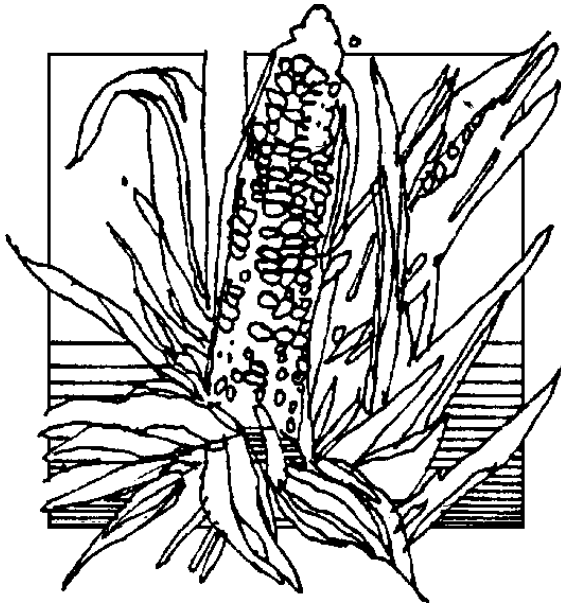
**2000 REPORT ON**



**GRAINS RESEARCH AND  
EDUCATIONAL PROGRAMS**

**SUPPORTED BY**

**KANSAS CORN, GRAIN SORGHUM,  
SOYBEAN, AND WHEAT COMMISSIONS**



*Kansas State University Agricultural Experiment Station and Cooperative Extension Service*

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by the Kansas Agricultural Experiment Station  
Kansas State University

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**Contribution no. 01-326-D from the Kansas  
Agricultural Experiment Station**

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## INTRODUCTION

We are pleased to provide this update on research and educational activities made possible with checkoff funds from the Kansas Corn, Grain Sorghum, Soybean, and Wheat Commissions. The Commissions provided \$2,223,926 in support in fiscal year 1999 – Corn, \$399,266; Grain Sorghum, \$485,678; Soybean, \$630,804; and Wheat, \$708,178. These funds have been utilized by teams of research scientists and extension specialists to address issues that are important to our clientele.

Agriculture is becoming more complex. Kansas producers depend on the Kansas Agricultural Experiment Station and Cooperative Extension Service to provide them with information that will improve their operations in order to maintain a competitive edge in an ever-changing global market. It is vital that K-State Research and Extension continues to serve Kansas producers and it is more important than ever that we supplement our limited state and federal funds with industry support. Funding from the Commodity Commissions is very much appreciated, both for the above reasons and because our association with them helps us to focus our efforts on issues important to producers.

Findings reported in this publication span cropping systems, water management and quality, pest management, breeding for disease and pest resistance, genetic studies to improve quality and performance, alternative uses for end products, processing, and marketing. Because all projects have the common aim of answering real problems, Kansas producers will benefit directly. The results are already being communicated to various audiences through scientific journals, seminars, workshops, and field days, and they are being incorporated into K-State Research and Extension educational efforts.

**George Ham**  
**Associate Director**  
**Kansas Agricultural Experiment Station**

# KANSAS CORN COMMISSION

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## **Irrigation Scheduling Demonstration of Efficient Water Use by Corn in Western Kansas**

### **Researchers and Units**

Mahbub Alam, Southwest Area Extension Office; Todd Trooien, Southwest Research Extension Center; Danny Rogers, Biological and Agricultural Engineering

**Funds (FY 99): \$26,155**

**Completion Date: Ongoing**

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**JUSTIFICATION:** Irrigation allows consistent annual production of corn, which covers 1.2 million acres in Kansas. Depletion of the primary water source for irrigation, the Ogallala aquifer, is a major concern for sustained production. Irrigation management and irrigation efficiency are key to sustainable production. Evapotranspiration (ET) based irrigation scheduling is available, but development of educational and demonstration programs is critical to encourage farmers to apply these tools and techniques at their farms.

### **PROJECT OBJECTIVES:**

1. Establish demonstration fields and educate irrigated-corn producers on irrigation scheduling.
2. Evaluate weather-based ET forecast for irrigation scheduling.
3. Conduct sprinkler uniformity tests.
4. Conduct seminars, field tours, and disseminate results at local and national irrigation meetings.

**RESULTS:** Irrigation scheduling demonstration fields were established in nine counties in southwest Kansas. Permanent signs for easy identification of the location and understanding of the objectives were established at demonstration fields. Irrigation field tours were held in all nine fields and these were attended by 124 individuals. Four educational seminars were also held and were attended by 66 individuals. Results of the Irrigation Scheduling Field Demonstration were presented and published in the proceedings of the Central Plains Irrigation Short Course and the Irrigation Association Conference. The producer partner in Finney County pumped five inches less water compared to the previous year and the producer partner in Stevens County shut down the pivot for total of 11 days during the growing season. Sprinkler uniformity tests revealed problems with use of an end gun on the center pivot and mistakes in use of nozzle packages. These tests also showed the relationship between pressure and nozzle type.

**SIGNIFICANCE:** Overall, the amount of irrigation was reduced. Growers used the information to their benefit and reduced pumping hours. The use of soil water sensors helped take advantage of soil water recharge of the root zone from rainfall. Adoption of irrigation scheduling has a bright future and will help reduce the pumping of water. The field study on sprinkler uniformity will help improve economy of production.

# KANSAS CORN COMMISSION

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## **Field-Scale Evaluation of Integrated Agricultural Management Systems Using Best Management Practices to Improve the Quality of Kansas Surface Waters at the Foster Site**

### **Researcher and Unit**

Philip Barnes, Biological and Agricultural Engineering

**Funds (FY 99): \$37,276**

**Completion Date: June 30, 1999**

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**JUSTIFICATION:** Atrazine is the foremost herbicide used for broadleaf weed control in corn and grain sorghum, with about 6 million pounds used annually in Kansas. Unfortunately, atrazine can move away from the point of application with surface water runoff and eroded sediments to streams, rivers, ponds, lakes, and other surface waters. Atrazine continues to be a contaminant of concern in surface water in specific locations within Kansas. The Kansas-Lower Republican River Basin is one such area. This basin cuts across 23 counties in the northeast corner of the state, from the Nebraska line in Republic County to Johnson County on the Missouri border. One of the challenges in managing atrazine in these watersheds is the high annual rainfall that falls on steep and often highly erodible soils that require erosion prevention management practices.

### **PROJECT OBJECTIVES:**

1. To monitor field conditions that create runoff losses from fields with atrazine applied at various times of the year.
2. To monitor contaminant reduction across a grass filter below each of the fields.

**RESULT:** Atrazine application timing can have a dramatic effect on the amount of atrazine contamination found in runoff water. If the atrazine is applied in the fall, losses are reduced by 83% compared with applying atrazine at planting. If the atrazine is applied early in the spring (late March or early April) before planting, the loss is reduced by 60%. Finally, if the atrazine is postapplied after the corn has emerged at a reduced application rate, the runoff losses can be reduced by 89%. Each of these application timings give good broadleaf weed control in corn. Grass filter strips below fields with these treatments gave additional protection to the quality of the surface water running off the fields. If the atrazine was fall applied, the grass filter reduced the contaminant an additional 70%. If the atrazine was applied in the early spring, the atrazine loss was reduced an additional 51%. At planting time atrazine application losses were reduced only 30% while post applied atrazine losses were reduced an additional 41%.

**SIGNIFICANCE:** Combining both application timing and grass filters are effective management practices that will allow our water to meet drinking water standards.

# KANSAS CORN COMMISSION

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## **Market Development Grant - International Grains Program Grain Storage, Handling, and Sanitation Specialist**

### **Researcher and Unit**

Brendan Donnelly, Grain Science and Industry

**Funds (FY 99): \$36,600**

**Completion Date: Ongoing**

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**JUSTIFICATION:** International buyers may face an unknown and complex marketing system when they buy U.S. corn and other grains. New players face many challenges, ranging from familiarization with pricing formation, grain grading and storage, quality control, shipping in ocean vessels, to specifics of contracting, arbitration, and financing. Additionally, understanding the nutritional and quality-related aspects of using corn in poultry, ruminant, and swine feeding rations is critical for the international buyer and feeder in order to obtain the maximum poultry and livestock output, thereby maximizing profit for the company.

### **PROJECT OBJECTIVES:**

1. Assist the U.S. Grains Council in educating clients who are international buyers of U.S. corn.
2. To identify the potential users and buyers of U.S. corn and determine their specific end product needs.
3. To support the national and state commodity associations with short courses, seminars, and consultants, both in the U.S. and overseas, dealing with issues of pricing, contracting, logistics, financing, feed formulation and nutrition, and grain grading and storing.

**RESULTS:** Four short courses dealt specifically with purchasing, pricing, and risk management of U.S. corn as well as other U.S. grains. Seventy executives from 19 countries received information from industry and university faculty. The topics dealt with ocean freight, grain grading, U.S. production and marketing systems, price analysis, the market outlook for cereal grains and soybeans, oil and meal, contracting the quality of the commodity, and managing currency risk. Eight persons from six countries attended the Feed Manufacturing Short Course, which covered developments in feed formulation, nutrition, and grain storage. Additionally, IGP met with a team of Russian dignitaries. Feed International, with an overseas circulation of 19,000 in more than 100 countries, published an article about IGP. A handbook on corn storage in tropical climates is being written and will provide vital information on maintaining quality prior to processing for buyers of U.S. corn.

**SIGNIFICANCE:** The increased demand for IGP short courses is reflected by the continuation of the level of participants in the purchasing and price analysis and risk management short courses. These courses enable IGP to influence international buyers to purchase U.S. corn. Case studies and problem sets further enhance the executives' understanding of the concepts presented. There is improved satisfaction and confidence by international buyers with their increased understanding of the U.S. production and marketing systems.

# KANSAS CORN COMMISSION

## Replacing Roughage in Growing Cattle Diets with Corn and Corn Gluten Feed

### Researchers and Units

Jim Drouillard, Evan Titgemeyer, and Dale Blasi, Animal Sciences and Industry

Funds (FY 99): \$29,800

Completion Date: December 1, 2000

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**JUSTIFICATION:** Traditional growing programs for beef and dairy animals rely heavily on roughage as the primary component of the diet. Forages often must be supplemented with energy, protein, and other nutrients to attain desired levels of performance. Combining forages with highly digestible forms of energy, such as corn, may actually decrease energy yield from roughages due to inherent differences in digestive characteristics. In extreme conditions, roughages simply add bulk to the diet and may not contribute toward meeting nutrient requirements. We propose to remove the majority of roughage from growing diets and, alternatively, to feed energy-dense diets comprised predominantly of corn or corn gluten feed.

### PROJECT OBJECTIVES:

1. To compare growth performance of cattle backgrounded on roughage-based diets to that of cattle fed restricted quantities of diets comprised predominantly of corn or corn gluten feed.
2. To evaluate the response to ruminally protected lysine in diets comprised predominantly of corn or corn gluten feed.
3. To develop a marketing brochure that summarizes available research pertaining to effective utilization of corn gluten feed in cattle feeding operations.

### RESULTS:

<u>Treatment</u>	<u>Daily Gain(lb)</u>	<u>Lb Feed/Lb Gain</u>
Full-fed corn/alfalfa	2.31	8.16
Full-fed corn gluten feed/alfalfa	2.36	8.51
Limit-fed corn	2.50	5.17
Limit-fed corn + Lysine	2.59	4.95
Limit-fed corn gluten feed	2.02	6.37
Limit-fed corn gluten feed + Lysine	1.98	6.52

**SIGNIFICANCE:** Efficiency of cattle growth on the limit-fed diets is superior to that of cattle fed the traditional roughage/concentrate mixtures. This reflects a reduction in total manure output by the limit-fed cattle, particularly those fed the corn-based diets. Corn gluten feed was equal to corn when fed as a component of roughage-based diets, and was approximately 80% of the value of corn when included in limit-fed, high-concentrate diets. Lysine addition resulted in a small improvement in performance when added to corn diets, but not when added to gluten feed diets.



# KANSAS CORN COMMISSION

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## **Bt Corn: Evaluation, Resistance Prevention, and Education**

### **Researchers and Units**

Randall Higgins, Larry Buschman, Kun Yan Zhu, and Phil Sloderbeck, Entomology;  
Victor Martin, Agronomy

**Funds (FY 99): \$63,300**

**Completion Date: June 30, 2000**

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**JUSTIFICATION:** Rapid and widespread adoption of Bt (*Bacillus thuringiensis*) corn has been accompanied by farmer demand for unbiased information on the effectiveness of different Bt events in Bt corn. The EPA also relies on land-grant universities for research assessing effectiveness, economic value, sustainability, and environmental compatibility of the technology so that rules governing planting and use can be updated. Providing this information requires ongoing laboratory and field experiments examining genetics, toxicology, ecology, and production agriculture.

### **PROJECT OBJECTIVES:**

1. Evaluate the insect resistance, yield potential, and other performance characteristics of commercially available and experimental Bt-corn hybrids with conventional corn hybrids.
2. Maintain and continue to apply selection pressure to colonies of Bt-resistant corn borers.
3. Evaluate the susceptibility of laboratory-selected Bt-resistant European corn borers for ability to survive on Bt corn hybrids.
4. Determine the physiological basis for resistance in European corn borers to Bt.
5. Use digital technologies to develop better educational materials for growers, consultants, and regulatory personnel and to communicate between on-campus, area, and in-field locations during problem diagnosis.

**RESULTS:** K-State Bt corn performance reports are available through handouts and web pages (<http://www.oznet.ksu.edu/entomology/extension/topics.htm>). Some Bt events provide excellent full-season protection from corn borer attack. Partial resistance to Bt toxins has been detected in the lab, but these insects have not been able to survive on Bt corn. Improvements in the ability to handle and transport electronic images are being made.

**SIGNIFICANCE:** Bt corn technology can provide tremendous corn borer-protection benefits in the absence of traditional insecticides. Bt corn prevented the physiological and harvest loss of up to 60+ bu/acre. Our data point out the importance of sound resistance management strategies to minimize the likelihood that resistance will reduce the effectiveness of this valuable new technology.

# KANSAS CORN COMMISSION

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## **Influence of Row Spacing and Plant Population on Corn Production**

### **Researchers and Units**

Barney Gordon, Dale Fjell, Victor Martin, Agronomy; Scott Staggenborg, Kevin Dhuyvetter, Northeast Area Extension Office

**Funds (FY 99): \$8,020**

**Completion Date: June 30, 2000**

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**JUSTIFICATION:** The development of effective herbicides, along with planting and harvesting equipment adapted for narrow rows, have given producers the option of reducing row spacing for corn production. Recent published information on narrow row spacing in corn for the western corn belt is limited. Most narrow-row corn research has been conducted in the upper Midwest and has only compared two row spacings (conventional 30-inch and one narrower spacing). Information concerning narrow-row spacing effects on corn yields under Kansas conditions is needed. This research compares conventional 30-inch rows to 20- and 15-inch row spacings on four plant populations under both dryland and irrigated conditions.

**PROJECT OBJECTIVE:** This research was designed to evaluate row spacing and plant population effects on corn grain yield under both dryland and irrigated crop production systems.

**RESULTS:** When averaged over the 3 years of the experiment at the dryland site, 30-inch rows yielded 7 bushels/acre more than the 20- or 15-inch rows. In 1997, a very dry growing season, 30-inch rows yielded 23 bu/acre more than the 20 inch rows and yield was 25 bu/acre greater than the 15-inch rows. Plant population, ranging from 20,000-36,000 plants /acre, had no effect on grain yield. At a sprinkler-irrigated site near Scandia Kansas, when averaged over 2 years, 20-inch rows yielded 15 bu/acre more than 30-inch rows. Yields were maximized with a population of 32,000 plants/acre. At another sprinkler-irrigated site near St. John, yield was 7 bu/acre greater for 20-inch rows than for 30-inch rows. At both sites the 15-inch rows yielded 5 bu/acre more than the 20-inch rows. At St. Johns, little yield difference was seen among plant populations.

**SIGNIFICANCE:** Under irrigation, yields were slightly improved by narrowing row spacings. The response to narrow rows was only seen at high yield levels. At yield levels below 200 bu/acre little advantage was seen by moving to narrow row spacing even under irrigation. Under dryland condition, yields could be reduced by utilizing row spacings narrower than 30 inches. Unless a producer has unlimited irrigation water and proven high yield levels, it would not be economically advantageous to change to a row spacing narrower than 30 inches for corn production.

# KANSAS CORN COMMISSION

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## Short-Season Corn Educational Program in Southeast Kansas

### Researchers and Units

Gary Kilgore and Marvin Fausett, Southeast Area Extension Office

**Funds (FY 99): \$3,382**

**Completion Date: June 30, 1999**

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**JUSTIFICATION:** Corn acreage has doubled in the last 11 years in southeast Kansas (SEK). In fact, acreage has increased by 40% in the last three years. Most of the increase is due to the use of short-season corn planted early on upland soils. Experiment station data show that short-season corn was more profitable than grain sorghum in 8 out of 10 years. Producers are seeking more on-farm trials and educational events.

**PROJECT OBJECTIVES:** This is an educational program designed to take current research from the SEK and ECK experiment stations to farmers' fields and show production and economic benefits. Objectives are to use on-farm demonstration trials to show producers:

1. Performance of Bt corn in regard to yield and reduction of corn borer infestation.
2. Evaluate weed control using transgenic corn with Roundup and Liberty herbicides.
3. Determine the effects of phosphorus placement using three different plant populations.
4. Evaluate 15- and 30-inch row corn planted with two different plant populations.

Each of the above objectives will include an economic analysis.

**RESULTS:** A total of 14 county tours and 22 winter crop schools were held, providing producers with several educational opportunities. More than 2200 producers saw or heard about short season corn production. Bt corn hybrids yielded 14.2% more than non-Bt hybrids. Corn borer populations were reduced by 90% in the Bt hybrids. Narrow-row corn did not increase yields this year. Overall, yields were low, averaging 40 to 50 bu/a, and 30-inch rows out performed 15inch rows. Nitrogen rates exceeding 90 lb/ac did not increase yields of short season corn.

**SIGNIFICANCE:** This year, short season corn produced 28 bu/a more than full season hybrids on the upland soils of SEK. That provided a \$44.00 per acre increase in production. On the 140,000 acres of corn planted, that resulted in an average advantage of over \$6,000,000 for area corn producers. A 11.0 bu/a increase in yield for Bt corn means an additional \$17.16 per acre. This year, 14 producers cooperated with on-farm research plots. This year's educational program was valued at more than \$7,000,000 for corn producers in SEK.

# KANSAS CORN COMMISSION

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## **Monitoring and Modeling Nitrogen Management in Conservation Tillage Production Systems**

### **Researchers and Units**

Ray Lamond, David Whitney, and Gary Pierzynski, Agronomy;  
Prasanta Kalita and Philip Barnes, Biological and Agricultural Engineering

**Funds (FY 99): \$21,000**

**Completion Date: June 30, 1999**

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**JUSTIFICATION:** Conservation tillage acreage in Kansas is increasing, partly because we are in the conservation compliance phase of the current farm program. Careful management of nitrogen (N) is critical in conservation tillage production systems, where large amounts of old-crop residue are left on the soil surface to help alleviate wind and water erosion. Previous work at Kansas State University indicated knifed placement of N was superior to broadcast N in high residue systems.

**PROJECT OBJECTIVE:** This research evaluated N rates, sources, and a urease inhibitor in conservation tillage systems to help improve efficiency of surface-applied N.

**RESULTS:** Ammonium nitrate, which is not subject to volatilization, and the use of the urease inhibitor AgrotaiN with urea outperformed urea when these N sources were surface broadcast around planting time. Averaged over three sites, ammonium nitrate produced 13 bu/a more than urea. Adding AgrotaiN to urea increased corn yields by more than 15 bu/a compared to urea alone.

**SIGNIFICANCE:** Data from this research indicate the volatilization loss of N from urea can be significant when urea-containing N fertilizers are surface broadcast in conservation tillage production systems. Over the course of this research, using either ammonium nitrate or urea with the urease inhibitor AgrotaiN resulted in 13-15 bu/a higher corn yields than urea. At \$2/bu, this would result in \$26-30/a more gross return. In addition, any practice that increases N use efficiency reduces the potential for long-term environmental concerns.

# KANSAS CORN COMMISSION

## Testing Bt Hybrids and Other Cultural Practices to Reduce Corn Ear Diseases

### Researchers and Units

Jim Long, Southeast Agricultural Research Center; Doug Jardine, Plant Pathology;  
Gary Kilgore, Southeast Area Extension Office

**Funds (FY 99): \$5,000**

**Completion Date: June 30, 1999**

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**JUSTIFICATION:** Corn production areas in Kansas experience periodic problems with ear disease, especially *Aspergillus flavus* and the resulting aflatoxin. Aflatoxin was reported in many samples for the 1996 growing season by the Kansas Feed Grain Inspection Service. Although it is widely believed that drought plays a major role in these diseases, many factors, including insect attack on the ear, cultural factors, and hybrid selection, may play important roles in ear disease. Recent studies have indicated that there may be large differences in levels of aflatoxin between individual hybrids. Anything that prevents drought stress or reduces insect damage may help in reducing ear molds. One promising development is the introduction of Bt (*Bacillus thuringiensis*) genetically engineered hybrids that prevent insect feeding and may also prevent disease/mold introduction into the ear. Aflatoxin levels greater than 20 ppb substantially decrease the amount of marketable grain. Therefore, it is important to determine if ear molds could be reduced through cultural practices or planting of Bt corn. *Aspergillus flavus* and subsequent aflatoxin production will be highlighted in this study, which will include field studies at the Southeast Agricultural Research Center and in farmer fields, where ear diseases will be surveyed.

### PROJECT OBJECTIVES:

1. Determine the effect of corn hybrids on corn ear disease, including new Bt hybrids that were genetically engineered to contain biological insecticide.
2. Determine how cultural practices such as planting populations, hybrid maturity and irrigation affect corn ear disease.

**RESULTS:** The use of Bt hybrids has reduced the amount of corn earworm damage. The percentage of corn kernels damaged by the corn earworm and susceptible to aflatoxin contamination was also reduced when low plant populations are utilized under non-irrigated conditions. The number of kernels damaged on irrigated corn was similar to non-irrigated corn; however, with more corn produced under irrigated conditions there was less percentage damage to corn kernels. Non-irrigated corn had more aflatoxin than did irrigated corn in 1997 and 1998.

**SIGNIFICANCE:** The presence of aflatoxin contamination in corn grain can prevent the marketing of dairy products or the grain itself through the local elevator. Local elevators also have difficulty marketing grain in bulk that is contaminated. These studies indicate the usefulness of Bt corn hybrids and cultural practices to reduce ear diseases and aflatoxin production in corn grain.

# KANSAS CORN COMMISSION

## **Environmental Stress Impacts on High-Oil Corn Yields**

### **Researchers and Units**

Larry Maddux, Barney Gordon, and Dale Fjell, Agronomy; Scott Staggenborg, Kevin Dhuyvetter, Northeast Area Extension Office

**Funds (FY 99): \$6,000**

**Completion Date: June 30, 2000**

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**JUSTIFICATION:** High-oil corn hybrids have gained tremendous popularity in northeast Kansas during the past three growing seasons and acreage has increased dramatically in the U.S. The elevated oil contents are achieved through blending seed of male sterile hybrid corn and pollinator hybrids that carry the high-oil trait. These hybrids offer corn producers several advantages compared to conventional yellow corn. An advantage for cash producers is that high-oil corn has the potential to bring a premium of up to \$0.30 per bushel under contract. An advantage to livestock producers is the impact that high-oil corn has when used in livestock rations. Studies have shown increased gain from the higher caloric density and amino acid content found in highoil corn. Current high-oil corn hybrids have not been tested over a wide range of conditions that can be experienced in Kansas.

**PROJECT OBJECTIVE:** The goal of this project was to determine the effects of environmental stress on the grain and oil yields of high-oil corn hybrids.

**RESULTS:** Under irrigation, high-oil corn hybrids average grain yields were similar to that of their conventional counterparts. Oil content of the high-oil corn hybrids averaged 6.8% compared to 4.3% for the conventional hybrids. This oil content difference resulted in a \$0.16 per bushel premium. The similar yields and increased premium resulted in a \$31.00/acre cash advantage for the high-oil corn hybrids. Under dryland conditions, the conventional hybrids resulted in yields that were 10 bu/acre higher than the high-oil hybrids. Despite oil contents that were 2 percentage points higher, which resulted in a \$0.16/bushel premium, the overall cash value of the high-oil corn hybrids were approximately \$10.00/acre lower than the conventional hybrids. Under extreme drought conditions encountered at one location, the high-oil hybrids resulted in yields that averaged 18 bushels/acre more than conventional hybrids. It was believed that the extended pollination period of the high-oil hybrids resulted in better kernel set under stressful conditions.

**SIGNIFICANCE:** As a cash grain crop, these results indicate that high-oil corn may be more profitable compared to conventional corn. Under irrigation, high-oil corn may produce higher cash revenue per acre as a result of similar yields and higher oil contents that result in an oil premium. Under dryland conditions, the high-oil corn yields were lower than the conventional hybrids. The yield difference was large enough such that the oil premium could not make up the difference on a cash per acre basis.

# KANSAS CORN COMMISSION

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## **Effect of Irrigation Rate, Planting Date, and Tillage on Varied Maturity Corn Production**

### **Researchers and Units**

Victor Martin and Richard Vanderlip, Agronomy;  
Gary Clark, Biological and Agricultural Engineering

**Funds (FY 99): \$7,000**

**Completion Date: December 31, 2000**

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**JUSTIFICATION:** Groundwater in southcentral Kansas (SCK) is a renewable resource with the ability for rapid recharge during periods of above average precipitation. Groundwater is shared among irrigators, municipalities, and two major wildlife refuges. Irrigation can seriously decrease surface water available to the refuges that is necessary to support migratory waterfowl during the critical fall period. Irrigators with continuous corn as the primary crop must optimize water use and decrease unnecessary applications to minimize groundwater use. This study evaluates the interaction of cultural practices to determine recommendations allowing for optimal corn production while efficiently applying irrigation water through irrigation scheduling.

### **PROJECT OBJECTIVES:**

1. To determine the effects of planting date, no-tillage vs. conventional tillage, hybrid maturity, level of irrigation input and their interactions on yield and water use for corn in SCK.
2. To determine the effects of planting date, no-tillage vs. conventional tillage, hybrid maturity, level of irrigation input and their interactions on the economic return for corn in SCK.

**RESULTS:** Water use and grain yield were optimized by early (mid-April) planting regardless of spring conditions. Delaying planting into May reduced yield significantly, up to 30%. Eliminating tillage significantly decreased yields in three of four years in this continuous corn system. Decreasing hybrid maturity did not significantly affect yields. Yields of shorter season hybrids were less affected by delaying planting while full season hybrid yields significantly decreased. Irrigation levels in typical growing seasons may be decreased 20 to 25% without negatively impacting yields with early planting and use of shorter season hybrids.

**SIGNIFICANCE:** Producers can pump from three to five inches less water than the area average during most years through early planting, selecting a hybrid with a maturity from seven to 10 days less than full season, and with irrigation scheduling. Savings are several-fold. First, with the recent increases in fuel prices, producers will significantly decrease pumping costs. Second, producers can increase yields by 5 to 15% (5 to 20 bushels/acre) through early planting while decreasing irrigation costs. Third, grain may be harvested and brought to market earlier. Finally, it should be possible to increase long-term streamflow into Quivira National Wildlife Refuge and maintain production without mandatory water allocation decreases.

# KANSAS CORN COMMISSION

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## Weed Control and Atrazine Best Management Practices for Corn

### Researchers and Units

David Regehr, Agronomy; Philip Barnes, Biological and Agricultural Engineering

**Funds (FY 99): \$32,000**

**Completion Date: June 30, 2000**

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**JUSTIFICATION:** Atrazine is an economical and highly effective herbicide used on 79% of Kansas corn acres. Even though there are several non-triazine alternatives to atrazine, it remains a key component of weed management in corn and fills a critical gap in controlling ALS-resistant weed biotypes. K-State Research and Extension is a leader in developing Best Management Practices (BMPs) addressing environmental aspects of atrazine use.

### **PROJECT OBJECTIVES:**

1. To continue previously funded field research on atrazine BMPs and the development of alternatives to atrazine for weed management in corn.
2. To determine atrazine losses in surface-water runoff from fall, early spring, and planting time applications to mini-watersheds on a ridge-tilled farm field.
3. To measure runoff water quality under different tillage systems and residue levels.

**RESULTS:** A 24-c label for atrazine application in fall to row-crop stubble was a direct result of our studies of atrazine loss in surface water runoff. Over a 3-year period in a Riley County field, atrazine losses in runoff averaged 1.9, 3.6, and 2.3 percent of applied for fall plus planting time, early preplant plus planting time, and planting time only treatments, respectively. Year-to-year differences were very high, with almost 100 times more loss in 1998-99 than in 1996-97. Water samples for 1999-2000 are undergoing laboratory analysis.

Atrazine and metolachlor losses averaged 6.4% and 4.7%, respectively, for 1999 when May through August rainfall was 17.4 inches. Adding 2.5 inches simulated rainfall on both the 2nd and the 9th day after planting increased seasonal losses to 11.5% and 8.4% of applied for atrazine and metolachlor, respectively. Preplant incorporation reduced atrazine and metolachlor losses by about 44% compared to soil surface application under tilled conditions, and by about 52% compared to soil surface application under no-till conditions.

**SIGNIFICANCE:** BMPs are available to corn producers that can provide excellent weed control with substantial reductions in herbicide losses in surface water runoff. In tilled soils, preplant incorporation reduced runoff losses by more than half. For no-till corn production, atrazine applied in fall to soybean stubble can greatly reduce both runoff losses and winter annual weed problems.



# KANSAS CORN COMMISSION

## Variable Nitrogen Management for Protecting Groundwater Quality

### Researchers and Units

John Schmidt and Ray Lamond, Agronomy;  
Mark Schrock, Biological and Agricultural Engineering

Funds (FY 99): \$34,100

Completion Date: June 30, 2000

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**JUSTIFICATION:** Irrigated corn grown on coarse-textured soils in Kansas predominately occurs in the Upper and Lower Arkansas River basins. Recent studies have shown groundwater NO<sub>3</sub> concentrations between 2 and 60 ppm NO<sub>3</sub>-N and that increasing NO<sub>3</sub> concentration was highly correlated to increasing well density and decreasing depth to groundwater. Fertilizer use in this region has been relatively constant since 1975, but well density has increased, thus increasing groundwater contamination potential. Increasing the accuracy of N recommendations requires that crop yield goals reflect within-field heterogeneity. Yield monitoring can be used to quantify the spatial distribution of yield potential within a field. Combined with a spatial distribution of potential mineralizable N and soil profile NO<sub>3</sub>, variable fertilizer N recommendations should be more accurate than those based on field averages.

### PROJECT OBJECTIVES:

1. Demonstrate the components of variable rate application technology (VRAT) to improve accuracy of predicting N rates and applying fertilizer.
2. Show the potential for VRAT to increase recovery of fertilizer N by the crop and to decrease fertilizer related NO<sub>3</sub> loss to groundwater.

**RESULTS:** Nitrogen on four of five fields was variably applied at rates ranging from 150 to 250 lbs N/acre. Leaf N content and soil nitrate content monitored during the growing season throughout the field indicated no areas of N deficiency. In several areas of the field, small plots were used to determine the yield response to N rates. Range of N applied on these plots was less than 100 to greater than 390 lbs N/acre. In every instance, 150 lbs N/acre was sufficient to produce optimum yield. Post-harvest soil samples (0-4 ft depth) indicated that regardless of N rate there were no differences in residual nitrate.

**SIGNIFICANCE:** On four of five fields variable N rates did not improve yield, but indicated that these producers were applying sufficient N for the entire field. The potential for variable N application appears to be in increasing N use efficiency by reducing the amount of N applied. Although a single year of small plot work is insufficient to predict long-term yield response to applied N, N applications 100 lbs/acre less than the maximum rate were sufficient to produce optimum yield. There are real economic and environmental benefits possible through reducing N rates for corn production.

# KANSAS CORN COMMISSION

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## **Corn Starches Used as Stabilizers in Yogurt**

### **Researchers and Units**

Karen Schmidt and Thomas Herald, Animal Sciences and Industry

**Funds (FY 99): \$23,909**

**Completion Date: December 31, 2000**

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**JUSTIFICATION:** Yogurt is a popular dairy product in the U.S., especially among children, who account for more than \$1 billion of sales each year. In response to the demand for yogurt, the USDA has approved yogurt as an alternative to meat in the school lunch program. This project was undertaken to determine the type of yogurt texture that corn stabilizers can produce in yogurt products. It is important to note that food likes and dislikes of children can differ from adults. Therefore this study focused on the preferences of youth (age range 11-14 years).

### **PROJECT OBJECTIVES:**

1. Textural and rheological properties of the yogurts will be evaluated.
2. Storage stability of the yogurts over 60 days will be evaluated.
3. Microbiological safety of yogurt will be evaluated.
4. Consumer acceptance of the yogurts prepared with modified corn starch will be evaluated.

**RESULTS:** Four different corn starches (native, crosslinked-acetylated, crosslinked-hydroxypropylated, and hydroxypropylated) were evaluated in set yogurt over a 60-day storage period. All corn starch stabilizers tested were able to produce acceptable yogurt products. Modification of the yogurt with the corn starches studied did not have a great effect on the overall quality, but differences in textural properties were observed. Consumer acceptability studies done with youth ages 11 - 14 showed that the youth preferred thick, spoonable yogurt as opposed to thin, pourable yogurt. The flavor of the yogurt did not affect texture perception or texture liking. However, if the yogurt was colored, the yogurt was perceived to be "thicker" by the panelists.

**SIGNIFICANCE:** This study showed that yogurt can be stabilized with an individual modified corn starch. The microbial, physical and textural properties were maintained throughout 60 days of storage at 4 °C and the yogurts were acceptable to the youth. Thus, a yogurt manufacturer can formulate an acceptable product using only modified corn starch as the stabilizer. This may have an economic advantage over stabilizers that use a combination of starch and gum products.

# KANSAS CORN COMMISSION

## Assessing the Role of Infrared Images and Yield Maps in Corn Production

### Researchers and Units

Scott Staggenborg, Kevin Dhuyvetter, Northeast Area Extension Office;  
Randy Taylor, Biological and Agricultural Engineering; Dale Fjell, Agronomy

Funds (FY 99): \$15,000

Completion Date: June 30, 2000

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**JUSTIFICATION:** Growing plants reflect light in the near infrared region of the spectrum (wavelengths between 800 to 1100 nm) and reflect a small percentage of visible red light. Infrared imaging can measure both types of light and in its early stages of development the ratio of near infrared:red light is used to distinguish between growing crops and bare soil. As plants begin to suffer from environmental stresses, the amount of red light reflected increases and stressed areas appear darker on infrared images. With this technology, it may be possible to identify stressed plants before visual deficiency symptoms appear to the naked eye. It may also be possible to identify weed pests because the ratio of reflected light varies among plant species as a result of canopy and leaf architecture. Early identification of crop production problems may allow treatment before extensive damage occurs. As an emerging technology, our experience with infrared imaging in Kansas is scarce. The objective of this study was to determine if infrared images could be an effective management tool in corn production.

### PROJECT OBJECTIVES:

1. Evaluate the value of NIR images as diagnostic tools.
2. Determine whether weeds, compacted, or insect-infested areas could be identified with NIR.
3. Determine the lead time necessary to effectively use NIR images as scouting tools.

**RESULTS:** Our results indicated that stressed areas in corn fields could be identified using infrared images. This technology can easily be used to aid corn producers and their scouts in identifying locations in a field to direct their scouting efforts. The types of problems that were identified using this technology were planting problems, nutrient stress, wildlife damage, stand reductions, reduced growth in shallow soils, and insect damage. However, NIR technology did not result in images that were of high enough quality to estimate grain yields on a fine enough resolution to replace yield monitors. One of the most glaring limitations of this technology was that cloudy weather prevented images from being captured at the desired times.

**SIGNIFICANCE:** Corn producers in Kansas can utilize infrared images taken from a small aircraft to identify problem areas in their fields. This technology can easily be used to determine where in a field to direct their scouting efforts. Producers should be aware that cloudy conditions can prevent this technology from being useful and that image quality will limit its ability to predict grain yields.

# KANSAS GRAIN SORGHUM COMMISSION

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## **Extruded Foods from White Grain Sorghum**

### **Researchers and Units**

John Brent, Jeff Gwartz, Paul Seib, Carol Klopfenstein, and  
Finlay MacRitchie, Grain Science and Industry; Carole Setser, Human Nutrition

**Funds (FY 99): \$23,130**

**Completion Date: June 30, 2000**

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### **PROJECT OBJECTIVES:**

- 1. Examine decortication and milling properties of two white sorghum hybrids (one commercial and one experimental).**
- 2. Study properties of white sorghum flour used in production of puff-type and chip-type snacks, and salt noodles.**

**RESULTS:** Extrusion technology was used to manufacture food products using white food-grade sorghum. Three products were developed and/or investigated - direct expanded snack (pufftype), indirect expanded snack (chip-type), and salt noodles. White food-grade sorghum was used as a primary formulation ingredient or combined with corn or wheat flours in productdependent composite formulations. Differences between hybrids were observed in endosperm hardness, decortication behavior (time and percent broken kernels), and protein content. The ramifications of these differences are manifested in the efficiencies apparent during decortication and milling as well as flour quality. For example, longer decortication times resulted in lighter colored flours for a given hybrid. These flours were lower in fat, fiber, and ash content.

Direct expanded snacks were produced using corn flour and sorghum flour or blends of the two. Under the same extrusion process conditions, sorghum flours produced lighter colored puffs, providing a neutral base for various coatings or seasonings. Sorghum puffs tended to have a finer cell structure, and hence were mechanically stronger than the corn counterparts. More axial expansion and less radial expansion were observed in the higher protein-content sorghum flour. Expansion was also influenced by the presence of decorticate. Up to 40% decorticate was added to 25% decorticated sorghum flour to determine if these type of snacks were a viable outlet for this milling by-product. Decorticate (higher-fiber content) reduces expansion. Consumer acceptance studies are needed to determine the viability of this application.

Another snack was developed using sorghum, corn, and rice flours whereby indirect expansion processes produced a light- or dense-textured chip. For noodles, a traditional flour bleaching strategy did not improve lightness (color). Higher protein sorghum flour tended to have higher cooking losses. Noodles from composite blends of sorghum flour and white wheat flour were not as light in color as those from white wheat flour. Cooked composite noodles were also firmer, but this attribute varied with extrusion process moisture. An optimization study based on the foundations laid with this study would lead to an improved extruded salt noodle.

# KANSAS GRAIN SORGHUM COMMISSION

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## **Market Development Grant - International Grains Program Grain Storage, Handling, and Sanitation Specialist**

### **Researcher and Unit**

Brendan Donnelly, Grain Science and Industry

**Funds (FY 99): \$36,600**

**Completion Date: Ongoing**

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**JUSTIFICATION:** International buyers may face an unknown and complex marketing system when they buy U.S. grain sorghum and other grains. New players face many challenges, ranging from familiarization with pricing formation, grain grading and storage, quality control, shipping in ocean vessels, to specifics of contracting, arbitration, and financing. Additionally, understanding the nutritional and quality-related aspects of using grain sorghum in poultry, ruminant, and swine feeding rations is critical for the international buyer and feeder to obtain the maximum poultry and livestock output, thereby maximizing profit for the company.

### **PROJECT OBJECTIVES:**

1. To assist the U.S. Grains Council in educating clients who are international buyers of U.S. grain sorghum.
2. To identify the potential users and buyers of U.S. sorghum and determine their specific end product needs.
3. To support the national and state commodity associations with short courses, seminars, and consultants, both in the U.S. and overseas, dealing with issues of pricing, contracting, logistics, financing, feed formulation and nutrition, and grain grading and storing.

**RESULTS:** Four short courses dealt specifically with purchasing, pricing, and risk management of U.S. grain sorghum as well as other U.S. grains. Seventy executives from 19 countries received information from industry and university faculty. The topics dealt with ocean freight, grain grading, U.S. production and marketing system, price analysis, the market outlook for cereal grains, contracting the quality of the commodity, and managing currency risk. A three-person Japanese Sorghum Trade Team, sponsored by USGC, learned about food uses of sorghum and met with the Kansas Grain Sorghum Producers Association. Eight persons from six countries attended the Feed Manufacturing Short Course, which covered developments in feed formulation, nutrition, and grain storage. Additionally, IGP met with a team of Russian dignitaries. Feed International, with an overseas circulation of 19,000 in more than 100 countries, published an article about IGP. A handbook on grain sorghum storage in tropical climates will provide vital information for buyers.

**SIGNIFICANCE:** The increased demand for IGP short courses is reflected by the continuation of the level of participants in the purchasing and price analysis and risk management short courses. These courses enable IGP to influence international buyers to purchase U.S. grain sorghum. Case studies and problem sets further enhance the executives' understanding of the concepts presented. There is improved satisfaction and confidence by international buyers with their increased understanding of the U.S. production and marketing system.

# KANSAS GRAIN SORGHUM COMMISSION

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## **Effects of New and Improved Genotypes and Processing Technologies on the Nutritional Value of Sorghum for Swine and Poultry**

### **Researchers and Units**

Joe D. Hancock and Robert H. Hines, Animal Sciences and Industry;  
Keith C. Behnke, Grain Science and Industry

**Funds (FY 99): \$26,250**

**Completion Date: June 30, 1999**

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**JUSTIFICATION:** This project evolved from a multi-year, collaborative effort with the Department of Agronomy to identify germplasm that could be used to increase the feeding value of sorghum grain. For the 1997-1998 fiscal year, we collaborated with a company (NC+ Hybrids) that had alternative germplasm close to release or recently released (i.e., heterozygous- and homozygouswaxy varieties). Our data suggested similar nutritional value in weanling pigs for the normal, hetero-waxy, and waxy sorghum. However, there were marked differences favoring the heterowaxy sorghum in pellet quality (a major concern in feed manufacturing), energy required to expand, and steam flaker settings. Likewise, there is growing interest in food quality and white seed/tan plant sorghum varieties. The goal of this research was to gather nutritional information on these varieties to determine if they were of superior nutritional value. Also, we evaluated the processing characteristics of these new, food-quality sorghums in light of advances in feed processing technologies that can make the feeding value of sorghum more comparable to corn.

**PROJECT OBJECTIVE:** To determine the effects of new and improved sorghum genotypes (i.e., waxy, food quality, and white seed/tan plant) and advanced processing techniques (pelletizing, steam flaking, and expanding) on the nutritional value of sorghum grain.

**RESULTS:** We secured delivery of about 22 tons of three food-quality sorghums (Cargill 888Y, NC+ 7W97, and Jowar 1) and a widely-grown, bronze-pericarp sorghum (Pioneer 8500) as a control. Our results suggest that these varieties of grain sorghum were similar in feeding value for nursery pigs and broiler chicks. Additionally, growth performance and carcass measurements were not different among finishing pigs fed the sorghums. Ileal digestibilities of amino acids were greater for corn than the sorghums and Cargill 888Y had, generally, the lowest digestibility of nutrients for all treatments. As for milling characteristics, the sorghums required less energy to grind than corn but the corn-based diets pelleted with greater efficiency.

**SIGNIFICANCE:** In conclusion, food-grade sorghums were similar in nutritional value to a conventional, bronze-pericarp sorghum (Pioneer 8500). Milling data suggested that sorghum ground easier than corn, but the various sorghums were similar in milling characteristics.

# KANSAS GRAIN SORGHUM COMMISSION

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## **Ergot: Is It Really a Problem for Livestock Fed Commercially Produced Sorghum Grain**

### **Researchers and Units**

Robert H. Hines, Joe D. Hancock, and Gerry Kuhl, Animal Sciences and Industry;  
George A. Kennedy, Diagnostic Medicine/Pathobiology

**Funds (FY 99): \$17,200**

**Completion Date: June 30, 1999**

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**JUSTIFICATION:** A recent publication from Australia indicated that sorghum ergot was much more toxic than previously thought and that it caused reduced growth performance and lactation failure in pigs. Fears of ergot toxicity will have major negative effects on the marketability of Kansas-produced sorghum grain if steps are not taken to determine the true consequences of sorghum ergot in livestock diets. It is entirely possible that sorghum ergot need not be a concern for U.S. livestock feeders if infestation is low in U.S.-produced sorghum, and/or if toxicity of the sorghum ergot itself (vs the highly toxic ergots that are known to infest barley, wheat, and oats) will be less pronounced than that in Australia. Finally, by coupling low infestations and low toxicity of sorghum ergot, our data could be used to refute concerns about use of sorghum in livestock diets.

**PROJECT OBJECTIVE:** The goal of this project was to determine the effects of sorghum ergot on growth, health status, and/or nutrient metabolism in poultry and swine.

**RESULTS:** In a 14-day growth assay with broiler chicks (1-day old), treatments were: 1) normal sorghum; 2) 50% normal:50% ergot infected sorghum (1.3 ppm dihydroergosine); and 3) ergot infected sorghum (3.6 ppm dihydroergosine). Rate of gain and food intake decreased (linear effects,  $P < .05$ ) as contaminated grain in the diets was increased from none to 100%. Efficiency of gain was not affected ( $P > .7$ ) by ergot contamination of the sorghum. The same results were observed in a 28-day experiment with nursery pigs. As dihydroergosine in the diet was increased from none to .6 to 1.2 ppm by replacing clean sorghum with ergot contaminated sorghum, rate of gain and food intake decreased with no change in efficiency of growth. Finally, the same treatment structure was used in an experiment with finishing pigs. Finishing pigs were no less sensitive to ergot contaminated sorghum grain, showing decreased rate of gain, food intake, and efficiency of gain as ergot in the diet was increased.

**SIGNIFICANCE:** Our results suggest sorghum grain infected with ergot, with as little as .6 to 1.3 ppm dihydroergosine, will decrease food intake and growth performance in broiler chicks and pigs. It is important to identify cleaning and/or processing technologies that can help to detoxify ergot-contaminated sorghum grain. The sorghum industry needs to encourage development of a cheap, rapid, and reliable screening technique for detection of ergot. This assay could be used to reassure livestock feeders that the sorghum grain they are purchasing is free of ergot alkaloids.

# KANSAS GRAIN SORGHUM COMMISSION

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## **Breeding Sorghum with Improved Grain Yield, Greenbug and Virus Resistance, and Pre-Flowering Drought Tolerance**

### **Researchers and Units**

Ken Kofoid and Dallas Seifers, Agricultural Research Center-Hays; John Reese, Tom Harvey, and Gerry Wilde, Entomology; Mitch Tuinstra, Agronomy; Phil Sloderbeck, Southwest Area Extension Office

**Funds (FY 99): \$70,000**

**Completion Date: June 30, 1999**

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**JUSTIFICATION:** For most Kansas sorghum producers, greenbugs continue to be the most serious insect pest. The utilization of genetic resistance is an important component of an integrated pest management system that emphasizes reduced input costs and less reliance on chemical control. The potyvirus complex, which includes maize dwarf mosaic, sugarcane mosaic, johnsongrass mosaic, and sorghum mosaic viruses, is present in Kansas sorghum fields every year. These diseases are spread by greenbugs and corn leaf aphids, and host plant resistance is the only control measure available. The development of sorghum lines with improved drought tolerance and higher grain yields without additional input expense will allow for greater net profit.

### **PROJECT OBJECTIVES:**

1. To develop and release grain sorghum parental lines with higher levels of grain yield that incorporate genetic factors for: a) greenbug resistance; b) resistance to viral diseases; and c) preflowering drought tolerance.
2. Evaluate sorghum tolerance to greenbug using SPAD meter measurements of chlorophyll loss.
3. To determine the distribution of greenbug biotypes, and distribution and abundance of insecticide-resistant greenbugs.

**RESULTS:** Nine biotype E greenbug-resistant, early maturing A-B parental lines were increased for release. Seven biotype I resistant R lines were increased and are being prepared for release. Yield trials were conducted with greenbug-resistant sources developed by this project. The second cycle of selection and recombination of greenbug tolerant lines using biotype K greenbugs was completed. Under natural infestation in the field, several of these lines showed significantly less damage. Results of biotyping studies showed that all of the greenbugs found were biotype I. Both type I and II resistance characteristics were found. Infection with johnsongrass mosaic virus (JgMV) revealed distinct symptoms for this disease, which had not been seen in other viral diseases. JgMV infection of hybrids showed that these symptoms were genetically controlled and that different genes were involved in the expression of the mosaic symptom. Sources of known drought tolerance, both pre- and post-flowering, were grown at high population pressure to simulate drought. Differences were noted in their response to this stress condition. Crossing among these sources of tolerance was initiated.

**SIGNIFICANCE:** Significant damage occurred in sorghum in 1998 due to the greenbug. Yield losses were reported in the range of 10-20 bushels per acre. While biotype K has been confirmed in the past, only biotype I was found this year. Development of germplasm that utilizes tolerance will decrease the need for chemicals and will also reduce input costs to the Kansas sorghum producer. The use of plant genetics contributes to a more sustainable production agriculture for insect resistance, drought tolerance, and virus resistance.



# KANSAS GRAIN SORGHUM COMMISSION

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## Evaluation of Early Planting and Cold Tolerance in Grain Sorghum

### Researchers and Units

Victor Martin, Mitch Tuinstra, and Mark Claassen, Agronomy;  
Ken Koifoid, KSU Agricultural Research Center-Hays;  
Merle Witt, Southwest Research-Extension Center

**Funds (FY 99): \$28,750**

**Completion Date: June 30, 2000**

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**JUSTIFICATION:** Increasing grain sorghum productivity requires genetic research for increasing yield potential, and in evaluating production strategies, such as early planting and cold tolerance. Advantages of early planting include more effective use of early season rainfall, earlier harvest allowing rotation to wheat, and decreased pest pressure. Research screening current hybrids for cold tolerance is needed; however, field screening does not provide reliable conditions. Developing a controlled environment test correlating with field results will allow for rapid, reliable determination of germplasm with cold tolerance. Through screening commercially available hybrids and a set of diverse breeding lines, germplasm can be released for development of future commercial hybrids

### PROJECT OBJECTIVES:

1. Examine the relationship between early and late planting and hybrid grain yield in trials at five locations.
2. A screening procedure will be developed to quantify cold tolerance in sorghum lines and hybrids using a controlled temperature environment.
3. The mode of inheritance of early season cold tolerance will be evaluated by genetic analysis of cold tolerant accessions and test cross hybrids.
4. Advanced breeding lines and test cross hybrids will be characterized for potential release.

**RESULTS:** A small set of hybrids has been identified that performed well when planted early. A controlled environment screening procedure of 12 lines has been correlated with field performance. Cold tolerant accessions from China and Russia have been identified through genetic analysis. Accessions showing good tolerance were prioritized in breeding programs. A set of 238 advanced breeding lines from the Manhattan cold tolerance breeding nursery identified two agronomically acceptable lines. These have been moved directly into the breeding program for release as cold tolerant germplasm.

**SIGNIFICANCE:** Producers will have commercially available hybrids that can be planted early, thus increasing yield potential, timeliness of operations, and income. Breeding programs will have a reliable, controlled environment screening test for cold tolerance allowing for faster identification and release of cold tolerant hybrids. They will also have available germplasm for inclusion in their programs with identified cold tolerance and acceptable agronomic characteristics.

# KANSAS GRAIN SORGHUM COMMISSION

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## **Constructing Agronomically Useful Genes for Sorghum Plant Transformation**

### **Researcher and Unit**

Subbaratnam Muthukrishnan, Biochemistry; George Liang, Agronomy

**Funds (FY 99): \$45,100**

**Completion Date: Ongoing**

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**JUSTIFICATION:** Stalk rot is a major disease of sorghum that leads to substantial yield loss and lodging problems close to maturity. Similarly, drought is a major environmental constraint that affects yields in Kansas. Successful sorghum transformation is completely dependent on the availability of agronomically useful genes. The goal of this project is to help solve these problems and reduce crop loss in an environmentally sound manner through genetic engineering.

### **PROJECT OBJECTIVES:**

1. To make gene(s) available for drought tolerance and resistance to fungal pathogens.
2. To produce sorghum plants that are pest-resistant and drought-tolerant.

**RESULTS:** We have utilized a rice chitinase gene and a rice thaumatin-like protein cDNA clone to construct transformation vectors that are useful for either biolistic or Agrobacterium-mediated transformation. These vectors are capable of delivering the genes into elite sorghum varieties for enhanced resistance to fungal pathogens, such as the stalk rot fungus. In addition, we have also introduced into a transformation vector a barley hva I gene that has been shown to enhance resistance to drought stress in other plants. These vectors were used in transformation of calli derived from immature sorghum embryos.

**SIGNIFICANCE:** Our results indicate that the genes for antifungal proteins introduced into expression vectors are indeed detectable in the putative transgenic plants and are expressed. The feasibility of the approach has been demonstrated by the detection of the transgenes in transgenic plants and the detection of their corresponding gene products. This is the first step in obtaining transgenic sorghum plants that are expected to be naturally resistant to fungal pathogens and drought stress, leading to increased crop yield and reduced dependence on environmentally polluting chemical pesticides.

# KANSAS GRAIN SORGHUM COMMISSION

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## **Weed Control and Atrazine Best Management Practices in Grain Sorghum**

### **Researchers and Units**

David Regehr, Agronomy; Philip Barnes, Biological and Agricultural Engineering

**Funds (FY 99): \$22,000**

**Completion Date: June 30, 2000**

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**JUSTIFICATION:** Atrazine is the most important herbicide for weed management in Kansas grain sorghum. It can be soil-applied from early spring through planting time, or foliar-applied over the growing crop, giving producers a range of weed management options. Because it moves readily with water, some atrazine is inevitably lost in surface water runoff that may affect drinking water quality downstream. K-State Research and Extension is a leader in developing Best Management Practices (BMPs) that reduce the potential for off-site movement of atrazine.

### **PROJECT OBJECTIVES:**

1. To continue previously funded field research on atrazine BMPs and the development of alternatives to atrazine for weed control in grain sorghum.
2. To test tillage and residue management effects on atrazine runoff from fields.
3. To determine atrazine losses in surface-water runoff from fall, early spring, and planting time applications to mini-watersheds on a farm field.

**RESULTS:** A 24-c label for atrazine application in fall to row-crop stubble was a direct result of our studies of atrazine loss in surface water runoff. Over a 3-year period in a Riley Co. field, atrazine losses in runoff averaged 1.9, 3.6, and 2.3 % of applied, for fall plus planting time, early preplant plus planting time, and planting time only treatments, respectively. Year-to-year differences were very high, with almost 100 times more loss in 1998-99 than in 1996-97. Water samples for 1999-2000 are undergoing laboratory analysis.

Atrazine and metolachlor losses averaged 6.4 and 4.7%, respectively, for 1999 when May through August rainfall was 17.4 inches. Adding 2.5 inches simulated rainfall on both the 2nd and the 9th day after planting increased seasonal losses to 11.5 and 8.4 % of applied for atrazine and metolachlor, respectively. Preplant incorporation reduced atrazine and metolachlor losses by about 44% compared to soil surface application under tilled conditions, and by about 52% compared to soil surface application under no-till conditions.

**SIGNIFICANCE:** BMPs are available to sorghum producers that can give provide excellent weed control with substantial reductions in herbicide losses in surface water runoff. In tilled soils, preplant incorporation reduced runoff losses by more than half. For no-till sorghum production, atrazine applied in fall to soybean stubble can greatly reduce both runoff losses and winter annual weed problems.

# KANSAS GRAIN SORGHUM COMMISSION

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## **Field-Scale Verification of Best Management Practices (BMPs) to Improve Water Quality in the Blue River Basin - Washington County Site**

### **Researchers and Units**

David L. Regehr (lead investigator), Daniel L. Devlin, Ray E. Lamond, Gerard J. Kluitenberg, Charles W. Rice, Kang Xia, W. Barney Gordon, Agronomy; Scott A. Staggenborg, NE Area Extension Office; Philip L. Barnes, Biological and Agricultural Engineering; Kevin C. Dhuyvetter, Northeast Area Extension Office; Jodie L. (Walker) Tate, Washington Co. Extension Office; Michael L. Vogt, Marshall Co. Extension Office.

**Funds (FY 99): \$50,000**

**Completion Date: June 30, 1999**

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### **PROJECT OBJECTIVES:**

- 1. Evaluate pesticide, tillage and nutrient BMPs to improve water quality in the Blue River Basin, under field-scale conditions.**
- 2. Build a database and verify small-plot findings for atrazine fall-applied to row-crop stubble, a new practice with excellent potential to reduce surface water contamination, and to integrate this practice with other pesticide, nutrient, and tillage practices.**
- 3. Support and complement education and demonstration activities on water quality in the Blue River basin, by involving area farmers in BMP discussion and by providing surface water runoff monitoring for selected farmer fields.**

**RESULTS:** Field activity prior to spring of 1999 consisted of intensive grid sampling of the 30-acre field, then applying and incorporating ag-lime. Elevations were measured on all watersheds in the field to determine average slopes, and the watersheds were grouped by slope. Since tillage was used to soil-incorporate the lime, only the two tillage treatments could be run in the 1999 growing season. The site was cropped to sorghum in 1999. There were four runoff events in June, following establishment of the treatments. Atrazine loss in surface runoff was 0.24 and 2.21 percent of applied for the preplant incorporated and the soil-surface applied preemergence treatment, respectively. Losses for S-metolachlor (Dual MAGNUM) were 0.49 and 2.56 percent of applied for incorporated and surface treatments. Thus, herbicide loss was reduced by 89 and 81 percent for atrazine and S-metolachlor, respectively, when chemicals were soil incorporated.

**SIGNIFICANCE:** Reducing herbicide losses from field runoff can have both economic and environmental benefits. Soil incorporated herbicides substantially reduced runoff in this field experiment.

# KANSAS GRAIN SORGHUM COMMISSION

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## **Characterizing Flavors of Cultivars Potentially Useful for Foods**

### **Researchers and Units**

Carole Setser, Human Nutrition; Kraig Roozeboom, Agronomy; X. Susan Sun and Charles E. Walker, Grain Science and Industry

**Funds (FY 99): \$33,600**

**Completion Date: June 30, 1999**

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**JUSTIFICATION:** Concerns about the bitterness and astringency of sorghums, particularly dark sorghums, have kept the grain from being utilized to its full potential in food products. Investigations were aimed at determining if some of the hybrids might be less bitter and less astringent, making them better suited for food usage.

### **PROJECT OBJECTIVES:**

1. To characterize flavors of commercially produced sorghum flours and cultivars for potential food uses.
2. To optimize flavor properties of sorghum flours for use as food ingredients in composite flours using two or more cultivars if necessary.
3. To characterize the bread baking properties of commercial sorghum flours and composite flours using sorghum.
4. To develop a model for sorghum bread baking activities.

**RESULTS:** Six sorghum flours used in muffins were compared by 53 consumers. Acceptability was compared for the three least astringent and least bitter sorghum flours and the three most astringent and most bitter flours. No differences were found among the sorghum flours for overall acceptability or for flavor acceptability. This unexpected finding led to further investigations related to the color and appearance of the muffins, which indicated higher acceptability for a reddish yellow over a greenish yellow muffin color. Two publications from the research are in press in the Journal of Sensory Studies; one publication is in press related to use of composite flours in bread baking; and one manuscript on flavors has been submitted to Cereal Chemistry and is being revised.

**SIGNIFICANCE:** Appearance is critical if flavors are nearly equivalent and flavor is more critical if the colors are similar but not greenish in color. The final product color did not correspond to the flour, pericarp, or endosperm color. Thus, it is important to optimize appearance, flavor, and textural attributes in each food product. A grain should not be eliminated on the basis of its own color, but the determination made after checking its appearance when used in the product after the interaction of the other ingredients. Green color notes were unacceptable in muffins, and likely would be unacceptable in most cereal products because it is not an expected color for cereal and bakery foods.

# KANSAS GRAIN SORGHUM COMMISSION

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## **Novel Sorghum Composite Flours Designed for Breadmaking**

### **Researchers and Units**

X. Susan Sun, Carol Klopfenstein, and Charles E. Walker, Grain Science and Industry

**Funds (FY 99): \$35,548**

**Completion Date: June 30, 2000**

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**JUSTIFICATION:** Results from last year's study showed that sorghum-based composite flour was promising for breadmaking. The appearance of the breads, such as crumb grain, color, and volume, were comparable to most commercial rye breads. This accomplishment allows for incorporation of more sorghum flour than traditionally has been possible. The bread containing 50% sorghum flour in the presence of various additives was highly acceptable, based on consumer sensory testing. Different sorghum varieties have different chemical compositions, which had a significant effect on bread baking quality. Also, particle size was an important factor affecting composite bread volume. Continuation of this research will allow better understanding of sorghum components and the effects of particle size and distributions in breadmaking.

### **PROJECT OBJECTIVES:**

1. Characterize functional properties of protein and starch of selected sorghum cultivars in sorghum composite breadmaking.
2. Study the interactions of sorghum protein and starch with wheat gluten and selected dough improvers.
3. Study effects of particle size and milling procedures on bread quality.
4. Obtain optimum particle size and distributions and formulation of sorghum-based bread.

**RESULTS:** Sorghum-based bread containing a higher percentage of sorghum protein had a smaller bread volume with dense crumb grain. The bread containing a higher percentage of sorghum starch yielded a larger volume with open grain. Sorghum flour with similar particle size and distribution as wheat flour used for bread baking gave smaller bread volume with dense crumb grain. The bread with larger particle size had large volume but more open and large crumb grains. An optimum particle size distribution was determined for sorghum-based bread making.

**SIGNIFICANCE:** The outcome of this research indicates that selected sorghum cultivars can be used for leavening bread and the bread is comparable to rye composite bread. From the nutrition point of view, sorghum contains some phenolic compounds that could prevent colon cancers. Also, it takes longer to digest the carbohydrate of sorghum than that of other grains, therefore sorghum may be beneficial to people with diabetes. Information about the role of sorghum protein and starch could be useful to sorghum breeders in Kansas. The information about the effects of particle size on bread volume and crumb texture will be helpful to the sorghum milling industry.

# KANSAS GRAIN SORGHUM COMMISSION

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## **Breeding Grain Sorghum for Improved Dryland Production**

### **Researchers and Units**

Mitch Tuinstra, Mark Claassen, Walter Gordon, and Victor Martin, Agronomy;  
Ken Kofoid, Agricultural Research Center - Hays; Merle Witt, SW Research-Extension Center;  
Larry Claflin, Plant Pathology

**Funds (FY 99): \$47,500**

**Completion Date: June 30, 2000**

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**JUSTIFICATION:** Grain sorghum is of great importance to Kansas agriculture and is an important crop across much of the central plains. In Kansas, about 92% of the sorghum crop is produced under dryland conditions while 8% is from irrigated acreage. The highest rate of return for grain sorghum producers is from dryland production. Development of elite, stress-tolerant lines and hybrids will reduce production problems and contribute to improved management strategies.

### **PROJECT OBJECTIVES:**

1. Lodging resistance genes derived from SC35, SC56, SC599, NSA440, P954035, and SC1158 will be characterized and incorporated into elite lines to improve stalk strength and quality.
2. Genetic sources of host-plant resistance to sooty stripe have been identified and are being incorporated into elite U.S. parent lines. The inheritance and breeding value of these germplasm sources will be evaluated in trials to be conducted at Manhattan and Belleville.
3. Applied breeding efforts will focus on germplasm enhancement to incorporate germplasm sources of preflowering and postflowering drought tolerance into high yielding lines that can be utilized by the sorghum seed industry.

**RESULTS:** Significant progress has been made in research and breeding for lodging and stalk rot resistance in sorghum. Several new and elite male parents with staygreen derived from SC35 are currently being evaluated for agronomic performance and yield potential in statewide trials. Germplasm characterization studies have indicated that most germplasm sources of lodging resistance are highly susceptible to Fusarium, the most important and common stalk rot pathogen in Kansas. However, one lodging resistant variety (SC 599) was found to be highly resistant to Fusarium stalk rot. Inheritance studies indicated that resistance was controlled by dominant gene effects. These genes for resistance are being integrated into elite genetic backgrounds.

**SIGNIFICANCE:** Stalk lodging is a significant dryland production constraint of sorghum. In 1998, the most commonly reported lodging problem in Kansas was associated with Fusarium stalk rot, although a low incidence of charcoal rot was also noted. Identification of sources of rot resistance and use of these genes in the sorghum breeding program will have a favorable long-term impact on sorghum production. Development of lines with resistance to lodging and stalk rot should translate into improved yield potential and stability of hybrids adapted for production in Kansas.

# KANSAS SOYBEAN COMMISSION

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## **Market Development Grant - International Grains Program Grain Storage, Handling, and Sanitation Specialist**

### **Researcher and Unit**

Brendan Donnelly, Grain Science and Industry

**Funds (FY 99): \$36,600**

**Completion Date: Ongoing**

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**JUSTIFICATION:** International buyers may face an unknown and complex marketing system when they buy U.S. soybeans and soybean meal. New players face many challenges, ranging from familiarization with pricing formation, grain grading and storage, quality control, shipping in ocean vessels, to specifics of contracting, arbitration, and financing. Additionally, understanding the nutritional and quality-related aspects of the using grain sorghum in poultry, ruminant and swine feeding rations is critical for the international buyer and feeder to obtain the maximum poultry and livestock output, thereby maximizing profit for the company.

### **PROJECT OBJECTIVES:**

- 1. To assist the American Soybean Association (ASA) and the United Soybean Board in educating clients who are international buyers of U.S. soybeans.**
- 2. To identify the potential users and buyers of U.S. soybeans and soybean meal and determine their specific end product needs.**
- 3. To support the national and state commodity associations with short courses, seminars, and consultants, both in the U.S. and overseas, dealing with issues of pricing, contracting, logistics, financing, feed formulation and nutrition, and grain grading and storing.**

**RESULTS:** Four of the short courses specifically dealt with the purchasing, pricing and risk management of soybeans and soybean meal and one other with the formulation, nutrition and processing of soybean meal in ruminant, swine, and poultry feeds. One week long course was designed for 12 soybean meal business executives or purchasers with leading companies in Tunisia and Algeria to ensure that the purchasing staff of these companies had up-to-date knowledge for optimizing their purchases of U.S. soybean meal. The other week long course was for 10 business executives with trading, manufacturing or importing companies in Indonesia and Thailand. Topics included ocean freight, grain grading, U.S. production and marketing systems, price analysis, the market outlook for soybeans and meal, contracting the quality of the commodity, and managing currency risk. The purchasing and price analysis and risk management short courses provided purchasing information to 48 executives from 17 countries. Eight persons from six countries attended the Feed Manufacturing Short Course. These persons learned the latest developments dealing with feed formulation; nutrition for poultry, ruminants, and swine; processing the feed; and ingredient specification and grain storage. Additionally, IGP met with a team of Russian dignitaries and with 14 persons involved with feed manufacturing in China.

**SIGNIFICANCE:** The increased demand for IGP short courses is reflected in the request by ASA to present two purchasing short courses as part of its market development efforts. These courses enable IGP to influence international buyers to purchase U.S. soybean and meal. Case studies and problem sets further enhance the executives' understanding the concepts presented. Buyers can help ensure the receipt of the quality and quantity contracted. There is improved satisfaction and increased confidence by the international buyers with increased understanding of the interrelationships between contract specifications, the associated risks, and price levels. An increased number of U.S. soybean farmers know about the IGP efforts because of the IGP exhibit that was at the Commodity Classic in Orlando, Florida and at the Kansas Soybean Association/Commission Exposition, Topeka.



# KANSAS SOYBEAN COMMISSION

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## **Whole Soybeans and Soy Whey as Constituents of Protein Blocks for Cattle**

### **Researchers and Units**

Jim Drouillard and Dale Blasi, Animal Sciences and Industry

**Funds (FY 99): \$26,500**

**Completion Date: June 30, 1999**

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**JUSTIFICATION:** Soy whey contains approximately 50% sugars and 20% protein, as well as appreciable levels of several important minerals. The majority of the sugar contained in soy whey is present as sucrose, which is consistent with other liquid ingredients such as cane or beet molasses. Soy whey contains approximately 2.5 times as much protein as beet molasses and nearly 5 times as much protein as cane molasses. This attribute would have enormous value in manufacturing low-moisture blocks, as the addition of protein to blocks generally represents the single greatest cost in manufacturing these products. A high energy density is also desirable in blocks, providing a distinct marketing advantage over other types of supplements. Inclusion of appreciable quantities of whole soybeans in low moisture blocks would provide the advantage of maintaining high palatability while increasing both protein and energy levels in the block.

### **PROJECT OBJECTIVES:**

1. To prepare low-moisture process supplement blocks containing high proportions of full-fat soybeans and soy whey.
2. To utilize residual heat from the low-moisture blocking process to increase the proportion of bypass protein in whole soybeans added to protein blocks.
3. Evaluate low-moisture process supplement blocks derived from whole soybeans and soy whey as free-choice supplements for growing cattle.

**RESULTS:** Intake of the SOYBLOCK was somewhat higher than the commercial 40% block supplement. We attributed this to the softer texture of the SOYBLOCK. Cattle fed the block supplements tended to consume less hay than the cattle fed CUBES or no supplement. Gains for cattle fed the two blocks were similar. Steers fed blocks tended to gain more rapidly than unsupplemented cattle and less rapidly than cattle fed range cubes. Efficiency of gain paralleled rate of gain. During the subsequent finishing phase, cattle previously fed the SOYBLOCK gained more rapidly and more efficiently than the other treatment groups. Efficiency was poorest for cattle previously fed range cubes, indicating some compensation by cattle in the other dietary treatments. When performance during the growing and finishing phases were combined, supplemented cattle gained more than non-supplemented cattle. Additionally, gains of the SOYBLOCK cattle were greater than those of cattle fed the commercial molasses-based block supplement.

**SIGNIFICANCE:** Superior performance associated with the soybean-based block supplements indicates that soybean solubles and full-fat soybeans are effective replacements for molasses and animal proteins in manufacturing low-moisture, cooked block supplements. The higher protein level of soy solubles in comparison to molasses also provides greater flexibility in formulation of blocks, making it feasible to achieve higher protein concentrations in cooked block products.

# KANSAS SOYBEAN COMMISSION

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## Use of Early Maturing Soybean Production Systems in Crop Rotations

### Researchers and Units

Barney Gordon and Dale Fjell, Agronomy; Scott Staggenborg, NE Area Extension Office

Funds (FY 99): \$8,000

Completion Date: June 30, 2000

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**JUSTIFICATION:** Recent farm legislation encourages rotations by giving farmers flexibility to plant the most profitable crop rather than planting to maintain base acres of a farm program crop. Opportunities exist for expanding soybean acres in central Kansas. A long term grain sorghum/soybean rotation at the North Central Kansas Experiment Field has shown that soybean production in rotation with grain sorghum is more profitable than continuous grain sorghum or grain sorghum grown in rotation with wheat. However, in a dryland environment soybean yields can be quite variable from year to year. The traditional longer season soybeans grown in central Kansas can use significant amounts of water in August and early September. Earlier maturing soybeans (Group I through early Group III) use the maximum amount of water earlier in the growing season when it is more likely to be available, thus potentially providing greater year-to-year yield stability and leaving a longer period for soil water recharge for the following crop. Early maturing soybeans will be harvested earlier allowing for easy rotation to wheat.

### PROJECT OBJECTIVES:

1. Investigate the yield potential, seed quality, and water use characteristics of soybeans in Groups I-IV.
2. Assess effects of maturity group on seed yield of soybeans grown in rotation with grain sorghum.

**RESULTS:** When averaged over the 3 years of the experiment, soybean yields in late Group II were equal to yields in early to mid Group III. Yields of soybean in late Group II were 10 bu/acre greater than in Group IV. Yields of Group I and early Group II soybean were lower than Group III but equal to Group IV. Late Group II soybean matured 18 days earlier than Group IV soybean. Soybean in late Group II used nearly 2 inches less water than Group IV soybean.

**SIGNIFICANCE:** Yield of soybeans in mid-late Group II were stable over years and equal to or better than yields in Groups III and IV. The earlier maturity of Group II soybeans allows producers to spread out the fall harvest work load and rotate to wheat following fall harvest, if desired. Soybeans in earlier groups used less water and produced better yields than Group IV soybeans, allowing farmers to increase profits and allow for more soil water storage for the following crop year.

# KANSAS SOYBEAN COMMISSION

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## **Extruder/Expander/Expeller Conditions to Optimize Utilization of Full-fat Soybeans in Nursery and Finishing Pigs**

### **Researchers and Units**

Joe Hancock, Robert Hines, and Terry Gugle, Animal Sciences and Industry;  
Keith Behnke, Grain Science and Industry

**Funds (FY 99): \$20,700**

**Completion Date: June 30, 1999**

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**JUSTIFICATION:** There is growing interest, domestic and world-wide, in the use of full-fat soybean products. However, this interest is hampered to an unacceptable extent by the lack of knowledge concerning appropriate processing methods to achieve maximal nutritional value. Furthermore, developments in plant breeding and biotechnology are rapidly creating soybean genotypes with extreme differences in chemical composition (e.g., unusual concentrations of oil, protein, and carbohydrates). These changes in chemical composition could alter the processing characteristics of full-fat soybeans. If the use of full-fat soybean products is to be expanded, or maintained at current levels, base knowledge of appropriate processing procedures is essential.

**PROJECT OBJECTIVE:** To determine the extrusion/expander/expeller conditions that optimize nutritional value of full-fat soybeans in nursery and finishing pigs. Particular attention was given to the interaction of cutting-edge soybean genotypes with extrusion/expansion/expeller conditions and their effects on growth performance, carcass merit, nutrient digestibility (and, thus, excretion of nutrients into the environment), and intestinal function in pigs.

**RESULTS:** We included commercial varieties that are now available, contacting university personnel for entries into our project, and solicited experimental soybeans from seed companies. From experiments completed with those soybeans, we demonstrated that modified soybean genotypes could be used to give greater firmness of the belly (fat) when problems with bacon slicing are encountered. Also, some of the soybean genotypes had lower processing requirements than others (e.g., the low trypsin inhibitor soybeans) and, thus, potentially lower processing costs.

**SIGNIFICANCE:** It appears that, based on our results, it is conceivable that in the not-so-distant future, we will be matching identity-preserved soybeans to a particular feedmill (processing) setup and a particular stage of production in pigs (e.g., fat hardening diets just before slaughter).

# KANSAS SOYBEAN COMMISSION

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## **Characterizing the Structural and Functional Properties of Soybean Protein Fractions**

### **Researchers and Units**

Tom Herald and Karen Schmidt, Animal Sciences and Industry; Bill Schapaugh, Agronomy

**Funds (FY 99): \$22,366**

**Completion Date: June 30, 1999**

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**JUSTIFICATION:** Approximately 40% of the world's soybean supply is produced in the U.S. More than 33% of U.S. soybeans are exported, with about half of all exports going to the Asian market. Soy proteins are used primarily for their functionality in food systems. Composition and conformation are responsible for a protein's functionality. Compositional differences that may alter functionality include the ratio of protein fractions, variation in subunit concentrations within fractions, or differences in amino acid profiles. The 7S and 11S are the main fractions that affect soy protein functionality.

### **PROJECT OBJECTIVES:**

1. Develop genotypes with specific functional properties that may increase the marketability of U.S. soybeans to countries where soy foods, such as tofu, are popular.
2. Determine if the chemical characteristics and functional properties of 7S and 11S fractions differed among several soybean genotypes.

**RESULTS:** The 7S and 11S fractions of soy protein were isolated from four soybean genotypes (Macon, Ohio FG1, Enrei, and IL2) and identified using polyacrylamide gel electrophoresis. The protein contents of the 7S and 11S fractions ranged from 61-72% and 63-77%, respectively. The 7S and 11S differed in thermal stability among genotypes. Amino acid analysis and reversed phase high performance liquid chromatography profiles revealed variations in the composition of each fraction that corresponded to differences in storage moduli (G') or elastic properties of the protein gels.

**SIGNIFICANCE:** The 7S and 11S proteins isolated from four genotypes of soybeans differed in physical and chemical properties. Knowledge of protein variations among genotypes may allow scientists to develop "designer" type soybeans that may better meet the needs of breeders and industry. Data from this research suggested that protein from the soybean genotype "Macon" provided gels with higher elasticity, which should produce a firmer gel. This information may be valuable to food industries that utilize soy protein for gelation purposes in products such as tofu.

# KANSAS SOYBEAN COMMISSION

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## Integrated Weed Management

### Researchers and Units

Michael Horak, Dallas Peterson, and Curtis Bensch, Agronomy

Funds (FY 99): \$15,890

Completion Date: June 30, 1999

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**JUSTIFICATION:** Pigweeds such as redroot pigweed, Palmer amaranth, and common waterhemp are particularly troublesome in Kansas soybean production. This research will furnish information on the competitive effects of these species in soybean to assist producers with control decisions.

**PROJECT OBJECTIVE:** The objective of this study was to determine soybean yield loss from various densities of redroot pigweed, common waterhemp, and Palmer amaranth emerging at different times in the season.

**RESULTS:** The competitive ability of three closely related pigweed species was evaluated. Experiments were conducted at two sites in northeast Kansas in 1997 and 1998. Pigweeds were planted at two times (with soybeans at planting, and then at 15 to 20 days later). Soybean yield loss was evaluated for each of the three pigweed species at various weed densities. Soybean yield loss varied between locations depending on weed density, time of emergence, and species. Palmer amaranth caused the greatest yield loss followed closely by common waterhemp. Yield loss from redroot pigweed was substantially less. Soybean yield loss increased as weed density increased. Maximum yield reduction was 79, 56, and 38% for Palmer amaranth, common waterhemp, and redroot pigweed, respectively. Yield loss was greatest when pigweed emerged with the soybean. Pigweed emerging 2 weeks or later after soybean did not affect soybean yield.

**SIGNIFICANCE:** The economic impact of this experiment is significant and can reduce herbicide cost to the farmer and total herbicide load on the environment. The difference in relative competitiveness of the pigweed species and the influence of pigweed time of emergence relative to crop emergence are both important to control decisions. Palmer amaranth and common waterhemp are much more competitive with soybean than redroot pigweed. Consequently, the economic threshold of Palmer amaranth and waterhemp is lower than for redroot pigweed. In addition, pigweed that emerged at the same time as soybean was much more competitive than pigweeds that emerged later in the season. No significant yield reductions were observed for pigweeds that emerged 2 weeks or more after soybeans and so treatment would not provide a direct return on investment. If a producer with 2000 acres of soybean could eliminate an herbicide application for scattered late emerging pigweed that would not reduce yields, the estimated savings would be approximately \$30,000 (2000 acres X \$15/a). However, yield is only one consideration in control decisions as uncontrolled weeds will also produce seed that may increase weed control costs in the future.

# KANSAS SOYBEAN COMMISSION

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## **Field-Scale Evaluation of Integrated Agricultural Management Systems Using Best Management Practices to Improve Surface Water Quality In the Marais des Cygnes River Basin**

### **Researchers and Units:**

Keith A. Janssen, Gary L. Pierzynski, Co-leaders, David L. Regehr, Charles W. Rice, Agronomy; Phillip L. Barnes, Biological and Agricultural Engineering; Michael Langemeier, Agricultural Economics; Gary L. Kilgore, SE Extension Office; Darren Hibdon, Franklin Co. Extension Office; Hershel George, Miami Co. Extension Office; Jill Zimmerman, Anderson Co. Extension Office; Rod Schaub, Osage Co. Extension Office; Herman Norwood, Nat. Res. Cons. Ser.

**Funds (FY 99): \$8,080**

**Completion Date: June 30, 1999**

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### **PROJECT OBJECTIVES:**

- 1. Evaluate the effectiveness of different combinations of tillage, fertilizer, and herbicide management practices for reducing sediment, nutrient, and pesticide losses in runoff from agricultural fields in the Marais des Cygnes River Basin.**
- 2. Expand the database, and verify research findings obtained from K-State Research and Extension small plot investigations.**
- 3. Enhance water quality awareness and education, and facilitate farmer adoption of integrated agricultural best management systems.**

**RESULTS:** Crops planted were grain sorghum in 1998 and soybean in 1999. On average, no-till reduced soil losses in surface water runoff by 46% when compared to the chisel-disk-field cultivation system. Levels of bioavailable P (algae useable P), and levels of atrazine and metolachlor herbicides in the runoff water were higher with surface applications than with incorporation by tillage. In no-till, deep banding the fertilizer P reduced bioavailble P losses. Averaged across all runoff collection dates, losses for bioavailable P were 1.0, 1.7 and 2.5 percent of the P applied for incorporated, deep-banded, and surface P applications, respectively. Atrazine losses in runoff were 1.0 and 4.4 percent and metolachlor losses were 0.5 and 2.2 percent of applied for incorporated and surface treatments, respectively.

# KANSAS SOYBEAN COMMISSION

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## **Effects of Crop Rotation and Tillage Systems on Soybean Yield in Southeastern Kansas**

### **Researchers and Units**

Kenneth Kelley and Dan Sweeney, Southeast Agricultural Research Center

**Funds (FY 99): \$6,500**

**Completion Date: June 30, 2000**

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**JUSTIFICATION:** In southeastern Kansas, approximately 1,600,000 acres are devoted to crop production, which consists primarily of soybeans, wheat, grain sorghum, and corn. Because of the diversity of crops grown in the area, this research will investigate the combined effects of both crop rotation and tillage on full-season and double-crop soybean yield. Research is needed to determine which tillage methods produce optimum soybean yields for the climatic and claypan soil conditions in southeastern Kansas. Options include: i) grow all crops with conventional tillage, ii) plant all crops no-till, or iii) alternate conventional tillage and no-till systems.

### **PROJECT OBJECTIVES:**

1. Evaluate crop rotation and tillage effects on full-season and double-crop soybean yield in a 3yr crop rotation of [corn / grain sorghum] - soybean - [wheat - double-crop soybean].
2. Evaluate previous crop and tillage effects on double-crop soybean yield in a 2-yr crop rotation of [corn / grain sorghum / soybean] - [wheat - double-crop soybean].

**RESULTS:** In 1999, double-crop soybean yields were influenced significantly by tillage and previous crop before wheat. Double-crop soybean yields averaged 28 bu/a when no-tilled into wheat stubble (7.5 in. row spacing) compared to 24 bu/a with disk tillage (no burning). In addition, yields were significantly higher when corn or grain sorghum preceded wheat than when full-season soybean preceded wheat.

**SIGNIFICANCE:** Results indicate that double-crop soybeans can be successfully grown using conservation tillage practices in shallow, claypan soil conditions. Because of the acreage devoted to double-crop soybean production in extreme southeast Kansas, significant long-term benefits to the soil and environment are possible.

# KANSAS SOYBEAN COMMISSION

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## **Field-scale Evaluation of Integrated Agricultural Management Systems Using Best Management Practices to Improve Surface Water Quality in the Neosho River Basin**

### **Researchers and Units**

Gary Kilgore (team leader), Southeast Area Extension Office

**Funds (FY 99): \$8,080**

**Completion Date: June 30, 1999**

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**The Neosho watershed site did not receive its equipment until late June. Crops were planted and no runoff events occurred for the rest of the growing season. Therefore, there is no data to report for 1999.**



# KANSAS SOYBEAN COMMISSION

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## A Soybean Extension Education Program in Southeast Kansas

### Researchers and Units

Gary Kilgore and Marvin Fausett, Southeast Area Extension Office

**Funds (FY 99): \$11,180**

**Completion Date: June 30, 2002**

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**JUSTIFICATION:** In an average year, soybean producers in the 21 counties that make up the Southeast KSU Extension Administration Unit produce over 21 million bushels of soybean. Eight of the top 10 soybean-producing counties are in southeast Kansas. This area has special problems, such as shallow top soils, that reduce yields. Research at experiment fields and research centers shows ways to improve production efficiency, and these findings must be transferred to the farm. This grant allows us to hire a person who helps with on-farm demonstrations and replicated research plots for use in the transfer of knowledge. This will greatly speed up the process of taking University research to the producer.

### **PROJECT OBJECTIVES:**

1. Establish on-farm trials using Roundup Ready soybeans and compare them with non-genetic engineered varieties.
2. Establish trials with soybean varieties that are resistant to the Soybean Cyst Nematode (SCN) on SCN infested sites.
3. Continue to demonstrate soybean population and primary tillage yield response.
4. Use the field trials data at winter crop schools and at county crop tours.
5. Continue to conduct double crop soybean variety trials.
6. Subject the production results to economic analysis to see if they are profitable.

**RESULTS:** Roundup Ready weed control programs continued to show outstanding weed control. Time of first application should occur three weeks after planting, followed by a second pint three weeks after the first. Soybean cyst nematode (SCN) resistant varieties showed a 52% yield advantage over susceptible varieties. Plant populations in 30-inch rows should be more than 3, but not more than 6, plants per foot of row. Populations more or less than that range resulted in low performance. Eleven counties held fall tours. All 21 counties held winter crop schools.

**SIGNIFICANCE:** Roundup Ready weed management programs, properly done, will reduce weed control costs by \$7.00 per acre. Amount of herbicide and timing of the two applications is important. Correct plant populations will add 3.8 bu/acre, resulting in more than \$17.00 per acre increased production. More than 2800 producers attended schools and/or tours in southeast Kansas this year. If these practices are adopted on 30% of our acres, one would expect more than \$3,000,000 added to the economy of southeast Kansas this year.

# KANSAS SOYBEAN COMMISSION

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## **Over-the-counter, Cholesterol-lowering, Extruded Soy Fiber Dietary Supplements**

### **Researchers and Units**

Carol F. Klopfenstein and John L. Brent, Grain Science and Industry;  
Carole S. Setser and Robert Reeves, Human Nutrition

**Funds (FY 99): \$42,500**

**Completion Date: June 30, 2000**

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**JUSTIFICATION:** Human study shows that dietary supplement dose level may be an important factor in effectiveness of cholesterol reduction by extruded soy fiber.

**PROJECT OBJECTIVE:** Test the cholesterol lowering effect of an over-the-counter type dietary supplement.

**RESULTS:** Forty four people (19 men, 25 women) participated in the double-blind, placebocontrolled, crossover designed study. Each took eight fiber supplement capsules per day that contained a total of 4 grams of processed soy fiber. No adverse effects were reported by any of the participants. When all subjects were included in the statistical evaluation of the data, significant lowering of serum cholesterol was not observed for the dietary supplement. However, 7 of the 9 women who consumed the soy fiber supplement treatment during the first 4 weeks of the experiment had lower cholesterol at the end of that period (-10.7%). When they stopped taking the supplement, their cholesterol levels went back up (+12.0%). Similar results were not found for the males in the study. That could be because the women were consuming a relatively larger dose of soy fiber than the men, considering their body size and total food intake.

**SIGNIFICANCE:** This work indicates that larger doses of the processed fiber might be necessary to achieve its desired cholesterol lowering effect. The tremendous amount of data generated by this work is still being processed. Currently, five publications are being prepared, and work on patenting the extrusion process to enhance the cholesterol lowering activity of the soy fiber is progressing. This patent is essential for commercialization of the product.

# KANSAS SOYBEAN COMMISSION

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## **Field-Scale Verification of Best Management Practices (BMPs) to Improve Water Quality in the Blue River Basin - Washington County Site**

### **Researchers and Units**

David L. Regehr (lead investigator), Daniel L. Devlin, Ray E. Lamond, Gerard J. Kluitenberg, Charles W. Rice, Kang Xia, W. Barney Gordon, Agronomy; Scott A. Staggenborg, NE Area Extension Office; Philip L. Barnes, Biological and Agricultural Engineering; Kevin C. Dhuyvetter, Northeast Area Extension Office; Jodie L. (Walker) Tate, Washington Co. Extension Office; Michael L. Vogt, Marshall Co. Extension Office.

**Funds (FY 99): \$4,990**

**Completion Date: June 30, 1999**

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### **PROJECT OBJECTIVES:**

- 1. Evaluate pesticide, tillage and nutrient BMPs to improve water quality in the Blue River Basin, under field-scale conditions.**
- 2. Build a database and verify small-plot findings for atrazine fall-applied to row-crop stubble, a new practice with excellent potential to reduce surface water contamination, and to integrate this practice with other pesticide, nutrient, and tillage practices.**
- 3. Support and complement education and demonstration activities on water quality in the Blue River basin, by involving area farmers in BMP discussion and by providing surface water runoff monitoring for selected farmer fields.**

**RESULTS:** Field activity prior to spring of 1999 consisted of intensive grid sampling of the 30-acre field, then applying and incorporating ag-lime. Elevations were measured on all watersheds in the field to determine average slopes, and the watersheds were grouped by slope. Since tillage was used to soil-incorporate the lime, only the two tillage treatments could be run in the 1999 growing season. The site was cropped to sorghum in 1999. There were four runoff events in June, following establishment of the treatments. Atrazine loss in surface runoff was 0.24 and 2.21 percent of applied for the preplant incorporated and the soil-surface applied preemergence treatment, respectively. Losses for S-metolachlor (Dual MAGNUM) were 0.49 and 2.56 percent of applied for incorporated and surface treatments. Thus, herbicide loss was reduced by 89 and 81 percent for atrazine and S-metolachlor, respectively, when chemicals were soil incorporated.

**SIGNIFICANCE:** Reducing herbicide losses from field runoff can have both economic and environmental benefits. Soil incorporated herbicides substantially reduced runoff in this field experiment.

# KANSAS SOYBEAN COMMISSION

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## **Improving Soybean Profitability through Breeding**

### **Researchers and Units**

William Schapaugh, Agronomy; Tim Todd, Plant Pathology;  
Jim Long, Southeast Agricultural Research Center

**Funds (FY 99): \$161,284**

**Completion Date: June 30, 2002**

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**JUSTIFICATION:** Soybean yields have increased approximately .44 bushel/acre/year since 1970. About half of this increase is due to genetic improvement in varieties. This project contributes to this genetic improvement by addressing adaptation and pest problems of concern to Kansas producers. The growing acreage infested with soybean cyst nematode (SCN) necessitates a strong emphasis on the development of varieties with broad-based resistance to the nematode. Opportunities exist for the soybean producer to supply seed for specialty markets involving the industrial or food-use of specific varieties. A portion of this project is directed at developing varieties for special uses. This project also enables Kansas producers to gain from improvements in public variety development throughout the country.

### **PROJECT OBJECTIVES:**

1. Develop high-yielding, pest-resistant varieties for full-season and double-crop production.
2. Develop varieties to meet specific needs, including varieties tolerant to iron chlorosis, varieties suitable for food uses, and varieties suitable for specific industrial uses.
3. Evaluate the productivity and impact of public and private cyst nematode-resistant varieties.
4. Develop procedures and strategies to improve the selection efficiency of important traits in soybean.

**RESULTS:** The Kansas Agricultural Experiment Station participated in the release of soybean variety, IA3010, offered by the Iowa State University Research Foundation. IA3010 is an F4 plant selection from the cross Jacques J285 x Northrup King S29-39. It carries resistance to Phytophthora rot. IA3010, an early Group III variety, has ranked number one in yield over the past two years in the Uniform III evaluations. In the 1998 Kansas Soybean Variety Performance Tests, IA3010 had, across 11 locations, an average percent of test average of 111%. Foundation seed of IA3010 was allocated to growers for increase in 1999. Seed for commercial production will be available for the growing season in 2000. Two research projects, supervised by graduate students were also completed this year.

**SIGNIFICANCE:** This program of breeding integration of new, disease resistant varieties into cropping systems increases seed yields about .1 to .2 bushel/acre/year. In Kansas, this improvement potentially increases farm revenue by \$1.2 to \$2.4 million per year. SCN resistant varieties and sound management practices are estimated to increase farm revenue by \$1 million per year for this pathogen alone. Identification of several yield-competitive cyst-resistant varieties provides useful information to soybean producers who are reluctant to plant resistant varieties because of the potential yield penalty on uninfested fields or areas of fields.

# KANSAS SOYBEAN COMMISSION

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## **Flavor Development in Extruded Mozzarella Soy Cheese Analogs**

### **Researchers and Units**

Karen Schmidt, Ike Jeon, and Thomas Herald, Animal Sciences and Industry;  
Carole Setser, Human Nutrition

**Funds (FY 99): \$33,357**

**Completion Date: June 30, 2000**

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**JUSTIFICATION:** The mozzarella cheese industry has experienced a sharp increase in demand for their product, as the popularity of Italian style food service foods continues to grow. Estimated U.S. per capita consumption of mozzarella cheese was 7.9 lbs/person for the year 1998. In response, a process to manufacture a soy-based mozzarella style cheese analog was developed, but the prototype lacked flavor.

**PROJECT OBJECTIVE:** To improve the flavor of soy-based mozzarella cheese analogs made by ultrafiltration and extrusion technology.

**RESULTS:** The appropriate way to incorporate the flavor was to use an enzyme-modified cheese (EMC) product in the cheese curds. A trained, descriptive panel evaluated the developed prototype and compared it to both regular and nonfat mozzarella cheese, as well as a commercial soy-based cheese analog. Results showed that the developed product had a less green flavor (soy notes) than the commercial soy-based cheese analog. However, the developed product did not melt as well as the commercial mozzarella cheese product, nor was it as glossy in appearance. The developed product was rated as having less dairy and cheese flavor than the commercial mozzarella cheese sample, but the differences were not great on the scale used by the panelists.

**SIGNIFICANCE:** The results indicated that the developed mozzarella cheese analog containing soy protein is an acceptable product on pizza. A trained descriptive panel found small differences in the "green" flavor as well as the dairy and cheesy flavors. More differences were noted in the melted appearance, which probably was a reflection of the differences in the fat contents of these cheeses. Thus, the process and formulation studied for producing the mozzarella soy cheese analog is a viable alternative for a cheese analog processor.

# KANSAS SOYBEAN COMMISSION

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## **Evaluating Roundup-Ready Soybean Yield Potential Under Different Weed Management Strategies**

### **Researchers and Units**

Scott Staggenborg and Kevin Dhuyvetter, Northeast Area Extension Office;  
Barney Gordon, Dale Fjell, and Dallas Peterson, Agronomy

**Funds (FY 99): \$8,000**

**Completion Date: June 30, 2000**

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**JUSTIFICATION:** Herbicide-resistant crops are the latest development in weed control technology. Roundup Ready soybeans (plants tolerant to over-the-top Roundup applications) were released in 1996. Their popularity was due to the simplicity of the program and the ability of Roundup to control a wide range of weed species. Initial research and observation led to concerns regarding the yield performance of Roundup Ready varieties compared to their conventional counterparts, as well as their performance under non-Roundup Ready herbicide programs.

**PROJECT OBJECTIVE:** The goal of this project was to compare yields of commercially available Roundup Ready soybean varieties to their non-Roundup Ready counterparts under conventional and Roundup weed control systems.

**RESULTS:** Data indicated few yield differences between the two varieties (Roundup Ready and conventional). Comparison of individual variety pairs within the participating companies indicated that some Roundup Ready varieties produced lower grain yields than conventional varieties of similar maturity. These yield difference were often 10% or less. Research results comparing yields of Roundup Ready soybeans under a conventional herbicide and a Roundup herbicide program yielded similar results. Yields were identical for Roundup Ready soybeans sprayed with Raptor or Pursuit as when sprayed only with Roundup, under the three environments where this research was conducted.

**SIGNIFICANCE:** There are two issues concerning Roundup Ready soybeans that Kansas soybean producers should be aware of. The first is that when selecting Roundup Ready soybean varieties, performance data should be utilized to select the highest yielding variety that is adapted to a particular area. Performance test data from Kansas State University Department of Agronomy, county extension demonstration plots, and local company data should all be consulted prior to selecting a variety, as performance variability does exist. The second issue that soybean producers should be aware of is that Roundup Ready soybean performance under conventional weed control systems will be similar to performance under Roundup weed control systems.

# KANSAS SOYBEAN COMMISSION

## **Weed Control in Solid-Seeded Versus Row-Planted Glyphosate-Resistant Soybean**

### **Researchers and Units**

Phillip Stahlman, Agricultural Research Center-Hays; Mark Claassen, Larry Maddux, Barney Gordon, and Dallas Peterson, Agronomy; Gerald Warmann, South Central Extension Office

**Funds (FY 99): \$15,000**

**Completion Date: June 30, 1999**

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**JUSTIFICATION:** Narrow row spacing in crop production has several advantages over wide row spacing, including earlier canopy development, better light interception, improved weed control, and potentially higher yield. Despite these advantages, most growers use wide row spacing so they can cultivate for control of escaped weeds, if needed. The development of glyphosateresistant (Roundup Ready) soybean offers a less costly weed management system with wide flexibility in herbicide application timing and improved control of some species. This system potentially will reduce the need for cultivation and facilitate adoption of narrow row spacing.

**PROJECT OBJECTIVE:** To evaluate crop safety, weed control effectiveness, and profitability of solid-seeded versus row-planted glyphosate-resistant soybean compared with conventional soybean production.

**RESULTS:** The optimum rate of Roundup Ultra varied, depending on the weed spectrum. Some weed species were controlled 100% with as little as 1.0 pt/a of Roundup Ultra, whereas 2.0 pt/a was needed for more than 90% control of velvetleaf. Velvetleaf control with a single application was better when Roundup Ultra was applied early postemergence compared with late postemergence, whereas control of Palmer amaranth and redroot pigweed was better when Roundup Ultra was applied at the later of the two timings. Best season-long control of most weed species was achieved when Roundup Ultra was applied early and applied again late postemergence, especially in soybean seeded in rows spaced 30 inches apart. When averaged over four locations, row spacings, and herbicide rates, net returns were 1.7- and 2.4-times higher, respectively, for single late postemergence and sequential herbicide application timings compared with the early postemergence timing. Narrowing the spacing between soybean rows enhanced control of several species when crop stands were good, but plant populations of drilled soybean at some locations were less than populations of row-planted soybean, resulting in lower yield and net return for drilled beans compared with row-planted beans. Growing glyphosate-resistant soybean and controlling weeds with Roundup Ultra was more profitable than growing conventional soybean and controlling weeds with competitive traditional herbicides.

**SIGNIFICANCE:** The research demonstrated the improved utility and economics of glyphosateresistant soybean compared to conventional weed management in non-glyphosate-resistant soybean. Two applications of Roundup Ultra at labeled rates will be needed in most instances to achieve season-long weed control. Use of glyphosate-resistant soybean technology will facilitate movement to narrow row spacing, which will enhance weed control and improve profitability.

# KANSAS SOYBEAN COMMISSION

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## **Molecular Structure, Dynamic Behavior, and Functional Properties of Soy Proteins**

### **Researchers and Units**

X. Susan Sun, Grain Science and Industry; Om Prakash, Biochemistry

**Funds (FY 99): \$58,600**

**Completion Date: December 31, 1999**

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**JUSTIFICATION:** Large amounts of plastic waste are produced each year from single-use products. Recently, research efforts have centered on utilizing biopolymers as alternatives for petroleum polymers. Soy proteins have been considered as one of the most promising biodegradable polymeric alternatives in several applications, including adhesives, molding or extrusion articles, and medical capsules. Pressure and temperature, and protein physical modification approaches are two major parameters in plastic processing. It is important to study the curing behavior of native or modified soy protein and soy protein components in the presence of various plasticizers and chemicals.

### **PROJECT OBJECTIVES:**

1. To blend soy protein with synthetic biodegradable polymers.
2. To evaluate for adhesive performance of modified soy proteins.

**RESULTS:** A blend from soy protein and polycaprolactone (PCL) at 50/50 mass ratio in the presence of 2% isocyanate resin had approximately 24 MPa of tensile strength and 13% elongation, which was strong enough for food utensils and packaging containers. Water absorption of this blend was about 10% after 26 hours of water soaking. Modified soy proteins showed superior adhesion properties and had great potential for plywood and fiber cardboard applications.

**SIGNIFICANCE:** Partial denaturation by selected chemicals has shown great potential for use in adhesives, films, and molding articles. The results of this study indicate that soy proteins are good polymer resources. The outcome of this research will be useful to soybean breeders, who can modify their soybean varieties in the future to provide better quality products for biodegradable resin applications.



# KANSAS SOYBEAN COMMISSION

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## Using Georeferenced Data to Optimize Soybean Production

### Researchers and Units

Randal K. Taylor, Biological and Agricultural Engineering; Gary Kilgore, SE Area Extension Office; Scott Staggenborg, NE Area Extension Office; Terry Kastens, Agricultural Economics

**Funds (FY 99): \$18,500**

**Completion Date: June 30, 2000**

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**JUSTIFICATION:** Kansas agricultural producers have shown increased interest in yield monitors and global positioning system (GPS) receivers and how this technology might improve productivity. There is an increasing number of Kansas producers taking the first steps into precision agriculture. Some are buying yield monitors, while others are trying to quantify field variability by taking soil samples. However, these singular approaches often lead to more questions than answers. Producers need more information to determine what actually happened during the past growing season and they cannot prepare for future growing seasons without more complete information than is currently available. Improving information quality through georeferenced data could help improve soybean production decisions.

**PROJECT OBJECTIVE:** To determine if georeferenced data can be used to optimize soybean production in eastern Kansas.

**RESULTS:** The data gathered during 1999 was pooled with 1998 data and analyzed. This data indicated an opportunity to improve lime application in eastern Kansas with variable rate technologies. Regression analysis on the combined data resulted in a pH of 6.4 for maximizing yield. Organic matter was also significant in this regression. Analysis of data for fields that had lime applied indicated that pH did not have a significant effect on yield. None of the other parameters that were measured had a significant effect on yield. A poster was presented at the Soybean Expo in Topeka. Data gathered as a part of this project was also used at winter discussions, meetings, and poster sessions.

**SIGNIFICANCE:** There are many variables to consider during crop production and every situation is different. These variables make economic analysis of precision agriculture technologies difficult. Obtaining data from fields similar to their own has helped producers understand the process of asking questions to reach economically beneficial decisions. Our results indicate that variable rate lime application in eastern Kansas is economically feasible on fields where the range in pH is sufficiently large. The rate of adoption of this practice also indicates its feasibility. There are still many other items influencing yield in a spatial manner, some of which are beyond the control of the producer. Methods for determining optimum management practices for varying landscapes should be explored.

# KANSAS SOYBEAN COMMISSION

## **Integrated Management of the Soybean Cyst Nematode and Charcoal Rot**

### **Researchers and Units**

Timothy Todd and Fred Schwenk, Plant Pathology; Jim Long and Kenneth Kelly, Southeast Agricultural Research Center; William Schapaugh, Agronomy

**Funds (FY 99): \$38,327**

**Completion Date: Ongoing**

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**JUSTIFICATION:** The known distribution of the soybean cyst nematode (SCN) in Kansas continues to increase by several counties per year. Increases in SCN-infested acreage have been accompanied by better adapted SCN-resistant soybean varieties, resulting in a greater reliance by Kansas soybean producers on resistance as a primary management strategy. With increased use of resistance, however, comes the risk of selection pressure and race shifts in SCN populations. Rotations of cultivars with different sources of resistance has been proposed as a method of minimizing or even managing selection pressure, but this approach has yet to be thoroughly tested. Crop rotation is an alternative strategy for managing SCN and other soybean diseases, such as charcoal rot, but data from long-term experiments are needed before recommendations can be developed across the range of environments common to Kansas.

### **PROJECT OBJECTIVES:**

1. To evaluate rotations of resistance source for management of the race structure of SCN populations.
2. To examine integrated approaches to the long-term management of SCN and charcoal rot, including resistance, crop rotation, tillage, double-cropping, and fungicide use.
3. To develop predictive models for soybean yield loss to SCN that incorporate the role of soybean maturity and determinacy, phenology, charcoal rot severity, and nematode population density.

**RESULTS:** Sixth-year results showed increases in nematode reproduction on Delsoy 4210, and on its resistance source, PI88788, at all locations. The ability of the nematode to reproduce on cultivars derived from Peking and PI437654 remained unchanged. Changes in race structure resulted in yield loss on a formerly resistant variety at one location during the past year. Resistant variety yields were 23% greater than susceptible variety yields across locations. No consistent benefit from rotating sources of resistance has been observed to date. A second study compared the effects of resistant varieties and rotation with nonhost crops on SCN population density and seed yield in full-season and double-cropped soybeans. Data showed that only resistance was effective in managing the nematode. Seed yield was 24% greater for the resistant variety compared to the susceptible variety following three years of nonhost crops.

**SIGNIFICANCE:** The amount of soybean acreage in Kansas infested with SCN is currently approaching 10%. Based on the 15% to 20% average yield loss measured in infested fields in Kansas during the past eight years, statewide losses from this pathogen average 1.5 million bushels (2% of total yield). Information resulting from this project will be utilized to improve guidelines for managing both the density and race structure of SCN populations and minimizing soybean yield losses due to both SCN and charcoal rot. This project also complements current efforts by the KSU Breeding Program to develop resistant soybean germplasm.

# KANSAS WHEAT COMMISSION

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## **Control of Residue-borne Winter Wheat Diseases**

### **Researchers and Units**

William Bockus and Robert Bowden, Plant Pathology; Mark Claassen, Agronomy;  
Gerald Wilde, Entomology

**Funds (FY 99): \$31,000**

**Completion Date: June 30, 2001**

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**JUSTIFICATION:** Several factors have resulted in drastic increases in the amount of crop residue that is left on the soil surface. Furthermore, it is anticipated that this trend will continue and that wheat in the future will be planted into increasing levels of plant residue. Leaving large amounts of crop residue on the soil surface has the potential to aggravate several wheat diseases. This research seeks to determine how trends toward reduced tillage will affect wheat diseases and insects. Additionally, the research will provide aid in the development of wheat cultivars that have resistance to diseases that can become problematic under reduced-tillage conditions.

### **PROJECT OBJECTIVES:**

1. The research will examine the impact of different tillage practices and crop rotations on the severity of major wheat diseases and insect pests to determine which wheat diseases and pests will become more important in Kansas with increased no-till wheat cropping practices.
2. Identify sources of resistance to diseases that should become increasingly important as wheat producers practice no-till farming. The ultimate goal is to produce germplasm wheat breeders can use to produce cultivars with resistance to diseases under a no-till environment.

**RESULTS:** Greatest disease occurrence was measured in the continuous wheat, no-till treatment. The continuous wheat, burn treatment and all the rotation treatments resulted in significantly lower ratings. Tan spot was the primary disease in the continuous wheat, no-till and chisel treatments while *Stagonospora nodorum* blotch and *Septoria tritici* blotch dominated in the rotation and continuous wheat, burn treatments. Progress was made in helping the wheat breeder and USDA geneticist identify resistance to head scab, tan spot, barley yellow dwarf, *Septoria tritici* blotch, and *Stagonospora nodorum* blotch.

**SIGNIFICANCE:** Because many plant pathogens survive between seasons in the crop residue, they can become yield limiting under reduced tillage. These findings help to identify those wheat diseases that can be problematic with reduced tillage. Additionally, data show that rotations to corn, sorghum, or soybean can be coupled with reduced tillage to help control some of these diseases. There was also a "sanitizing" effect from burning of crop residue on certain pathogens. Finally, progress reported here toward identifying resistance to wheat pathogens should help in the development of resistant wheat cultivars to aid wheat producers in managing diseases that can be important under reduced tillage.

# KANSAS WHEAT COMMISSION

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## **Development of Wheat Germplasm with Multiple Disease and Insect Resistance for the Southern Great Plains**

### **Researchers and Units**

Gina Brown-Guedira, USDA-ARS and Agronomy; Rollie Sears, Agronomy

**Funds (FY 99): \$6,000**

**Completion Date: Ongoing**

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**JUSTIFICATION:** Each year in the southern Great Plains (SGP), yields are reduced an estimated 20-25% by both plant diseases and insect damage. Under average cropping conditions, this results in an estimated \$500 million loss. The impact of this loss can be measured not only in poorer onfarm yields, but also in poorer milling and baking quality of the harvested crop. The large number of pests that attack wheat in the SGP creates difficulty in breeding and releasing disease and insect resistant wheat varieties. It is dangerous for wheat breeding programs to focus on one or a few diseases or insects. By emphasizing the development of germplasm with multiple pest resistance that can be incorporated into wheat breeding programs, the quality of the wheat grown in Kansas could improve.

**PROJECT OBJECTIVE:** The proposed program would provide a new source of resistance genes that have not been previously utilized in any wheat breeding program. This germplasm could be utilized to diversify resistance genes across the SGP, making resistance more stable and longer.

**RESULTS:** A hard red winter wheat germplasm with resistance to the Hessian fly was approved for release to wheat breeders and geneticists. KS99WGRC42 is resistant to Biotype L of Hessian fly, based on greenhouse test of seedlings. The pedigree of KS99WGRC42 is Karl 92/PI 94641//Jagger\*2. Hessian fly resistance in KS99WGRC42 is derived from PI 94641, an accession of cultivated emmer wheat (*T. turgidum* ssp. *dicoccum*) from Germany. This the first report of a gene for Hessian fly resistance transferred to common wheat from this wheat relative. Except for resistance to Hessian fly, KS99WGRC42 is similar to the Karl 92 parent in height, days to heading, and overall phenotype.

**SIGNIFICANCE:** Sporadic outbreaks of the Hessian fly have been detected on susceptible wheat varieties in the SGP in recent years. Prior to discovery of resistant wheat lines, tremendous yield losses due to the Hessian fly were experienced. The Hessian fly is constantly producing new strains that can overcome plant resistance. The identification of diverse sources of resistance to this pest and incorporation of resistance into hard winter wheat germplasm is essential to continue to minimize loss of production due to this potentially devastating pest.

# KANSAS WHEAT COMMISSION

## **Support for the Research in the Milling Sciences Lab**

### **Researcher and Unit**

Brendan Donnelly, Grain Science and Industry

**Funds (FY 99): \$10,000**

**Completion Date: June 30, 1999**

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**This was a one-time contribution earmarked for equipment repair and improvement in the milling sciences lab.**

# KANSAS WHEAT COMMISSION

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## Market Development Grant - International Grains Program

### Researcher and Unit

Brendan Donnelly, Grain Science and Industry

Funds (FY 99): \$142,650

Completion Date: Ongoing

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**JUSTIFICATION:** The world's flour millers face increased competition, subsequently the costs and benefits of the wheat they purchase are intensely scrutinized and U.S. wheats face fierce competition. Due to world wide privatization, millers are no longer supplied by their government buying agencies, but instead are buying their own wheat. Many of these buyers are new to the commodities markets and are unfamiliar with the world grain trade. Additionally they are unaware of the US grain grading system, quality control, proper storage, shipping, handling, and sanitation. Pricing, basis, futures markets, and price discovery fundamentals are not utilized adequately by many grain purchasers.

### PROJECT OBJECTIVES:

1. To identify potential buyers of U.S. wheat in cooperation with US Wheat Associates (USWA) and the USDA's Foreign Agricultural Service.
2. To solicit potential buyers and users to participate in short courses at the International Grains Program (IGP) that address the issues outlined above.
3. To identify opportunities with USWA where specifically designed IGP courses could be conducted in the country or countries targeted.
4. To maintain contact with individual participants in order to continue to provide them with the latest information concerning wheat utilization.

**RESULTS:** One hundred fifty two persons participated in IGP's regularly scheduled short courses. Four of the five short courses covered wheat. Numerous special trade teams were met by faculty and staff of IGP at the request of USWA and the Kansas Wheat Commission. The Hard Red Winter Wheat States of Colorado, Oklahoma, and Texas have also supported the IGP. IGP faculty and staff assisted in consulting for USWA at crop quality seminars and foreign millers associations' meetings.

**SIGNIFICANCE:** Buyers of U.S. wheat have a better knowledge of our grade, contracts, and price discovery mechanisms. They are able to purchase with more confidence and are able to obtain the exact product they need, thus enhancing their margins.

# KANSAS WHEAT COMMISSION

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## **Wheat Genetics Resource Center (WGRC) and Its Contributions to the Kansas Wheat Industry**

### **Researcher and Unit**

Bikram Gill, Plant Pathology

**Funds (FY 99): \$80,000**

**Completion Date: Ongoing**

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**JUSTIFICATION:** The Wheat Genetics Resource Center (WGRC) was established in 1984 to collect, conserve, evaluate, and document the genetic resources of wheat. To assure future advances in wheat breeding, the WGRC is involved in broadening the crop genetic base and in developing genetic and cytogenetic stocks for rapid and efficient gene transfer to breed superior wheat cultivars. Resistance and other agronomically useful genes are incorporated into wheat lines through interspecific hybridization, and the lines are released as germplasm. The WGRC also generates new cytogenetic stocks and chromosome and DNA-based assays for plant genome analysis and efficient germplasm and cultivar development.

### **PROJECT OBJECTIVES:**

1. To develop hard red winter and white wheat germ plasm with sources of resistance, quality, and other useful traits usually derived from unadapted or wild wheat germplasm.
2. To develop biotechnological approaches that expedite the development of improved germplasm.

**RESULTS:** Center scientists prepared 14 research publications. The WGRC, in collaboration with Nanjing Agriculture University (China), organized an international symposium in Suzow, China, on wheat head scab disease. The wheat genetic map was improved by the addition of 177 new markers. Positions of agronomically important genes affecting spike morphology (Q), vernalization response, frost resistance, and rust resistance were determined. Genetic stocks were developed to expedite genetic transfers from rye and other grasses. The WGRC was a part of three university consortium that won a major wheat genomics grant (\$4.4M over 4 years) from the National Science Foundation. The germplasm collection now stands at 8,391, an increase of 16% over last year. Most noteworthy were new germplasm strains from Azerbaijan, a hot spot of resistance to leaf rust. A new leaf rust-resistant germplasm was released raising the total to 41. Seventy-four requests were filled for wheat genetic materials. Nearly a dozen scientists visited the WGRC for training, consultations, and seminars to promote national and international collaborations and sharing of wheat genetic resources.

**SIGNIFICANCE:** Germplasm is the foundation on which wheat breeders construct superior wheat cultivars that provide the livelihood for wheat farmers, drive the economic engine of society, and provide sustenance and nourishment to humankind. The germplasm pool must be deep, secure, and replenished from time to time to serve the crop needs of today, tomorrow, and forever. Tools to utilize germplasm must be honed constantly. Cutting-edge technology must be applied to enhance the efficiency of wheat breeding, sustainability of crop varieties, and competitiveness of producers. The WGRC research results ensure these outcomes in the near future and beyond.

# KANSAS WHEAT COMMISSION

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## **Field-Scale Evaluation of Integrated Agricultural Management Systems: Improving Surface Water Quality by Using Best Management Practices in the Cheney Reservoir and N. Fork of the Ninnescah River Watershed**

### **Researchers and Units**

William Heer and John Schmidt, Agronomy

**Funds (FY 99): \$15,000**

**Completion Date: June 30, 1999**

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**JUSTIFICATION:** Runoff from agricultural land has been identified as a nonpoint source contributor to sediment and phosphorus in surface waters in Kansas. Conservation tillage, especially no-till, is an effective method to control sediment loss from cropland. Switching tillage practices from conventional tillage requires a producer to embrace an alternative ideology and represents a capital investment in machinery. Best Management Practices should be both environmentally and economically attractive. The proposed study will evaluate and demonstrate the consequences of no-till in the Cheney Lake – N.F. Ninnescah Watershed. Two producers have been selected and have agreed to contribute field sites for the proposed study.

### **PROJECT OBJECTIVES:**

1. To evaluate the effectiveness of newly proposed integrated agricultural management systems for reducing sediment, pesticide, and nutrient losses in runoff from agricultural fields in the Cheney Lake – N.F. Ninnescah Watershed.
2. To expand the database, and to verify research findings obtained from K-State Research and Extension small plot investigations.
3. To enhance water quality awareness and education, and facilitate farmer adoption of integrated agricultural best management systems.
4. To assess the economics, profitability, yield potential, machinery requirements, labor costs, restraints and ease of implementation of these systems.

**RESULTS:** Field sites were established in FY 99, but a runoff event had not been recorded. Consequently, there were not any results to report.

**SIGNIFICANCE:** The soils in this region contrast sharply with many of the soils in eastern Kansas (location of other IAMS sites). Soils in our study are usually sandier and have smaller slopes and as a result, runoff is less likely to occur except for very large storm events. In trying to manage these fields to minimize runoff into the watershed, we must consider these differences from the other Kansas IAMS sites and results from other geographic regions.



# KANSAS WHEAT COMMISSION

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## Wheat Starches used as Stabilizers in Yogurt

### Researchers and Units

Tom Herald and Karen Schmidt, Animal Sciences and Industry;  
Paul Seib, Grain Science and Industry

**Funds (FY 99): \$24,403**

**Completion Date: June 30, 1999**

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**JUSTIFICATION:** During the past 20 years yogurt consumption has increased steadily in the U.S. Current yogurt production is estimated to be 153 million gallons. Because of the widespread acceptance of yogurt, the USDA approved yogurt as an alternative to meat in the nations' public-education school lunch program. Advances in wheat starch chemistry have now made possible products suitable for implementation as stabilizers in dairy products. The functionality of wheat starches may show a positive impact on yogurt texture and stability.

**PROJECT OBJECTIVE:** Evaluate the storage stability of low fat set-styled yogurt stabilized with native or modified wheat starch. Samples were compared to and evaluated against gelatin-stabilized yogurt using chemical, microbiological, and physical measurements over a refrigerated storage period of 60 days.

**RESULTS:** Yogurt formulated with native wheat starch exhibited a significantly greater storage modulus ( $G'$ ), elastic component, and firmness compared to yogurts prepared with modified wheat starches. Minimal syneresis was measured in all the yogurt samples. The titratable acidity of yogurt samples increased, whereas pH decreased during storage. Yeasts/mold were not detected, but lactic acid bacteria counts decreased approximately 1 log CFU/g by day 60 for all yogurts.

**SIGNIFICANCE:** Use of wheat starch as stabilizers in yogurt produced positive effects to varying degrees. A wide range of physical textures could be obtained in yogurt by using different types of wheat starch to meet consumers' expectations. This study showed that the characteristics of yogurt formulated with native wheat starch were similar to those of gelatin-stabilized yogurt. Therefore, native wheat starch can be used as an alternative in set-type yogurt. Additionally, the modified wheat starches can be considered in stirred-type yogurt formulations.

# KANSAS WHEAT COMMISSION

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## **Kansas Dual Purpose Pest Resistant White Wheats**

### **Researchers and Units**

T. Joe Martin, Dallas L. Seifers, and Thomas. L. Harvey, Agricultural Research Center-Hays

**Funds (FY 99): \$76,000**

**Completion Date: Ongoing**

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**JUSTIFICATION:** The primary reason for the development of hard white wheat varieties adapted for production in Kansas is to increase demand for Kansas wheat thereby increasing our world market share. Much of the world market increase should come from Asia, where white wheat is used for noodle production. Our current white wheat varieties are good bread wheats but do not produce good quality Asian noodles. Hard white wheats grown in Kansas need to meet the quality requirements for both bread and Asian noodle production. The intent of this project is to develop white wheat varieties that combine good bread and noodle quality with improved levels of pest resistance. Kansas production efficiency can be improved by as much as 15% if our most serious pests are controlled with pest-resistant varieties.

**PROJECT OBJECTIVE:** Development of high-yielding hard white wheat varieties adapted for production in Kansas that are capable of resisting our most serious wheat pests and producing grain with good bread and noodle production characteristics.

**RESULTS:** After the harvest of the 1999 wheat crop, 6500 bushels of foundation seed of our newest hard white variety, Trego, were distributed to Kansas seed producers. Trego is best adapted to the western half of Kansas and has the best performance record of any wheat variety in this region. Trego is a non-shattering wheat with very good winter hardiness and has effective levels of resistance to several major pests, including leaf rust, stem rust, soilborne mosaic virus, wheat streak mosaic virus, and Hessian fly. Trego's bread quality has been rated above average in two years of testing by the Wheat Quality Council. It has the quality needed to make salt noodles but is still inferior in the production of alkaline noodles. Alkaline and salt noodles represent the major types of Asian noodles.

**SIGNIFICANCE:** The release of Trego represents significant progress towards our objective. It is a top performing variety that has good overall milling and bread baking quality and can be used in the production of salt noodles. However, we must eventually have the quality characteristics in our white wheats that will allow for production of alkaline noodles as well. Trego's yield advantage alone could result in a 10% increase in western Kansas production efficiency, while its improved flour yield could also add value.

# KANSAS WHEAT COMMISSION

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## Quality Evaluation of Materials from KAES Wheat Breeding Programs

### Researchers and Units

P. J. McCluskey and Brendan Donnelly, Grain Science and Industry

Funds (FY 99): \$53,000

Completion Date: Ongoing

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**JUSTIFICATION:** Wheat researchers often cross existing hard wheat varieties with soft wheats and diverse grass-like relatives of wheat having unacceptable quality as a means to improve agronomic performance of the wheat. Breeding groups can measure factors that determine agronomic performance among the segregating progeny. However, laboratory tests carried out by persons with specialized equipment, training, and experience are required to identify the lines that have acceptable or superior hardness; protein quantity and quality; milling; and physical dough, breadbaking and Asian-style noodle properties.

### PROJECT OBJECTIVES:

1. To provide timely evaluation of important milling, bread-baking, and other end use quality properties of agronomically-promising lines developed by KAES wheat breeders.
2. To cooperate with research staff and graduate students in Agronomy, Plant Pathology, Entomology, Grain Science, and the USDA in studies designed to determine influence of diseases, insects, soil and environmental factors, and grain storage and processing on milling and bread baking quality needed in ethnic breads and Asian-style noodles.

**RESULTS:** Data collected on wheat samples harvested in 1999 were used by KAES wheat breeders to make quality selections among agronomically promising early and advanced generation lines for planting, crossing, and increase and release decisions. In one study, 186 samples of about 1000 grams each were analyzed for chemical constituents, test weight, kernel size distribution, kernel hardness, milling performance, mixing characteristics and test baking. Additionally, starch quality characteristics and color stability (as related to Asian noodle quality) were determined. An additional 292 samples were milled and analyzed for mixing characteristics. In a separate project related to wheat improvement in Kansas, more than 4500 additional early generation samples were screened solely for protein content and hardness.

**SIGNIFICANCE:** As a result of testing experimental lines in the wheat quality evaluation program, new varieties like Lakin, Stanton and Trego are available to Kansas wheat producers. Additional advanced hard white wheat lines that exhibit acceptable to outstanding milling and baking quality continue to be extensively tested. This project helps identify varieties having improved field performance and acceptable or improved processing quality for domestic wheat and flour processors and international buyers of U.S. hard winter wheat. These varieties and others under development will make significant contributions to the Kansas economy.

# KANSAS WHEAT COMMISSION

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## **Development of Hard White Winter Wheat for Kansas**

### **Researchers and Units**

Rollie Sears and Gary Paulsen, Agronomy. Report prepared by Allan Fritz, Agronomy

**Funds (FY 99): \$45,000**

**Completion Date: Ongoing**

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**JUSTIFICATION:** White wheats offer many advantages including higher flour extraction, better tasting whole wheat products, and greater demand in the international marketplace. In order to maximize the benefit of white wheat, it is important that we have high yielding, high quality white wheats with resistance to key diseases, insects, and environmental stresses.

**PROJECT OBJECTIVES:** Continue development of hard white winter wheats that are adapted to Kansas, have excellent milling and baking quality, improved Asian-type noodle quality, improved kernel color, increased sprouting tolerance and protein concentration, as well as good levels of disease and insect tolerance.

**RESULTS:** In 1998, Kansas State University released two new white wheats, Betty and Heyne. Both Betty and Heyne have excellent milling and baking quality. Betty, a sister to Jagger, has good levels of resistance to septoria leaf blotch, tan spot, and soil-borne mosaic virus. It is moderately susceptible to leaf rust. It appears to be best adapted to areas of central Kansas. Heyne is slightly earlier than Betty and has a similar disease-resistance package, except it has a higher level of resistance to leaf rust. Heyne's best area of adaptation is south central Kansas. Both varieties should make a significant impact on Kansas wheat production and provide Kansas producers with additional choices among white wheat varieties.

**SIGNIFICANCE:** The development of new wheat varieties has been an excellent investment for Kansas wheat producers. In a recent economic analysis of Kansas wheat breeding, it was determined that for every public dollar invested in wheat breeding research, nearly \$12 of benefits resulted. Most of those benefits accrued to the Kansas wheat producer. The development of Betty and Heyne white wheats is a part of that on-going effort to develop new wheat varieties adapted to Kansas. In order to make white wheats a viable alternative to red wheats, it is important that we develop new varieties with excellent quality and agronomic characteristics. Both varieties have resistance to many of our key production constraints. In addition, both have excellent milling and baking quality. Both Betty and Heyne should make strong contributions to our effort to move forward with the adoption of hard white wheat for Kansas. Because of their excellent milling and baking characteristics, as well as their disease-resistance packages, Betty and Heyne also will serve as the foundation for a continued effort to improve white wheat. Plant breeding is more of a process than a project, and these two lines have already shown considerable promise as parents for the next generation of Kansas white wheat varieties.

# KANSAS WHEAT COMMISSION

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## **Improvement of Hard Red Winter Wheat for Kansas**

### **Researchers and Units**

Rollie Sears, Agronomy; T. Joe Martin, Agricultural Research Center–Hays.  
Report prepared by Allan Fritz, Agronomy

**Funds (FY 99): \$92,000**

**Completion Date: Ongoing**

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**JUSTIFICATION:** Kansas is the leading producer of hard red winter wheat. In addition, Kansas wheats have earned a reputation as high quality wheats. The advances that have allowed Kansas to earn and maintain this status have been the product of a strong historical commitment to wheat improvement by both the Kansas Agricultural Experiment Station (KAES) and the Kansas Wheat Commission (KWC). Considerable advances in yield and disease resistance have been made while also improving protein content and milling and baking quality. Continued investment in wheat breeding is required for future challenges to be faced by Kansas wheat producers.

### **PROJECT OBJECTIVES:**

1. Improve disease resistance, insect resistance, test weight and yield, while maintaining/improving end use quality.
2. Improve protein concentration, kernel size and uniformity, crumb grain, and crumb color.
3. Improve resistance/tolerance to heat, low soil pH, and key diseases and insects.

**RESULTS:** In 1999, KS97P0630-4-5 was entered in the Southern Regional Performance Nursery. This nursery is a cooperative test conducted at 33 locations throughout the southern Great Plains and contains elite entries from both public and private breeding programs. When the data was analyzed across locations, KS97P0630-4-5 was the highest yielding pureline entry in the test. This line has excellent yield potential, as well as resistance to leaf rust and soil-borne mosaic virus. It also has good milling and baking characteristics. Given its outstanding performance across the region, we will continue to evaluate the line as a potential candidate for release.

**SIGNIFICANCE:** The development of new wheat varieties has been an excellent investment for Kansas wheat producers. In a recent economic analysis of Kansas wheat breeding, it was determined that for every public dollar invested in wheat breeding research, nearly \$12 of benefits resulted. Most of those benefits accrued to the Kansas wheat producer. KS97P0630-4-5 appears to be a strong candidate for future release and would continue the tradition of a strong return on the investment the Kansas wheat producers have made in wheat breeding research. KS97P0630-4-5 appears to be best adapted to central Kansas, where it represents approximately a two bushel per acre increase in yield potential over Jagger and 2137.

# KANSAS WHEAT COMMISSION

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## **Gluten Proteins that Improve Bread Quality**

### **Researchers and Units**

Paul Seib, Grain Science and Industry; George Lookhart and Michael Tilley, USDA-ARS Grain Marketing Research Laboratory; Rollin Sears and George Liang, Agronomy; S. Muthukrishnan, Biochemistry

**Funds (FY 99): \$30,150**

**Completion Date: Ongoing**

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**JUSTIFICATION:** Breeders are continually trying to improve the breadmaking quality of wheat. In order to do this, breeders must make a large numbers of crosses, grow and harvest them, and then perform baking and other tests on all crosses. This is expensive and time consuming and delays the release of new cultivars to Kansas farmers. We hope that by understanding how these new proteins influence milling and baking characteristics of modern cultivars, the time and expense required to get the proteins into Kansas adapted cultivars can be reduced.

**PROJECT OBJECTIVE:** The goal of this project is to study and understand the novel proteins and how they relate to reducing mixing time and improved baking quality. These proteins are currently being characterized to determine the structures of these new proteins. Once the structures are known, then we can learn how these particular proteins function in dough.

**RESULTS:** The first phase of the protein analysis consisted of extracting one particular type of gluten protein called Gliadin. *Triticum aestivum* (wheat) x *T. tauschii* crosses had a unique set of high molecular weight glutenins. Separating the gliadins by high performance capillary electrophoresis and reverse-phase high-performance liquid chromatography showed that *T. tauschii* has patterns similar to traditional U.S. hard red wheats. However, the amount of protein was higher in the *T. tauschii* lines than typically found in hard red winter wheats. In addition, analysis was performed for a second class of gluten proteins termed glutenins. Again, differences were noted between the patterns of *T. tauschii* lines and the patterns of typical U.S. hard red winter wheats.

**SIGNIFICANCE:** The characteristics of these novel gluten proteins need to be thoroughly understood to improve quality in wheats. Through characterization of these novel proteins and understanding of their functional properties, K-State wheat breeders will be able to select plants that provide farmers with a higher quality product. This is extremely important as today's wheat economy is a buyer's market with many countries now exporting wheat that competes for U.S. markets. Buyers are becoming more selective of quality and can purchase from numerous sources making it critically important to improve the quality of Kansas wheat.

# KANSAS WHEAT COMMISSION

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## **On-Farm Wheat Action Research**

### **Researchers and Units**

James P. Shroyer, Dale Fjell, Bill Heer, Barney Gordon, Agronomy; Scott Staggenborg, Stu Duncan, Curt Thompson, Randy Brown, NE, SC, SW, NW Area Extension Offices; Bob Bowden, Plant Pathology

**Funds (FY 99): \$9,000**

**Completion Date: June 30, 1999**

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**JUSTIFICATION:** Kansas is a very diverse state with wheat grown in every county. New technologies that have been developed at research centers and experiment fields need to be tested and observed over many environments. The interval from the time a new technology becomes available until acceptance by farmers is about 10 years, and we would like to shorten that lag time. On-farm trials and plot tours allow local farmers to see new technologies and, because farmers are "practicing researchers," they can make the needed modifications so these practices are suitable for their farms early during the lag time in the transfer and adoption process.

### **PROJECT OBJECTIVES:**

1. To speed the time of farmer acceptance of new wheat technologies through use of on-farm trials and plot tours.
2. To broaden the database of research that has been conducted at experiment fields.

**RESULTS:** The introduction of several hard white wheat varieties has attracted considerable interest among farmers. This has resulted in more than 30 educational meetings across the state to help farmers identify concerns and opportunities. Also, the excessive rain during harvest in the central areas of the state caused sprouting problems in the white wheat varieties. Our research, based on visual ratings and falling numbers, indicated the white wheats were more susceptible than red wheats to sprouting under those conditions and until sprouting-resistant varieties are available, white wheat should be grown west of Hays.

Farmers are trying to intensify cropping rotations and more wheat is being planted no-till after row crop harvest in the fall. Our results show that nitrogen rates of at least 80 lb/a is needed and a seeding rate of at least 90 lb/a is needed after either sorghum or soybean. Wheat after sorghum produced lower yields than after soybean.

**SIGNIFICANCE:** We better understand areas for which white wheat is best adapted in the state and the potential benefits of planting white wheat. No-till planting wheat after row crops can be successful, but modifications in seeding and nitrogen rates must be made to optimize grain yield.

# KANSAS WHEAT COMMISSION

## Compatibility of Starch and Polylactic Acid

### Researchers and Units

X. Susan Sun, Paul Seib, and John Brent, Grain Science and Industry

Funds (FY 99): \$22,625

Completion Date: June 30, 2000

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**JUSTIFICATION:** Kansas is number one in the production of wheat. Starch comprises about 70% of wheat components. This research will enhance the utilization of wheat starch in industrial materials, which could bring more money into rural economies. In addition, environmental protection has become one of the top priorities of both national and international government agencies, and among the public as well. This research plan will provide technology for producing low cost, durable, and biodegradable wheat starch-based plastics.

### PROJECT OBJECTIVES:

1. Investigate the compatibility of wheat starch and PLA compared to blends of corn starch and polylactic acid (PLA).
2. Develop wheat starch-based formulation and processing technology for biodegradable plastics.

**RESULTS:** Wheat starch with different initial moisture contents (0, 11.6, 30, and 50%) was extruded at five temperatures (mixing zone) to observe the effects of moisture and temperature on starch melting and PLA degradation in relation to the blending strength. Testing tensile bar specimens were prepared using a hot press. Tensile strength, elongation at break, and Yong's modulus were analyzed. Results showed that moisture content played an important role in starch blending. Wheat starch has comparable blending performance and quality as corn starch.

Preliminary results have identified one chemical with potential as a co-polymer. Two different co-polymer synthesis procedures were used and one procedure was found superior, resulting in higher tensile strength of the blend. Corn starch, wheat starch, and selected high amylose corn starch were used for comparison.

**SIGNIFICANCE:** Large solid-plastic wastes are produced from a wide range of sources, such as packaging, medical services, grocery bags, trash bags, fast-food containers, eating utensils, and even flower/plant pots. The newly-developed plastics from this research could provide possible solutions to the disposal problem associated with these items. Also, the plastics from this proposed research could be used as a slow-releasing carrying matrix in biomedical or pesticide applications. The outcome of this research will enhance the utilization of wheat as an industrial material.



# KANSAS WHEAT COMMISSION

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## **Cancer Protective Effects of Wheats with Different Antioxidant Potentials**

### **Researchers and Units**

Delores Takemoto, Biochemistry; Carol Klopfenstein, Grain Science and Industry

**Funds (FY 99): \$30,000**

**Completion Date: Ongoing**

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**JUSTIFICATION:** Diets that are rich in wheat are associated with a decreased risk of colon cancer. Few studies have attempted to identify the individual contributions of antioxidants to the protective effects of different wheat classes, cultivars, and climactic conditons. Such a correlation would allow wheat breeding programs to select for high antioxidant potential as a trait in breeding programs and, thus, provide greater protection against the development of intestinal and colorectal cancers.

### **PROJECT OBJECTIVES:**

- 1. Determine cancer preventive potential of 90 different wheat samples representing 6 classes, 5 cultivars and 3 locations, using a cell culture screen assay.**
- 2. Quantify and identify the antioxidant potentials and some of the individual compounds that contribute to anticancer activity.**

**RESULTS:** Seventy-eight wheat samples representing 5 classes and 34 cultivars were screened by the cell culture assay. Some wheat samples exhibited better anticancer activity. This was not correlated with fiber content or wheat class. That is, hard red winter did not differ from hard white winter as a class.

Wheats differed in their total antioxidant potentials. Again, this was not correlated with wheat class or fiber content. One class of antioxidant was identified as correlating with anticancer activity, the ortho-phenolics. Individual wheats with high ortho-phenolic content had high anticancer activity. This was not correlated with either fiber content or wheat class. Several hard white winter wheats were superior, such as Betty and Heyne.

**SIGNIFICANCE:** We have identified wheats with high intermediate and low protective effects and these will be tested in mice. Both antitumor effects in diets and serum antioxidant potential will be determined. In addition, other compounds that contribute to anticancer and antioxidative potential will be identified. This will identify compounds that can be used for genetic engineering projects, for wheat breeding selection, for value added produce, and for the development of robust assays that can be used by wheat research labs to identify these compounds. Production of wheat cultivars with higher cancer protective potential will enhance the health of the population.

Kansas State University Agricultural Experiment Station and Cooperative Extension Service, Manhattan 66506

Department Report

March 2001

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