2005 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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INTRODUCTION

We are pleased to provide this update on research and educational activities made possible in Fiscal Year 2005 using check-off funds from the Kansas Corn, Grain Sorghum, Soybean, and Wheat commissions. The commissions provided $1,613,031 in FY 2005, up just slightly from $1,599,605 in FY 2004. As always, our faculty sought to make wise use of the funds received in FY 2005 from the commissions, as listed below:

Corn Commission – $170,820
Grain Sorghum Commission – $115,500
Soybean Commission – $449,537
Wheat Commission – $877,174

Our faculty is grateful for these funds and is striving to produce results that will offer our clientele opportunities to strengthen their operations. We are mindful of the fact that these funds come directly from Kansas farmers, and we feel a special responsibility to use their money judiciously. The commissions help us stay on track by providing useful guidance on focus areas for research and in the selection of proposals for funding. Commission-funded research and extension programs represent a real partnership.

We anticipate that most users will find the CD format of these reports to be very useful. Articles are published as Adobe Acrobat PDF files. This allows readers to search either individual documents or the entire CD. The reader can then download or print articles of interest without having to print the entire publication. If a printed version of this report is preferred, they are available for a nominal charge through K-State Research and Extension.

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 education efforts.

Forrest Chumley
Associate Director
Kansas Agricultural Experiment Station

AGMANAGER.INFO: Corn Basis and Other Farm Management and Marketing Information

RESEARCHERS AND UNITS:
Kevin Dhuyvetter, Department of Agricultural Economics; Terry Kastens, Department of Agricultural Economics; Mykel Taylor, Department of Agricultural Economics (former, currently Mykel is a PhD student at NC-State)

FUNDS (FY 04): $9,300

COMPLETION DATE: June 30, 2005 (the grant and portions of this project are finished as of June 30, but this is an on-going project that never has a true "completion date" as the AGMANAGER.INFO website continually evolves over time.

JUSTIFICATION: Producers are increasingly using the Internet for information. Recent surveys by the Ohio State University, Purdue University, USDA, and other organizations suggest that more than half of all full-time producers use the Internet as an information source. Within the Department of Agricultural Economics at Kansas State University, several websites previously existed that addressed livestock marketing, farm management, risk management, and other topics. The development of AGMANAGER.INFO has allowed producers to access all of this information, plus new content, at one website that is supported by the entire faculty. This project addressed issues identified in section 3(b) Marketing Extension Program and Transportation of the Request for Proposals and, thus, applies directly to issues identified by the Corn Commission.

Both the Department of Agricultural Economics and the College of Agriculture have identified the movement toward more electronic delivery mechanisms as a key component of extension education in the future. The developed and maintained database and computer tools resulting from this project will aid producer decision-making with regard to marketing and management by making available information, specifically historical corn basis data for numerous locations throughout Kansas that was not available in the past.

Recent budget cuts suffered by K-State Extension may jeopardize the department's ability to provide educational materials that help keep Kansas producers competitive. A challenge for the department will be the dissemination of information being generated by current research with resources significantly below historical levels. With the departure of grain marketing specialist Dr. Bill Tierney, it has been important for price data to be collected, analyzed, and disseminated to help fill some of the gaps in market information that currently exist – this project has helped fill some of those marketing information gaps. The use of AGMANAGER.INFO and the continued development of web-based educational materials contribute to making this information more readily available to producers and others in the corn industry in a timely fashion at a relatively low cost to users and the department.

Extension faculty often receive questions on crop price basis and what is going on with regard to basis levels in Kansas because this information is vital to producers' marketing decisions. The last two Farm Bills have made producers even more aware of the importance of marketing, and this trend is likely to continue in the future. By providing basis information in a web-based database, producers can now

request current and historical basis for specific locations from their home computer and use this information when making marketing decisions. In addition to providing the data directly to producers on AGMANAGER.INFO, researchers can use the data to analyze grain markets and marketing strategies.

The department's web presence has improved significantly over the past year. Recent investment in the departmental website, as well as AGMANAGER.INFO, has improved the visible appeal and organization of content. The department also uses the Internet for the MAST program, a distance education program for producers. The movement of extension to web-based programming not only provides resources to producers on a 24-hour basis, but it supplements county and state meetings with documents and spreadsheets that can be downloaded and used on home computers.

The development and continued success of a nationally recognized website targeting commercial agricultural managers is consistent with the current strategic direction of the Agricultural Economics Department. A primary theme identified by the extension faculty in the department was re-balancing outreach efforts among the four delivery mechanisms (i.e., meetings, publication, mass media, and the Internet), with greater emphasis being placed on electronic media. Successful implementation of new products on the website, such as the "Interactive Crop Basis Tool" and "GrainSeasonals.xls" that resulted from this project, has required some reallocation of time and financial resources to web-based delivery. These new efforts cannot be accomplished in a timely manner by simply "adding on" to existing activities without securing additional resources; thus, support from commodity groups such as the Corn Commission are critically important for projects such as this one.

OBJECTIVES:

- Develop a database of weekly cash prices and basis information for soybeans, corn, grain sorghum, and wheat from various Kansas elevators.
- Analyze the costs of forward contracting of corn by using basis information from cash prices database.
- Maintain and further develop a comprehensive website with farm and ranch management and marketing information for Kansas producers and agribusinesses.

RESULTS:

Objective #1 – The database we have developed of corn cash prices (and other commodities) for numerous locations in Kansas and the surrounding states continues to be updated weekly. These data, along with futures prices, are used to construct basis maps and basis deviations maps for corn, soybeans, sorghum, and wheat that are posted to the web monthly. Examples of the most recent corn-basis and basis-deviation maps are displayed in the example web screens shown in figures 1 and 2. Basis maps such as figure 1 provide a good visual representation of the corn market in Kansas and the High Plains region. For example, it can quickly be seen how the cattle feeding industry in southwestern Kansas impacts the price of corn because basis in that region is much stronger than in central and eastern Kansas.

The most recent (6-15-05) basis-deviation map for corn (figure 2) reveals that corn basis is weaker than expected (3-year average) in all of Kansas, with the relatively weakest region being in central Kansas. Information such as that depicted in figure 2 is useful as producers consider marketing both old crop and new crop corn. Historical basis maps are archived, which allows users to go back and view previous spatial patterns.

An "Interactive Crop Basis Tool" was developed that allows users to extract historical weekly basis data as displayed in figures 1 and 2 for their specific location and time period (e.g., current year, 3-year average, 5-year average). This interface allows producers to view the historical basis data in either tabular or graphical format directly on the web, without requiring any specific software on their computer. Figures 3 through 7 show web screen examples that relate to the Interactive Crop Basis Tool. It can be seen in figure 4 that the user has the ability to pick the commodity desired (corn, grain sorghum, soybeans, or wheat), location, and time period of data to examine. Figure 5 represents an example of corn basis data displayed in the table format, and figures 6 and 7 show examples of corn basis data displayed graphically.

At this point, users need to enter their location by typing in their city or zip code. If their particular location (i.e., city) is not in the database, they need to try other nearby locations. We are in the process of building a map that will allow users to pick a county, and then any locations available in that county will be displayed on a pick list. Thus, although we have a very functional tool currently available to producers, we intend to continuously improve upon it, based on feedback we receive, as resources permit.

As can be seen on figures 1 through 4, we have identified the Kansas Corn Commission as providing support for the information relating to the basis maps and interactive basis tool. In addition to recognizing the Corn Commission on these pages, the Commission has been identified as being a general sponsor/partner for the AGMANAGER.INFO website on a "Sponsor Page" (figure 8).

Objective #2 – One of the ways producers evaluate forward contract bids is by examining how an offered contract price compares with what might be expected by using futures prices and historical basis. Because this approach requires a forecast of basis, being able to accurately forecast basis is important. A research project was conducted that looked at how current basis deviations (i.e., information similar to what is displayed in figure 2) might be used to improve upon basis forecasts. The results of this research are promising with regards to forecasting post-harvest basis, but less promising for forecasting harvest-time basis before harvest. This research was written up in a paper that has been posted to the AGMANAGER.INFO website:

> Taylor, M., K.C. Dhuyvetter, and T.L. Kastens. "Incorporating Current Information into Historical-Average-Based Forecasts to Improve Crop Price Basis Forecasts."

In addition to the paper posted to the web, a manuscript has been submitted to a refereed journal article. The value of submitting a journal article to producers is that it provides us an opportunity to have our research critiqued and to have suggestions for improvements made. A goal for the future will be to incorporate information from this research into basis forecasts that can be updated and posted to the website weekly.

A research project examining the costs of forward contracting corn, based on forward contract bids from 1999-2004, has been initiated (thesis research for a current graduate student). This information will be written in a paper that can be posted to the website when it is finished. Based on preliminary work that has been done with wheat, this research should prove useful to corn producers in two ways – (1) knowing the historical cost of forward contracting will help producers choose between pricing with forward contracts versus hedging, and (2) this information might be used to improve upon pre-harvest basis forecasts that are based solely on historical averages.

Objective #3 – Although the first two objectives identified some specific projects we are working on, this objective is more general in the sense that it relates to the website as a whole. Ways we have met this objective are by adding information to the website in a timely fashion and making sure the website is user friendly. Some specific examples of information that has been posted to the site that are useful for corn producers as they make production and marketing decisions are:

- GrainSeasonals.xls – spreadsheet for examining historical cash prices and seasonal patterns
- NH3 and Diesel Price Forecasts – one-page report of forecasted prices that is updated monthly
- Grain Marketing – Things to Think About – paper that discusses a number of grain marketing issues

Figures 9, 10, and 11 show examples of information that is made available through the GrainSeasonals.xls Excel spreadsheet (users are required to have Excel on their computer for this tool). The "Intro" screen allows the user to pick a region of the state (e.g., Northeast, South Central, Northwest) and also the individual years to include for two different time periods that seasonal indices are calculated for. For example, seasonal price patterns can be compared for "normal crop years" versus "short crop years" or for a 10-year average versus a 30-year average. Figure 10 shows graphs that are displayed, based on the user inputs, and figure 11 shows the data used in tabular format.

A goal for the near term is to get the information presented in figures 10 and 11 into a format such that it is available to users without requiring them to have Excel on their computer (i.e., make it available in a manner similar to the Interactive Crop Basis Tool). The previously mentioned papers and tools listed are not all-inclusive of everything that has been posted to the AGMANAGER.INFO website that is relevant to corn producers, but it does provide some examples of the types of information and tools that are available and that have been made possible by support from the Kansas Corn Commission.

SIGNIFICANCE OF RESULTS: This project has lead to several key results that will benefit corn producers and others in the agricultural industry in Kansas. The development of the Interactive Crop Basis Tool makes weekly historical (1998-2005) basis data readily available for well over 100 locations in Kansas. This information, not previously available to the general public, can now be easily accessed in a user-defined format by anybody having access to the internet. In addition to the information made available through the Interactive Crop Basis Tool, a secondary benefit of this tool is that the developed interface will allow us to duplicate these efforts with other types of information (e.g., livestock prices, land values, futures prices, etc.). Thus, the development of the Interactive Crop Basis Tool is significant both for the information it currently provides and for the benefit of the future applications of this technology.

Another important result of this project has been estimating the benefit of including current information into historical-average-based basis forecasts. This information will allow us to develop algorithms that can be used to more accurately forecast post-harvest basis. More accurate basis forecasts benefit producers as this information can be used to make better production and marketing decisions. In addition, preliminary research examining the costs of forward contracting wheat and how this information might help improve pre-harvest basis forecasts has set the stage for similar research that is currently being conducted for corn.

This project has focused on developing information, applications, and tools that can be posted to the internet. This is significant because producers are increasingly relying upon the internet for information and, thus, it is imperative that we also increase our use of this method of disseminating information.

Corn Production in Kansas: Extension and Applied Research

RESEARCHERS AND UNITS:
Dale L. Fjell, Dept. of Agronomy

FUNDS (FY 05): $4,000 **Completion Date:** Ongoing

PROGRESS REPORT:
My extension and applied research for corn production in Kansas during April, May, and June consisted of many activities across the state.

1. I visited on the phone and in the fields with many producers on the effects of cold weather and frost on their corn fields.
2. Re-plant decisions were recommended to producers that had concerns about population of their corn fields.

With the funding available from this grant I was able to get to more places around the state and not worry about depleting the Extension Agronomy's travel funds.

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         MAP CODE: 37060            FLAGS: DEL FRZ RVW DRP SUP ABR
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 OBJ  DESCRIPTION          BUDGET         ACTUAL         ENCUMB          AVAIL
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4-⌐              1 KSUVM     129.130.12.1                              4/10
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Use of Strip-tillage for Corn Production in Kansas

RESEARCHERS AND UNITS:
Barney Gordon, Chad Godsey, Keith Janssen, Dept. of Agronomy; Dan Sweeney, Southeast Kansas Agricultural Research Center; and Gary Kilgore, Southeast Kansas Area Extension Office

FUNDS (FY 04): $30,000 **Completion Date:** June 31, 2005

JUSTIFICATION: Production systems that limit tillage are being used by an increasing number of producers in the central Great Plains because of several inherent advantages. These include reduction of soil erosion losses, increased soil water use-efficiency, and improved soil quality. But early-season plant growth can be poorer in reduced tillage systems than in conventional systems. The large amount of surface residue present in a no-tillage system can reduce seed zone temperatures. Lower-than-optimum soil temperature can reduce the rate of root growth and nutrient uptake by plants. Soils can also be wetter in the early spring with no-tillage systems. Wet soils can delay planting. Early-season planting is done so that silking will occur when temperature and rainfall are more favorable. Strip tillage may provide an environment that preserves the soil and nutrient saving advantages of no-till, while establishing a seed-bed that is similar to that from conventional tillage.

OBJECTIVES: The objectives of this experiment were to compare the effectiveness of strip-tillage to no-tillage corn production and to assess the effects of timing and placement of N-P-K-S fertilizers on growth, yield, and nutrient uptake of corn grown in no-till or strip-till production systems.

RESULTS: In 2004, use of fall strip tillage improved early-season growth, nutrient uptake, and grain yield of corn, compared with no-till, at 3 of the 4 experiment locations. When averaged over the 3 years of the experiment, strip tillage out yielded no-till at all locations except in Southeast Kansas. Fall fertilization proved to be as effective as spring application at Belleville, Manhattan, and Ottawa. In 2003 and 2004, soil temperature was monitored at Belleville and Manhattan from planting until early June. Soil temperatures proved to be 4 to 6 °F warmer in strip-tilled plots than in no-till at both locations in both years. When averaged over fertility treatments at the Belleville location, strip tillage shortened the time from emergence to mid-silk by 10 days, compared with no-till. Strip tillage has proven to be an effective production practice in both low- and high-yielding environments. Strip tillage does provide a better early-season environment for plant growth and development, while preserving a reasonable amount of residue on the soil surface.

SIGNIFICANCE OF RESULTS: Use of fall strip tillage does provide an environment for crop growth similar to that from conventional tillage, while maintaining significant amounts of residue on the soil surface. Early-season plant growth and nutrient uptake are improved in strip-tillage systems, compared with no-till production. Strip-tillage production methods increased grain yield at 3 of the 4 locations in both 2003 and 2004. Strip tillage has proven effective in solving some of the problems associated with no-till production systems, thus making conservation-tillage methods more attractive to producers.

International Grains Program Support Project

RESEARCHERS AND UNITS:
John Howard, International Grains Program

FUNDS (FY 05): $36,000 **Completion Date:** Ongoing

JUSTIFICATION: The world's feed manufacturers face increased competition. As a result, the costs and benefits of the raw materials used to manufacture their feeds face intense scrutiny. Buyers and potential buyers of U.S. corn are not as familiar as they should be with the many specialized corns available to them. They are ignorant of the value of quality raw materials and the benefits to their customers. In addition, U.S. corn customers are not as familiar with grade, shipping, quality control, proper storage and fumigation, contracting, and sanitation issues as they need to be. Pricing, basis, futures markets, and price-discovery fundamentals are not well understood. Genetically modified organisms (GMOs) continue to become a more sensitive issue to consumers, requiring additional education on GMO development, use, safety, and value.

OBJECTIVES:

1. To identify potential buyers of corn, in cooperation with the U.S. Grains Council (USGC) and the USDA's Foreign Agricultural Service (FAS).
2. To seek out corn buyers and users who would benefit from the international Grains Program (IGP) short courses, both in and outside the United States.
3. To identify specific target markets, with the USGC, where specifically designed short courses would be paramount.
4. To maintain contact with buyers and users of U.S. corn to provide them with the latest information available after participation in IGP programs.

RESULTS: There were 185 persons who participated in IGP's short courses.

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

A Short-season Corn Education Program in Southeast Kansas

RESEARCHERS AND UNITS:
Gary L. Kilgore and Sarah L. Fogleman, K-State Research & Extension Office, Southeast Kansas

FUNDS: (FY'04): $3,950 **Completion Date:** June 30, 2006

JUSTIFICATION: In Southeast Kansas, corn acreage has more than doubled in the last few years. In the last six years, acreage has increased by 50%. In 2004 alone, there was a 12% increase in corn acres in Southeast Kansas. That is due to the planting of short-season corn on the upland. Experiment Station data shows that short-season corn is much more reliable in yield than full-season corn on upland sites. If corn can be planted early (March 25 - April 10), experimental results show it is more profitable than grain sorghum. Because additional counties have been added to the Southeast Area, the time is right to hire part-time labor and expand our educational program. Producers are asking for on-farm trials to determine plant populations, correct nitrogen rates, and proper hybrid to grow on our shallow upland soils; genetic engineered plants; and starter fertilizer rates and placement. Best Management Practices (BMP) to reduce water0quality problems is most important. Phosphorus placement and rates in no-till plantings are especially needed.

OBJECTIVES: This is an Extension Education Program and is designed to take current research from the Southeast Kansas and East Central Kansas Experiment Stations to farmers' fields and show production BMPs and economic benefits for corn production in the southeastern area of Kansas. This educational program not only shows the latest production techniques, but also serves as a source of data for grower educational meetings during the winter. Taking the University to the people is the goal.

Objectives are to show producers, by using on-farm demonstration trials that will include:

1. Increase the number of on-farm trials to demonstrate BMPs for corn on those farms.
2. Determine the effects of phosphorus placement with different plant populations.
3. Determine optimum nitrogen rates on upland short-season corn.
4. Measure response of short-season corn yields to topsoil thickness.
5. Evaluate 15- and 30-inch row corn planted with two different plant populations.
6. Conduct an economic analysis of each of the above objectives.
7. Use on-farm sites for tours and data for winter schools.
8. Present new corn budget worksheets.

RESULTS: Short-season corn yields were outstanding. Long-time average upland soil production is 86 bu/a. The 2004 yields ranged from 110 to 185. Average production was around 140 bu/a.

- For the first time ever, plant population trials resulted in highest production at 25,000 plants/A. Past year's average is 20,000 plants/A.
- Nitrogen at a higher rate also increased yields. But because yields were higher, more N was required.
- Side dressing nitrogen proved beneficial in 2004. Research plots where 60 pounds of N was side dressed with 60 pounds pre-plant out-performed treatments with 120 pounds of N applied pre-plant.
- Adequate moisture in July and August resulted in a delay of corn maturity. Most were mature by August 30 instead of August 10.

- County plot tours were held in 10 counties. More than 800 producers attended.
- Winter schools were held throughout the Southeast Kansas area. More than 2,000 producers were exposed to the data that the field trials produced in 2004.
- Corn acreage continues to increase in Southeast Kansas. This education program is well received by producers.

SIGNIFICANCE OF RESULTS: Producers continue to "see and hear" the on-farm trials and the data that they provide. Nitrogen rates and yield response is a major issue. A survey among growers in 2004 indicated that they reduced N rates by 15% over previous years. They saw our trial results and accepted the results. That one fact alone reduced input costs by $6.00/A. This one practice reduced costs by more than $800,000 in Southeast Kansas. The overwhelming acceptance of deep placement of fertilizer must have reduced nutrient runoff into our streams. What value - - - - - - - - - - I don't know.

Reducing Irrigation Water Needs with High-frequency, Limited, Subsurface Drip Irrigation

RESEARCHERS AND UNITS:
Freddie R. Lamm and Robert M. Aiken, Northwest Research-Extension Center, Colby KS

FUNDS (FY 05): $12,000 **Completion Date:** June 30, 2005

JUSTIFICATION: Decline of the Ogallala aquifer has been identified as a critical water issue by the State Water Plan (Kansas). It is anticipated that, over time, irrigators in western Kansas will need to approach irrigation from a supplemental or limited basis rather than the typical current full-irrigation status.

Supplemental or limited irrigation presents a challenge for irrigators growing corn for the important red meat industry of the region. Corn is sensitive to water stress at all stages of growth, and grain yields are linearly related to water use from the dry matter threshold (the value of water use where grain yield begins to accumulate) up to the point of maximum yield. Deficit or limited irrigation of corn is difficult to implement successfully without reducing grain yields. But some strategies are more successful than others at maintaining corn yields under limited irrigation.

Conceptually, one limited-irrigation method that might work successfully (both economically and water efficient) is to provide small daily supplemental, but deficit, amounts of irrigation by subsurface drip irrigation (SDI). These small daily "doses" would attenuate crop water stress, allowing crop processes to continue and also allowing the crop to "scavenge" the soil profile for its remaining daily water needs.

Advanced control systems, using crop canopy sensors, may offer cost-effective means of improving irrigation efficiency for systems with limited pumping capacities. Some degree of water stress is likely under limited irrigation systems. Crop canopy sensors use information from the crop to indicate when stress is likely to limit yield. In a sense, this is letting the crop “talk” to the irrigation system, to indicate when irrigation is needed. This study also evaluated the potential for infrared temperature (IR) sensor use to control irrigation scheduling.

OBJECTIVES: The overall objective of this study is to determine the effect of subsurface drip irrigation (SDI) frequency on corn under limited irrigation. The specific objectives are:

1. Evaluate corn grain yield and water use under SDI frequencies of 1, 3, 5, or 7 days, with a limited irrigation capacity of 0.15 inches/day.
2. Quantitatively determine the effect of SDI frequency on the specific yield components of ears/plant, kernels/ear, kernels/land area, and kernel mass.
3. Evaluate the potential for advanced irrigation-control technologies to increase corn yield under limited-irrigation capacity.
4. Determine the effect of SDI frequency on soil water depletion patterns.
5. Determine the economic impact of varying SDI frequency on corn production under limited irrigation.

RESULTS: A three-year study examining the effect of irrigation frequency on deficit subsurface-drip irrigated corn was concluded in the fall of 2004. Frequency had an effect on corn yields in only one year, the extreme drought year of 2002 (Table 1). In that year, the more infrequent, 5- and 7-day

irrigation frequencies had higher corn yields due to larger numbers of kernels/ear. One possible explanation for this effect is that, during the extreme drought year, the greater irrigation amounts for these 5- and 7-day frequencies wetted a greater portion of the crop root zone during the early vegetative period of the season. This larger wetted crop root zone may have provided better conditions for kernel initiation. Corn yields were generally high in all years, averaging 223-239 bu/acre for the three-year period. The yields for the deficit-irrigated frequency treatments (Trt 1 through 4) averaged 97% of the fully irrigated crop yield (Trt 5), while only using 70% of the full irrigation amount.

Canopy temperature and available soil water were measured for corn during the 2002, 2003, and 2004 growing seasons. Leaves of a well-watered crop are cooled by evaporation. Lacking water, the canopy can be warmer than the surrounding air. The average differences between canopy and air temperature are shown (Figure 1) for full, limited, and non irrigated treatments for a selected day in 2002. The solid lines represent a model of canopy temperature; symbols represent average measurements for four replicated plots. Infrared thermometers indicated similar canopy temperatures for limited and fully irrigated treatments, though warmer conditions for non-irrigated crop. Results are consistent among years and consistent with the 3% yield reduction and 30% reduction in irrigation water application for limited-irrigation crop, relative to full irrigation capacity.

Table 1. Corn yield and irrigation amounts from a limited subsurface-drip irrigation (SDI) study at KSU Northwest Research Extension Center, Colby, Kansas, 2002-2004.

	Corn grain yield (bu/a)				**Irrigation amount (inches)**			
Irrigation Treatment	2002	2003	2004	Mean	2002	2003	2004	Mean
Trt 1. 0.15 in/day	210	206	268	228	13.05	12.60	10.65	12.10
Trt 2. 0.45 in/3 days	208	192	268	223	13.50	12.60	10.80	12.30
Trt 3. 0.75 in/5 days	232	229	265	242	13.50	12.75	11.25	12.50
Trt 4. 1.05 in/7 days	232	207	267	235	13.65	12.60	11.55	12.60
Trt 5. 0.30 in/day (Full)	244	218	256	239	20.40	18.30	14.70	17.80
Trt 6. No irrigation	73	45	200	106	0.00	0.00	0.00	0.00

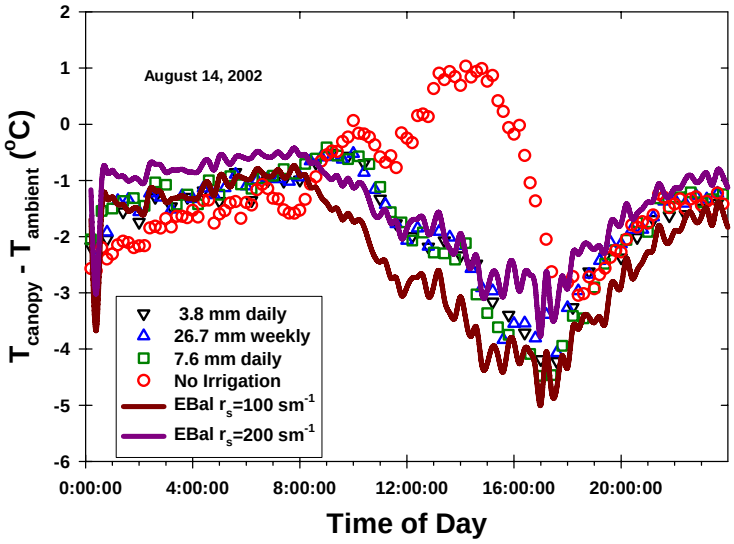

Figure 1. Differences in crop canopy and ambient air temperature for selected treatments in an irrigation-frequency study, KSU Northwest Research Extension Center, Colby, Kansas. The treatments are 0.15 in/day, 1.05 in/7 days, 0.30 in/day and no irrigation (3.8 mm/d, 1.05 in/7 d, 7.6 mm/d and no irrigation).

SIGNIFICANCE OF RESULTS: The absence of an irrigation-frequency effect for limited irrigation corn means that producers can use less-expensive SDI systems that do not require automation to handle frequent irrigation events. The results from this study under limited irrigation and an earlier study in the 1990s under full irrigation both indicate that frequencies as long as 7 days are adequate for corn production using SDI on the deep silt loam soils of western Kansas. In areas of soils with less water-holding capacity or shallow-rooted crops, frequency of SDI still could be a significant issue. Limited irrigation with SDI can maintain high corn yields while still reducing irrigation requirements. The results from the extreme drought year of 2002, in which the longer 5- and 7-day frequencies resulted in higher number of kernels/ear has suggested that further research is needed to examine this issue with SDI. This follow-up research has been initiated with federal funding from the Ogallala Initiative. The infrared (IR) temperature sensor aspect of the study has also led to follow-up research in which KSU is trying to develop better, plant-based irrigation scheduling routines.

SPENDING REPORT

019 SL ACCOUNT SUMMARY NWREC KS CORN COMM
DATE: 07/06/05 FY: 05
SCREEN: ACCT: 525789 SUBTOTAL OPTION: A1 PRINT SUBTOTAL: O
FUND: 2697 1100
DEPARTMENT: 10210 RESP PERSON: LAMM F / AIKEN R
MAP CODE: 25789 FLAGS: DEL FRZ RVW DRP SUP ABR
0 0 0 0 1 5

OBJ	DESCRIPTION	BUDGET	ACTUAL	ENCUMB	AVAIL
	SALARIES,WAGE	6,850.00	6,821.78	0.00	28.22
	CONTRACTUAL S	0.00	30.00	0.00	30.00-
	TRAVEL	700.00	653.01	0.00	46.99
	OTH CONTR SER	0.00	0.72	0.00	0.72-
	MATERIALS & S	4,450.00	4,494.49	0.00	44.49-
	TOTAL DIRECT	12,000.00	12,000.00	0.00	0.00
	TOTAL EXPENSE	12,000.00	12,000.00	0.00	0.00
	ACCOUNT TOTAL	12,000.00	12,000.00	0.00	0.00

Revising KSU Corn Phosphorus and Potassium Recommendations

RESEARCHERS AND UNITS:
Dale Leikam and Ray Lamond, Dept. of Agronomy; Alan Schlegel, South West Research-Extension Center

FUNDS (FY 2005): $10,000.00 **Completion Date:** Ongoing

JUSTIFICATION: Soil testing is recognized as the cornerstone of profitable corn-production fertility programs. Extensive and ongoing correlation research is required to determine the relationship between crop response (nutrient uptake and/or yield) and the amount of nutrient extracted by the soil test method. Likewise, ongoing research is also needed to calibrate the soil test method with the amount of supplemental crop nutrient required for optimum crop production and the amounts of nutrients removed in the harvested portions of crops in Kansas. It is important that KSU's new crop-nutrient recommendations be based on modern correlation/calibration research that identifies critical soil test P and K values, crop nutrient-removal factors and soil nutrient-buffering capacities so that the recommendations are defendable to those not directly involved with production agriculture. An additional important factor is the possibility that more USDA farm programs may require the use of nutrient-management programs based solely on land-grant university guidelines.

OBJECTIVES:

- To develop a new KSU nutrient recommendation framework for corn.
- Locate, summarize, and review all pertinent research conducted on corn phosphorus (P) and potassium (K) nutrient requirements in Kansas and adjacent states over the past two decades.
- Use on-the-farm field trials to gather modern P and K soil test correlation and calibration data for Kansas corn production.
- Establish longer-term studies to provide for future benefits.

RESULTS: Several corn and grain sorghum studies were initiated across the state to improve crop nutrient P and K recommendations. To meet this objective, the following information is being gathered from various studies conducted across the state of Kansas; 1) crop response to various rates of P and/or K application at various soil test levels, 2) percentage sufficiency (for maximum yield) at various soil test levels, 3) amounts of P and K nutrient application/crop removal to change soil test levels, and 4) the amounts of P and K removed in the harvested grain.

Because the 2005 studies were just initiated this past spring, there are no crop or soil test results for the final year of the project to report at this time.

SIGNIFICANCE OF RESULTS: The information developed through this research will provide needed information for developing individualized fertility programs for each field of individual producers. Soil test correlation/calibration information, crop-removal factors, and expected changes in soil test values will allow for flexibility in producers nutrient-management programs, including NRCS Nutrient Management Planning efforts.

2004 Crop Year Yield Results: Significant, large yield responses were obtained at both the Greeley and Stevens County locations. The large response at Stevens County was particularly interesting because the

surface broadcast applications were not incorporated. Grain P contents were increased with increasing P application rate, whereas grain moisture declined.

Table 1. Effect of phosphorus application to corn, Stevens Co., 2004

	Corn Grain			
P_2O_5 Rate	**Yield**	**Test Weight**	**Moisture**	**P Content**
- lb/a -	bu/a	lb/bu	%	lb P_2O_5/bu
0	141	52.3	27.2	0.18
20	160	53.1	27.3	0.19
40	192	54.4	24.5	0.22
80	213	52.9	26.9	0.24
120	226	55.1	21.7	0.26
Sig. Level	0.0003	0.02	0.18	0.0001

Bray P1 Soil Test – Range of 4-8 ppm; Average of 6 ppm.

Table 2. Effect of phosphorus application to corn, Republic Co., 2004

	Corn Grain			
P_2O_5 Rate	**Yield**	**Test Weight**	**Moisture**	**P Content**
- lb/a -	bu/a	lb/bu	%	lb P_2O_5/bu
0	160	58.5	16.9	0.27
20	164	59.8	15.9	0.26
40	172	60.0	16.2	0.25
80	190	59.9	16.2	0.27
120	170	59.2	15.8	0.29
Sig. Level	NS	0.16	NS	0.08

Bray P1 Soil Test – Range of 15-23 ppm; Average of 17 ppm.

Table 3. Effect of phosphorus application to corn, Greeley Co., 2004

	Corn Grain			
P_2O_5 Rate	**Yield**	**Moisture**	**P Content**	**K Content**
- lb/a -	bu/a	%	lb P_2O_5/bu	lb K_2O/bu
0	180	30.5	0.20	0.14
20	191	29.9	0.21	0.16
40	206	29.5	0.23	0.16
80	222	29.2	0.25	0.16
120	222	29.1	0.27	0.17
Sig. Level	0.0001	0.09	0.0001	0.004

Bray P1 Soil Test – Range of 7-9 ppm; Average of 8 ppm.

Correlation of different P soil tests for corn production. The Bray P1 extractant has traditionally been the common extractant used for soil testing in the Midwest and Great Plains, whereas the Olsen P test has been the dominant phosphorus (P) extractant used in many western states. The use of the Mehlich-3 extractant for determining soil test P in private and state-operated soil test laboratories has become more commonplace in recent years. The ability to extract multiple elements is a major advantage of the Mehlich-3 test. Although the Mehlich-3 test is often run by using the more traditional colorimetric procedure, the use of ICP in conjunction with the Mehlich-3 extractant is also becoming more

commonplace as pricing declines. With changes in extractants and analytical techniques also comes the need to evaluate these new tests for agronomic and environmental stewardship purposes. As part of a larger P management project, this study used 367 soil samples collected from 10 locations across Kansas and western Missouri, which were analyzed by Bray P1 with colorimetric determination (BP1), Mehlich-3 with colorimetric determination (M3-Col), and Mehlich-3 with ICP determination (M3-ICP). The BP1 test was highly correlated with both the M3-Col and M3-ICP procedures, especially for non-calcareous soils (r2 = 0.91-0.93). Likewise, M3-Col and M3-ICP were highly correlated across all soils (r2 = 0.98). The relationship of M3-Col to M3-ICP varies, however, depending on the M3-Col soil test value. Additional work to further define this relationship and the relationship of each of these tests to crop response and grain nutrient content will continue.

2005 Studies. Corn P and/or K studies were established in the early spring of 2005 in Greeley, Morton, Shawnee, and Grant counties. All locations are under irrigation.

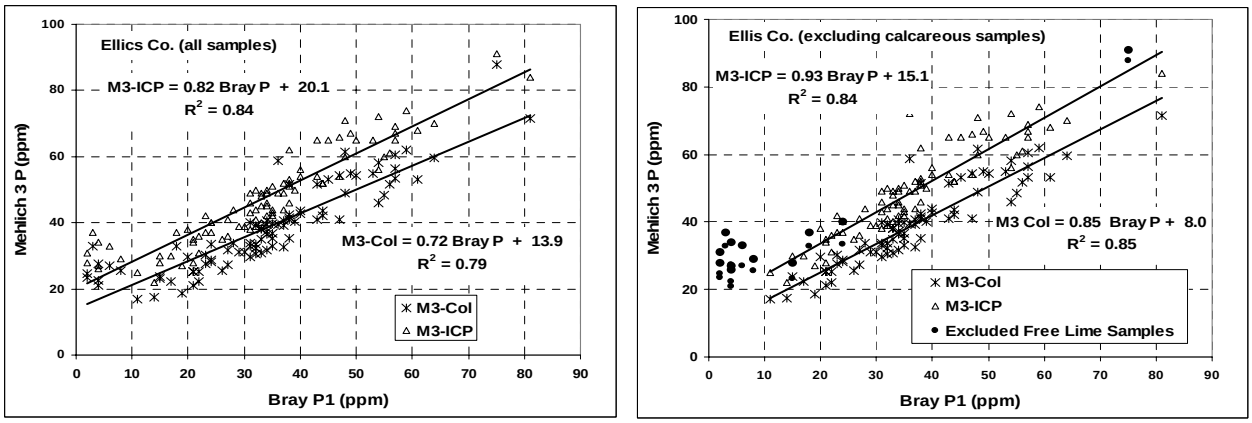

Figure 1. Relationship of M3-Col and M3-ICP with Bray P1 Soil Tests Values On Calcareous and Non-calcareous Soils (Ellis county Kansas, 2003).

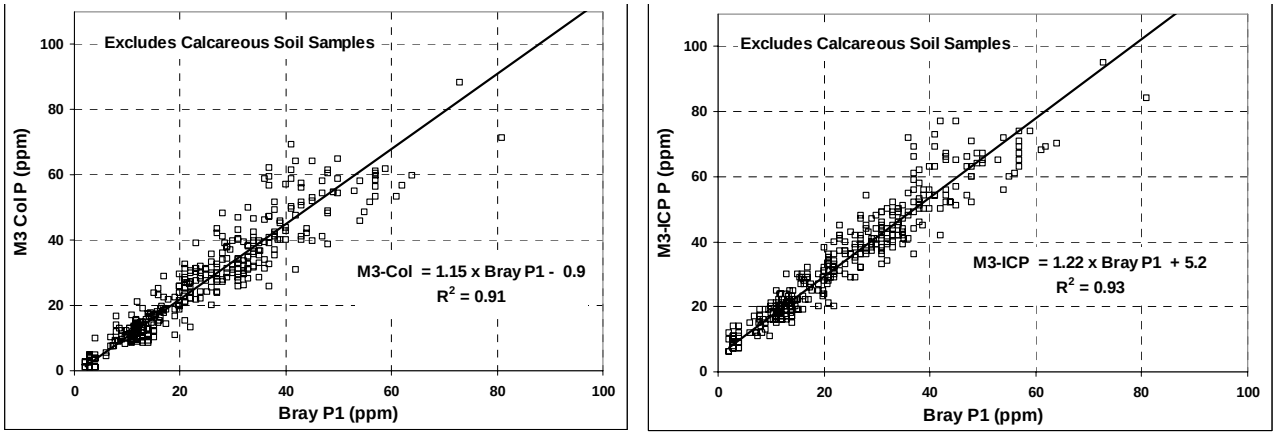

Figure 2. Overall Relationship of M3-Col and M3-ICP with Bray P1 Soil Tests Values On Non-calcareous Soils (10 locations, 2003).

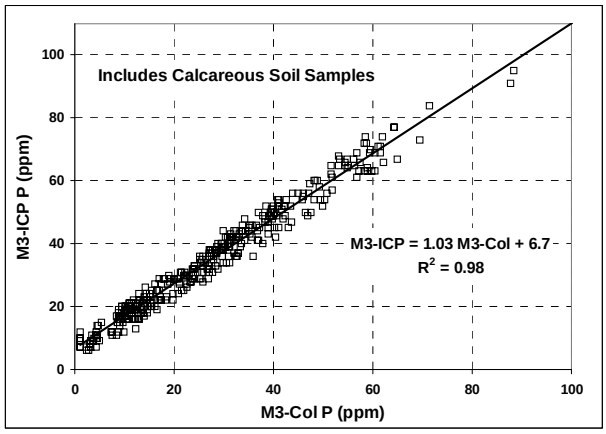

Figure 3. Overall Relationship Of M3-Col and M3-ICP P Soil Test Values (10 locations, 2003)

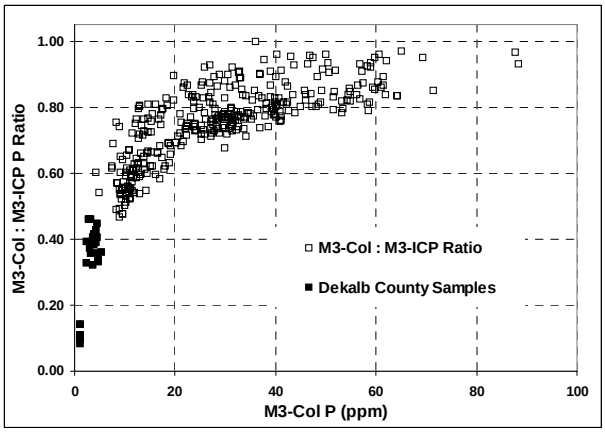

Figure 4. Relationship Of M3-Col : M3-ICP P Ratio To M3-Col Soil Test Value (10 locations, 2003)

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 019 SL ACCOUNT SUMMARY                          AGRON KS CORN COMM
 DATE: 01/18/05                                                    FY: 05
 SCREEN:     ACCT: 537062      SUBTOTAL OPTION: A1  PRINT SUBTOTAL: O
             FUND: 2697 1100
       DEPARTMENT: 10040      RESP PERSON: LEIKAM D / LAMOND R
         MAP CODE: 37062            FLAGS: DEL FRZ RVW DRP SUP ABR
                                           0   0   0   0   1   5
 OBJ  DESCRIPTION           BUDGET         ACTUAL         ENCUMB          AVAIL
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      SALARIES,WAGE       7,710.00       3,402.78           0.00       4,307.22
      CONTRACTUAL S           0.00          34.23           0.00          34.23-
      TRAVEL              1,000.00       2,103.10           0.00       1,103.10-
      OTH CONTR SER         500.00         808.73           0.00         308.73-
      MATERIALS & S         790.00         217.75           0.00         572.25
      TOTAL DIRECT       10,000.00       6,566.59           0.00       3,433.41
      TOTAL EXPENSE      10,000.00       6,566.59           0.00       3,433.41
      ACCOUNT TOTAL      10,000.00       6,566.59           0.00       3,433.41


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4-⌐              1 KSUVM     129.130.12.1                                 4/10

 019 SL ACCOUNT SUMMARY                          AGRON KS CORN COMM
 DATE: 04/14/05                                                    FY: 05
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             FUND: 2697 1100
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                                           0   0   0   0   1   5
 OBJ  DESCRIPTION           BUDGET         ACTUAL         ENCUMB          AVAIL
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      CONTRACTUAL S           0.00          51.68           0.00          51.68-
      TRAVEL              1,000.00       2,681.00           0.00       1,681.00-
      OTH CONTR SER         500.00       1,033.41           0.00         533.41-
      MATERIALS & S         790.00         217.75           0.00         572.25
      TOTAL DIRECT       10,000.00       9,572.51           0.00         427.49
      TOTAL EXPENSE      10,000.00       9,572.51           0.00         427.49
      ACCOUNT TOTAL      10,000.00       9,572.51           0.00         427.49


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4-⌐              1 KSUVM     129.130.12.1                                 4/10

 019 SL ACCOUNT SUMMARY                          AGRON KS CORN COMM
 DATE: 07/01/05                                                    FY: 05
 SCREEN:     ACCT: 5370620000  SUBTOTAL OPTION: A1  PRINT SUBTOTAL: O
             FUND: 2697 1100
       DEPARTMENT: 10040      RESP PERSON: LEIKAM D / LAMOND R
         MAP CODE: 37062            FLAGS: DEL FRZ RVW DRP SUP ABR
                                           0   1   0   0   1   5
 OBJ  DESCRIPTION           BUDGET         ACTUAL         ENCUMB          AVAIL
 ---- ------------ -------------- -------------- -------------- --------------
      SALARIES,WAGE       6,030.00       5,936.79           0.00          93.21
      CONTRACTUAL S           0.00          55.09           0.00          55.09-
      TRAVEL              2,680.00       2,681.00           0.00           1.00-
      OTH CONTR SER         500.00       1,109.37           0.00         609.37-
      MATERIALS & S         790.00         217.75           0.00         572.25
      TOTAL DIRECT       10,000.00      10,000.00           0.00           0.00
      TOTAL EXPENSE      10,000.00      10,000.00           0.00           0.00
      ACCOUNT TOTAL      10,000.00      10,000.00           0.00           0.00


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4-⌐              1 KSUVM     129.130.12.1                                 4/10
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Control of Field Pansy, a "New" Winter Annual in No-till Crops

RESEARCHERS AND UNITS:
David Regehr and Dallas Peterson, Dept. of Agronomy

FUNDS: $4,500 (FY 04) and $6,500 (FY 05). **Completion Date:** 30 June, 2005

JUSTIFICATION: Starting in about 2000, no-till corn and soybean producers in Northeast Kansas and surrounding areas, reported that field pansy (Viola rafinesquii Greene) was not being controlled by spring burndown applications of atrazine plus 2,4-D or Sencor plus 2,4-D. This weed also appeared in no-till plots around Manhattan in 2002, where poor control was observed for those treatments and for low rates of glyphosate.

OBJECTIVES:

1. Evaluate herbicide application timing, and herbicides with different modes of action, for effective and economical control of field pansy and other winter annuals in no-till corn and soybean fields.
2. Investigate aspects of field pansy life cycle, such as germination timing, growth and development characteristics, and effects on corn and soybean performance.

RESULTS: Over the two years, we did five experiments in farm fields going to field corn. One of these was a fall x spring factorial experiment; the others were spring-applied only. All treatments contained adjuvants or ammonium sulfate, as needed, and many included low rates of 2,4-D and dicamba (which have almost no effect on field pansy) to control other winter annuals.

Treatments averaging 95-100% control were:	Treatments averaging 90-94% control were:
1 lb atrazine + 2.25 fl oz Balance Pro	1 lb glyphosate IPA salt
1 lb " + 4 fl oz Callisto	1 lb " " " + 3 fl oz Resource
1 lb " + 1.25 lb Princep	1 lb " " " + 0.5 oz Aim 40DF
1 lb " + 1.67 pt Gramoxone Max	1 lb " " " + 1 lb atrazine
2 lb " + 1.67 pt " "	1 lb atrazine + 0.5 oz Basis

Over two years, we did two fall x spring factorial experiments, and two spring experiments in farm fields going to soybean. About half the treatments gave significantly less control when applied in spring rather than in fall.

Fall treatments averaging 95-100% control:	Spring treatments averaging 85% or greater control:
0.6 oz FirstRate	0.6 oz FirstRate
0.6 oz " + 2 oz Valor	1 lb glyphosate
2.5 qt BackDraft	2.5 qt BackDraft
1 lb glyphosate + 2 oz Canopy XL + 2.5 oz Authority	1 lb " + 0.5 oz Harmony GT
	1 lb " + 0.3 oz " + 2.5 oz Authority
Fall treatments averaging 90-94% control:	1 lb glyphosate + 2 oz Canopy XL + 2.5 oz Authority
1.67 pt Gramoxone Max	
1 lb glyphosate	
1 lb " + 0.5 oz Harmony GT	
1 lb " + 0.3 oz " + 2.5 oz Authority	
1 lb " + 3 oz Resource	
5.3 oz Authority	
2.5 oz " + 2 oz Canopy XL	

We were unable to propagate field pansy in the greenhouse, so progress in completing the second objective was limited to field observations.

SIGNIFICANCE OF RESULTS: Thanks to support from the Corn Commission and farmer cooperators, producers using no-till now have much better information on herbicide programs to control field pansy.

Mobile Irrigation Lab – Improved Irrigation Efficiency for Corn Production

RESEARCHERS AND UNITS:
Dan Rogers, Gary Clark, and Mahbub Alam; Dept. of Biol. & Agric. Engineering

FUNDS (FY 05): $15,500 **Completion Date:** June 30, 2005
Department Head: Dr. James K. Koelliker

4th Quarterly and Final Report: April 1, 2005 – June 30, 2005

PROJECT SUMMARY:

Physical and Electronic Tool Development: Development of the enhanced KanSched2 (ET based irrigation scheduling program) is continuing. The KanSched2 programming framework was delivered for review during this quarter. The project is still on schedule for summer testing and review in preparation for fall and winter producer meeting and training sessions.

MIL Irrigation Training/Information Activities: The 4th-quarter events where MIL activities were conducted or materials were presented or displayed are outlined in Table 1. Individual consultations via personal contact, telephone, or email were also conducted. A number of the calls were to help irrigators re-initialize their KanSched files for the new irrigation season. MIL CDs were also provided to agents and District Conservationists for distribution to additional producers. Distribution of MIL materials and software via the MIL web site also remains an effective distribution tool, as noted in Table 2.

Table 1. 4th quarter activity report.

Event	Location	Format	Date	Attendance
Irrigation Management Seminars and Field Tours				
Spring Action Conference	Salina	Presentation	April 6	40
MIL Software Seminar	Oberlin	Computer Training	April 26	8
MIL Software Seminar	Lakin	Computer Training	April 8	4
Ark River Festival	Garden City	Presentation	April 11& 12	264
3-I Trade Show	Garden City	Booth	April 28-30	110
MIL Poster Displays				
BAE Career Days	Manhattan	Poster Display	May 2	90
Irrigation System Evaluation / Demonstration				
Center Pivot Evaluations (2)	Finney County	Field Evaluation	May 26	8
Center Pivot Evaluation	Shawnee County	Field Evaluation	June 2	10
Center Pivot Evaluations (4)	Thomas/Sheridan Co.	Field Evaluation	June 15- 16	12
Center Pivot Evaluation	Stevens County	Field Evaluation	May 11& 12	8

Table 2. 4th quarter FY 05, 2003, 2004, and 2005 to date MIL web site activities report.

	Jan – Mar 2005	Apr- Jun 10 2005	2005 to June 10	2004	2003
Visitors	1341	1185	2391	4469	3084
Visitors >1	406	240	1797	1032	749
Visits	3848	2057	5905	12594	8248
Page Views	14971	6930	21901	37570	26240

System Evaluations/Demonstrations. Eight field evaluations of uniformity or performance of center-pivot irrigation systems were conducted in this quarter, including the first three using the new in-canopy test procedure. The locations of the evaluations are noted in Table 1. Evaluations will continue throughout the summer months.

Irrigated Cropping Systems to Reduce Groundwater Depletion while Sustaining Profitability

RESEARCHERS AND UNITS:
Alan J. Schlegel, Southwest Research-Extension Center; Loyd Stone, Dept. of Agronomy; Troy Dumler, Southwest Area Extension Office

FUNDS (FY05): $12,000

FINAL REPORT: July 1, 2004 to June 30, 2005

JUSTIFICATION: Most groundwater pumped from the High Plains (Ogallala) Aquifer in western Kansas is used for irrigation, with corn being the predominant crop. Groundwater withdrawal from the aquifer has reduced saturated thickness and well capacities. Although corn responds well to irrigation, it also requires substantial amounts of water to maximize production. Alternative crop-management practices are needed to reduce the amount of irrigation water required while striving to maintain economic returns sufficient for producer (and community) sustainability. To prepare for less water being available for irrigation in the future, whether from physical constraints (reduced well capacities and declining water tables) or from regulatory limitations, information on crop productivity and profitability with less irrigation water will be beneficial for agricultural sustainability.

OBJECTIVES:

1. Determine crop rotations that can be used with limited irrigation to reduce irrigation water use while maintaining producer profitability.
2. Determine the impact of limited irrigation on crop yield and profitability.

RESULTS:

Limited Irrigation Study: Crop yields were good in 2004, particularly for corn. Precipitation from June through August was 11.49 inches (47% above normal). Corn yields were 40 bu/a greater with 10 inches than with 5 inches of irrigation (Table 1), but there was little or no increase in yields of the other crops with increased irrigation (<10%). Sorghum yields were lower than expected, possibly partly due to wet weather delaying harvest until late November.

Table 1. Grain yield of four crops in 2004, as affected by irrigation amount.

Irrigation amount	Corn	Sorghum	Soybean	Sunflower
inches	- - - - - - - - - - - - bu/acre - - - - - - - - -			lb/acre
5	204	111	49	2532
10	245	103	52	2607
15	260	106	49	2775

An economic analysis found that, at the lowest irrigation rate, net returns were best for corn in 2004 (Table 2) because of the exceptional corn yields of more than 200 bu/a with only 5 inches of irrigation. At the lower irrigation rates, the next-most-profitable crops were soybean and sunflower. At the highest irrigation rate, corn was also the most profitable crop. Corn was the only crop for which profitability increased with more than 5 inches of irrigation.

Table 2. Net return to land, irrigation equipment, and management for four crops in 2004, as affected by irrigation amount.

Irrigation amount	Corn	Sorghum	Soybean	Sunflower
inches	- - - - - - - - - - annual net return, $/acre - - - - - - - -			
5	166	24	92	109
10	219	-11	85	96
15	228	-24	53	98

In 2004, the original plots in the limited irrigation study were split, and a ~20% higher seeding rate for each crop was added. The original seeding rates were 30,000 for corn, 80,000 for sorghum, 150,000 for soybean, and 23,500 for sunflower. The same hybrids were used for each crop, except for sorghum, for which a longer-season hybrid was planted at the higher population. For soybean, the higher seeding rate tended to increase yields at the higher irrigation amounts (Table 3). For corn, the higher seeding rate tended to reduce yield at the lower irrigation rate, but had no effect at the higher irrigation amounts. With sunflower, results were mixed, with slightly lower yields at both the low and high irrigation amounts with higher seeding rate. Sorghum yields were greater with the higher seeding rate, but because this also involved a different hybrid, it is not possible to determine which factor affected yield.

Table 3. Grain yield of four crops in 2004 as affected by irrigation amount and seeding rate.

Irrigation amount	Corn	Sorghum	Soybean	Sunflower
inches	- - - - - - - - - - - - bu/acre - - - - - - - - -			lb/acre
5	204 (178)	111 (134)	49 (43)	2532 (2253)
10	245 (240)	103 (140)	52 (55)	2607 (2748)
15	260 (256)	106 (126)	49 (56)	2775 2482)

The values in parentheses are with a ~20% greater seeding rate.

Crop Rotation Study: Grain yields of all crops except wheat were very good in 2004. The wheat in all rotations followed corn and received 5 inches of irrigation. Wheat yields were severely reduced by a freeze in mid-May (Table 4). All rotations were limited to 10 inches of irrigation, but the corn following wheat received 15 inches, because the wheat only received 5 inches. This extra 5 inches of irrigation increased corn yields about 30 bu/a, compared with yield of the continuous corn (which only received 10 inches of irrigation). Corn yields were similar following wheat, sorghum, or soybean, as were sorghum yields in the 3- and 4-yr rotations.

Table 4. Grain yield of four crops, as affected by rotation in 2004.

Rotation	Corn	Sorghum	Soybean	Sunflower
		- - - - - - - - - - - - bu/acre - - - - - - - - -		
Cont. corn	210	--	--	--
Corn-wheat	243	28	--	--
Corn-wheat-sorghum	239	27	138	--
Corn-wheat-sorghum-soybean	239	29	145	58

An economic analysis was performed to determine returns to land, irrigation equipment, and management for all four rotations. Because of the poor wheat yields and good corn yields, all returns for the multi-crop rotations were less than for continuous corn. The economic return to continuous corn was $160/a, compared with $80 to $94/a for all other rotations.

SIGNIFICANCE OF RESULTS: Because of differences in growing conditions, the most profitable crop changes from year to year, so that there is not a single best crop. Growing different crops when irrigation is limited can reduce risk and increase profitability. In 2004, corn was the most profitable crop

at all irrigation amounts. In multi-crop rotations, relatively poor results with one crop can reduce profitability, compared with a monoculture, when the monoculture crop does very well. But the multi-crop rotation may reduce economic risk when the monoculture crop does not perform so well.

SPENDING REPORT

019 SL ACCOUNT SUMMARY SWREC KS CORN COMM
DATE: 07/06/05 FY: 05
SCREEN: ACCT: 526220 SUBTOTAL OPTION: A1 PRINT SUBTOTAL: O
FUND: 2697 1100
DEPARTMENT: 10235 RESP PERSON: SCHLEGEL A
MAP CODE: 26220 FLAGS: DEL FRZ RVW DRP SUP ABR
0 0 0 0 1 5

OBJ	DESCRIPTION	BUDGET	ACTUAL	ENCUMB	AVAIL
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	CONTRACTUAL S	2,000.00	724.41	0.00	1,275.59
	TRAVEL	1,250.00	1,224.64	0.00	25.36
	OTH CONTR SER	750.00	0.00	0.00	750.00
	MATERIALS & S	1,750.00	4,014.94	0.00	2,264.94-
	TOTAL DIRECT	12,000.00	9,507.29	0.00	2,492.71
	TOTAL EXPENSE	12,000.00	9,507.29	0.00	2,492.71
	ACCOUNT TOTAL	12,000.00	9,507.29	0.00	2,492.71

Grain Sorghum Production in Kansas: Extension and Applied Research

RESEARCHERS AND UNITS:
Dale L. Fjell, Dept. of Agronomy

FUNDING: $3,000 **Completion Date:** Ongoing

PROGRESS REPORT:
My extension and applied research for grain sorghum production in Kansas during April, May, and June consisted of many activities across the state.

1. I visited with many producers about whether they should plant grain sorghum this year. Because corn planting was delayed, grain sorghum became the summer crop of choice for many producers. I encouraged grain sorghum as a good summer crop because of the "toughness" that it has.
2. Plant population and row spacing were questions that producers called and visited with me about.

With the funding available from this grant, I was able to get to more places around the state and not worry about depleting the Extension Agronomy's travel funds.

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019 SL ACCOUNT SUMMARY                          AGRON KS GRAIN SORG
 DATE: 01/18/05                                                    FY: 05
 SCREEN:     ACCT: 537065      SUBTOTAL OPTION: A1  PRINT SUBTOTAL: O
             FUND: 2697 1100
       DEPARTMENT: 10040      RESP PERSON: FJELL D
         MAP CODE: 37065            FLAGS: DEL FRZ RVW DRP SUP ABR
                                           0   0   0   0   1   5
 OBJ  DESCRIPTION           BUDGET         ACTUAL         ENCUMB          AVAIL
 ---- ------------ -------------- -------------- -------------- --------------
      CONTRACTUAL S         200.00           0.00           0.00         200.00
      TRAVEL              2,700.00       1,004.12           0.00       1,695.88
      MATERIALS & S         100.00           0.00           0.00         100.00
      TOTAL DIRECT        3,000.00       1,004.12           0.00       1,995.88
      TOTAL EXPENSE       3,000.00       1,004.12           0.00       1,995.88
      ACCOUNT TOTAL       3,000.00       1,004.12           0.00       1,995.88


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4-⌐               1 KSUVM     129.130.12.1                              4/10

 019 SL ACCOUNT SUMMARY                          AGRON KS GRAIN SORG
 DATE: 07/01/05                                                    FY: 05
 SCREEN:     ACCT: 5370650000  SUBTOTAL OPTION: A1  PRINT SUBTOTAL: O
             FUND: 2697 1100
       DEPARTMENT: 10040      RESP PERSON: FJELL D
         MAP CODE: 37065            FLAGS: DEL FRZ RVW DRP SUP ABR
                                           0   1   0   0   1   5
 OBJ  DESCRIPTION           BUDGET         ACTUAL         ENCUMB          AVAIL
 ---- ------------ -------------- -------------- -------------- --------------
      CONTRACTUAL S         200.00         121.93           0.00          78.07
      TRAVEL              2,700.00       2,878.07           0.00         178.07-
      MATERIALS & S         100.00           0.00           0.00         100.00
      TOTAL DIRECT        3,000.00       3,000.00           0.00           0.00
      TOTAL EXPENSE       3,000.00       3,000.00           0.00           0.00
      ACCOUNT TOTAL       3,000.00       3,000.00           0.00           0.00


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4-⌐               1 KSUVM     129.130.12.1                              4/10
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Breeding Sorghum with Improved Grain Yield, Greenbug and Virus Resistance, and Pre-Flowering Drought Tolerance

RESEARCHERS AND UNITS:
K. D. Kofoid and D. L Seifers, KSU Agric. Res. Center- Hays; T. L. Harvey and J. Reese, Dept. of Entomology; and M. R. Tuinstra, Dept. of Agronomy, KSU, Manhattan

FUNDS (FY05): $48,000 **Completion Date:** 6-30-2005

JUSTIFICATION: Greenbugs are the most economically important insect pest of sorghum in Kansas. Viral diseases are the most common diseases in sorghum in western Kansas. Genetic resistance is the most cost-effective control of this pest. Improved drought tolerance and higher yields are major keys to making sorghum a preferred crop for Kansas' producers.

OBJECTIVES: To develop and release grain sorghum parental lines and germplasm with higher grain yield that incorporate genetic factors for greenbug resistance, virus resistance, and pre-flowering drought tolerance.

RESULTS:
Greenbug: Seed of the biotype I greenbug-resistant A/B lines (KS 116- KS 120) released to the seed industry in 2003 was requested by every sorghum company in the United States with a breeding program. In addition, seed was requested from several companies based in Europe and South America. These lines should prove useful in the development of greenbug-resistant tan plant (food grade) hybrids. Screening of segregating families for greenbug resistance was continued. Levels of resistance to biotype I greenbug have been increasing over the years. Approximately 1,800 F_2 selections were screened in the fall of 2004 through the spring of 2005, and more than half were found to be resistant to biotype I greenbug. With each cycle of crossing and selection, we seem to be getting higher levels of resistance, as noted in lower damage scores. In many instances, our selections have less damage than the original resistance sources. But screening of some of these lines to biotype K greenbug indicated that there is little resistance to this biotype in this material. More emphasis will be placed upon screening for biotype K resistance. Development of new parental lines with greenbug resistance was continued in both the summer and winter nurseries. More than 400 A-B pairs, most with tan plant color, were backcrossed. Tan plant B lines were crossed to A3 TX 436 (a line that is used as the male parent in several tan hybrids) and purple plant B lines were crossed to A3 TX 430. These hybrids were planted in yield trials in the field in 2005. The A-B pairs also are being backcrossed again this summer. Hybrids involving new greenbug-resistant R lines (male parents) were also planted in the field. More than 1500 parental lines, both B and R types, currently are being evaluated in hybrid combination for grain yield. These tests are being conducted at two or three locations in Western Kansas.

Yield: On the basis of hybrid performance in 2004, 128 high-yielding R lines were grown in the winter nursery and crossed to 2 females. Included in this group of males are greenbug-resistant and -susceptible lines, and tan and purple plant types. There is also a range of maturities. These hybrids are being grown at 3 locations, and they are being compared with the best commercial hybrids. The best lines will be crossed with more females for statewide testing in 2006.

Drought: 2004 started out as a very dry season. May and early June were so dry that planting was halted because there wasn't enough moisture in the top 6 inches of soil to get uniform germination. This prevented our stress populations from being planted. But heavy rains in late June and early July made for a good season. Post-flowering drought conditions were encountered during August and September, however, and lodging was severe on hybrids without tolerance to this type of stress. The R lines selected based upon high-yielding hybrids, therefore, were also somewhat tolerant to post-flowering stress. Several B line F_2 populations were discarded because of severe lodging caused by drought stress.

Greenbug Tolerance: Although tolerance work was not funded in this current project, we are using other resources to finish work on a set of inbred lines with enhanced levels of tolerance. These lines have been inbred for 4 generations and were crossed to A lines so that their fertility reaction can be ascertained. In addition, a final screening of the inbreds is being completed, and the lines will be released in the fall of 2005. These lines should be of special interest to molecular geneticists trying to develop maps of the sorghum genome and to anyone interested in how aphids feed and cause plant damage.

SIGNIFICANCE OF RESULTS: The acceptance of the new A-B lines with greenbug resistance by the commercial industry will allow for resistance to come from both parents in a hybrid, thus allowing for more than one type of resistance to be incorporated into a single hybrid. This in turn would make a hybrid less vulnerable to changes in the greenbug. These A-B pairs are tan plant types, so release of this material should expedite the development of tan plant, greenbug-resistant hybrids. New high-yielding R lines, especially those with a slightly earlier maturity, will further enhance the growing of sorghum hybrids. Greenbug-resistant selections that survive our screening have very high levels of resistance because, in many of the tests, even the resistant check hybrid can be killed by the greenbugs. We will also need to keep a close watch on the greenbug biotype to determine if there is a shift in the predominant biotype because most of the material with resistance to biotype I has little to no resistance to biotype K. The availability of greenbug-tolerant lines may help to lessen the adverse effects of greenbug feeding and will also be useful in gene mapping.

Revising KSU Grain Sorghum Phosphorus and Potassium Recommendations

RESEARCHERS AND UNITS:
Dale Leikam and Ray Lamond, Dept. of Agronomy; Alan Schlegel, South West Research-Extension Center

FUNDS (FY 2005): $15,000.00 **Completion Date:** Ongoing

JUSTIFICATION: Soil testing is recognized as the cornerstone of profitable grain sorghum production fertility programs. Extensive and ongoing correlation research is required to determine the relationship between crop response (nutrient uptake and/or yield) and the amount of nutrient extracted by the soil test method. Likewise, ongoing research is also needed to calibrate the soil test method with the amount of supplemental crop nutrient required for optimum crop production and the amounts of nutrients removed in the harvested portions of crops in Kansas. It is important that KSU's new crop-nutrient recommendations be based on modern correlation/calibration research that identifies critical soil test P and K values, crop nutrient-removal factors, and soil nutrient-buffering capacities in order that the recommendations are defendable to those not directly involved with production agriculture. An additional important factor is the possibility that more USDA farm programs may require the use of nutrient-management programs based solely on land-grant university guidelines.

OBJECTIVES:

1. To develop a new KSU nutrient recommendation framework for grain sorghum.
2. Locate, summarize, and review all pertinent research conducted on grain sorghum phosphorus (P) and potassium (K) nutrient requirements in Kansas and adjacent states over the past two decades.
3. Use on-the-farm field trials to gather modern P and K soil test correlation and calibration data for Kansas grain sorghum production.
4. Establish longer-term studies to provide for future benefits.

RESULTS: Several corn and grain sorghum studies were initiated across the state to improve crop nutrient P and K recommendations. To meet this objective, the following information is being gathered from various studies conducted across the state of Kansas; 1) crop response to various rates of P and/or K application at various soil test levels, 2) percentage sufficiency (for maximum yield) at various soil test levels, 3) amounts of P and K nutrient application/crop removal to change soil test levels, and 4) The amounts of P and K removed in the harvested grain.

Because the 2005 studies were just initiated this past spring, there are no crop or soil test results for the final year of the project to report at this time.

SIGNIFICANCE OF RESULTS: The information developed through this research will provide needed information for developing individualized fertility programs for each field of individual producers. Soil test correlation/calibration information, crop-removal factors, and expected changes in soil test values will allow for flexibility in producers nutrient management programs, including NRCS Nutrient Management Planning efforts.

2004 Crop Year Yield Results: Droughty conditions affected all locations, with the Sheridan county site being the most severely affected. As a result, significant variability existed in grain yield data at each site. Grain yield was consistently improved with P applications at each location, however, although differences were not all significant at traditional significance levels.

Table 1. Effect of phosphorus application to grain sorghum, Sheridan Co., 2004

	Grain Sorghum Grain		
P_2O_5 Rate	**Yield**	**Test Weight**	**P Content**
- lb/a -	bu/a	lb/bu	lb P_2O_5/bu
0	37	56.9	0.30
20	69	57.6	0.30
40	50	57.2	0.31
80	58	57.5	0.31
120	57	56.3	0.35
Sig. Level	0.38	NS	0.09

Bray P1 Soil Test – Range of 26-36 ppm; Average of 32 ppm.

Table 2. Effect of phosphorus application to grain sorghum, Republic Co., 2004

	Grain Sorghum Grain			
P_2O_5 Rate	**Yield**	**Test Weight**	**Moisture**	**P Content**
- lb/a -	bu/a	lb/bu	%	lb P_2O_5/bu
0	89	53.8	17.7	0.27
20	99	56.6	17.3	0.24
40	104	54.9	17.8	0.26
80	108	54.0	17.5	0.25
120	120	56.8	16.0	0.26
Sig. Level	0.20	0.34	0.28	NS

Bray P1 Soil Test – Range of 9-15 ppm; Average of 12 ppm.

Table 3. Effect of phosphorus application to grain sorghum, Ford Co., 2004

	Grain Sorghum Grain	
P_2O_5 Rate	**Yield**	**Test Weight**
- lb/a -	bu/a	lb/bu
0	61	55.4
20	82	57.9
40	77	57.6
80	91	58.8
120	90	56.8
Sig. Level	0.15	NS

Bray P1 Soil Test – Range of 15-47 ppm; Average of 29 ppm.

Table 4. Effect of phosphorus application to grain sorghum, Greeley Co., 2004

	Grain Sorghum Grain			
P_2O_5 Rate	**Yield**	**Moisture**	**P Content**	**Test Weight**
- lb/a -	bu/a	%	lb P_2O_5/bu	lb/bu
0	91	16.0	0.27	58.0
20	107	16.1	0.29	58.3
40	107	16.0	0.31	58.5
80	117	16.0	0.32	58.8
120	119	16.0	0.35	58.5
Sig. Level	0.01	NS	0.0001	0.01

Bray P1 Soil Test – Range of 7-9 ppm; Average of 8 ppm.

Correlation of different P soil tests for corn production: The Bray P1 extractant has traditionally been the common extractant used for soil testing in the Midwest and Great Plains, whereas the Olsen P test has been the dominant phosphorus (P) extractant used in many western states. The use of the Mehlich-3 extractant for determining soil test P in private and state-operated soil test laboratories has become more commonplace in recent years. The ability to extract multiple elements is a major advantage of the Mehlich-3 test. Although the Mehlich-3 test is often run using the more traditional colorimetric procedure, the use of ICP in conjunction with the Mehlich-3 extractant is also becoming more commonplace as pricing declines. With changes in extractants and analytical techniques also comes the need to evaluate these new tests for agronomic and environmental stewardship purposes. As part of a larger P management project, this study used 367 soil samples collected from 10 locations across Kansas and western Missouri, which were analyzed by Bray P1 with colorimetric determination (BP1), Mehlich-3 with colorimetric determination (M3-Col) and Mehlich-3 with ICP determination (M3-ICP). The BP1 test was highly correlated with both the M3-Col and M3-ICP procedures, especially for non-calcareous soils (r^2 = 0.91-0.93). Likewise, M3-Col and M3-ICP were highly correlated across all soils (r^2 = 0.98). The relationship of M3-Col to M3-ICP varies, however, depending on the M3-Col soil test value. Additional work to further define this relationship and the relationship of each of these tests to crop response and grain nutrient content will continue.

2005 Studies: Sorghum P studies were established in the early spring of 2005 in Greeley, Morton, Butler, and Hodgeman counties. Because of the adverse effects of the previous two years of drought, both the Greeley and Morton County locations are under irrigation.

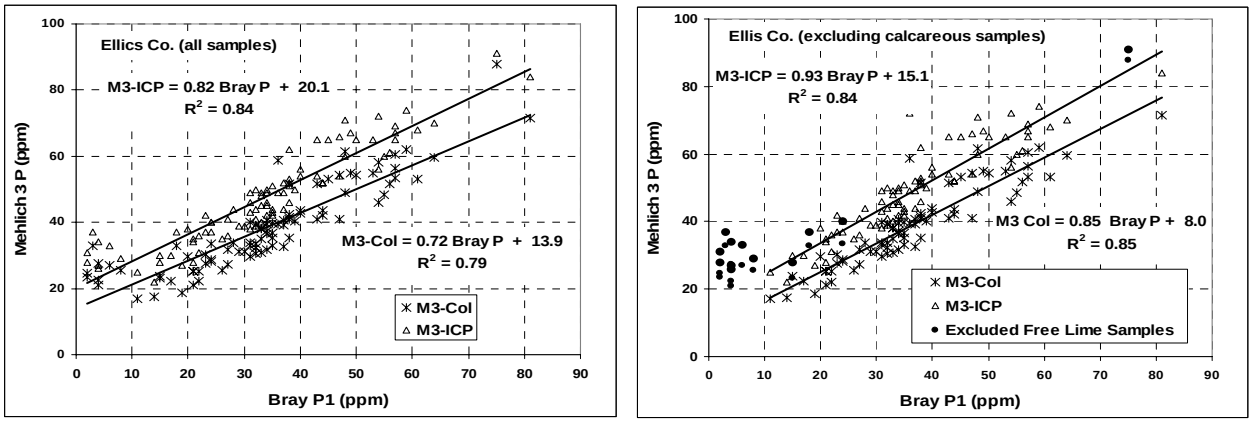
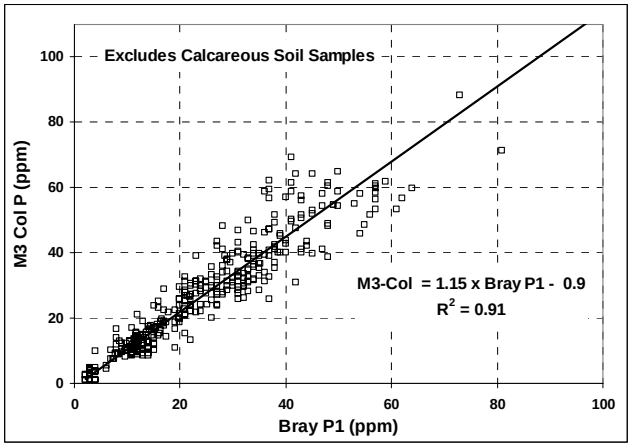


Figure 1. Relationship of M3-Col and M3-ICP with Bray P1 Soil Tests Values On Calcareous and Non-calcareous Soils (Ellis County, Kansas, 2003).



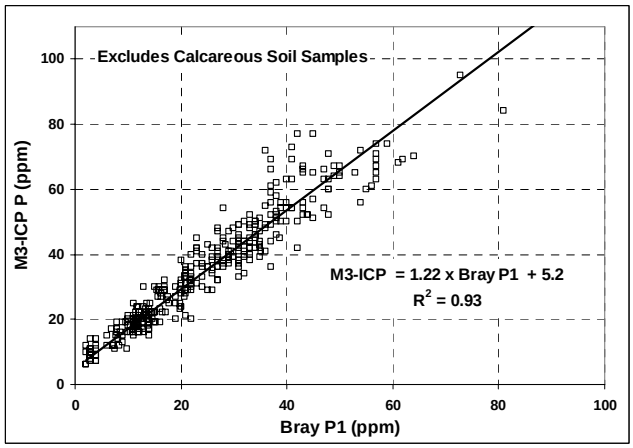


Figure 2. Overall Relationship of M3-Col and M3-ICP with Bray P1 Soil Tests Values On Non-calcareous Soils (10 locations, 2003).

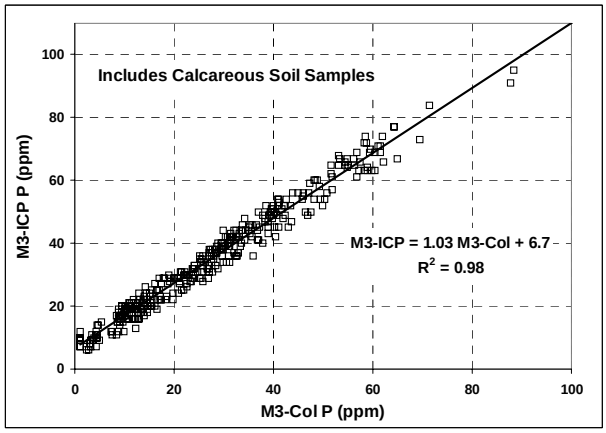


Figure 3. Overall Relationship Of M3-Col and M3-ICP P Soil Test Values (10 locations, 2003)

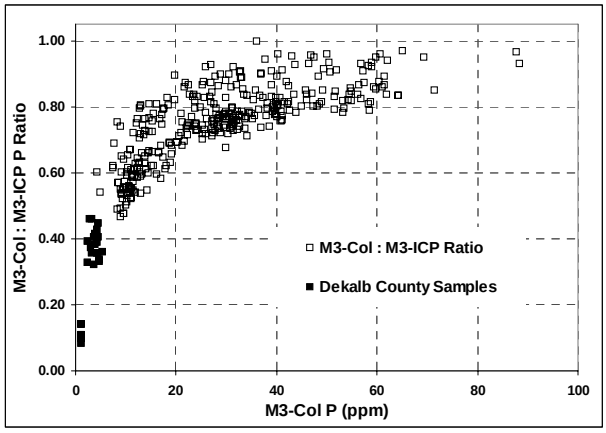


Figure 4. Relationship Of M3-Col : M3-ICP P Ratio To M3-Col Soil Test Value (10 locations, 2003)

Irrigated Cropping Systems to Reduce Groundwater Depletion while Sustaining Profitability

RESEARCHERS AND UNITS:
Alan J. Schlegel, Southwest Research-Extension Center; Loyd Stone, Department of Agronomy; Troy Dumler, Southwest Area Extension Office

FUNDS (FY05): $6,500

FINAL REPORT: July 1, 2004 to June 30, 2005

JUSTIFICATION: Most groundwater pumped from the High Plains (Ogallala) Aquifer in western Kansas is used for irrigation, with corn being the predominant crop. Groundwater withdrawal from the aquifer has reduced saturated thickness and well capacities. Although corn responds well to irrigation, it also requires substantial amounts of water to maximize production. Alternative crop-management practices are needed to reduce the amount of irrigation water required while striving to maintain economic returns sufficient for producer (and community) sustainability. To prepare for less water being available for irrigation in the future, whether from physical constraints (reduced well capacities and declining water tables) or from regulatory limitations, information on crop productivity and profitability with less irrigation water will be beneficial for agricultural sustainability.

OBJECTIVES:
1. Determine crop rotations that can be used with limited irrigation to reduce irrigation water use while maintaining producer profitability.
2. Determine the impact of limited irrigation on crop yield and profitability.

RESULTS:
Limited Irrigation Study: Crop yields were good in 2004, particularly for corn. Precipitation from June through August was 11.49 inches (47% above normal). Corn yields were 40 bu/a greater with 10 inches than with 5 inches of irrigation (Table 1), but there was little or no increase in yields of the other crops with increased irrigation (<10%). Sorghum yields were lower than expected, possibly partly due to wet weather delaying harvest until late November.

Table 1. Grain yield of four crops in 2004, as affected by irrigation amount.

Irrigation amount	Corn	Sorghum	Soybean	Sunflower
inches	- - - - - - - - - - - - bu/acre - - - - - - - - -			lb/acre
5	204	111	49	2532
10	245	103	52	2607
15	260	106	49	2775

An economic analysis found that, at the lowest irrigation rate, net returns were best for corn in 2004 (Table 2) because of the exceptional corn yields of more than 200 bu/a with only 5 inches of irrigation. At the lower irrigation rates, the next-most-profitable crops were soybean and sunflower. At the highest irrigation rate, corn was also the most profitable crop. Corn was the only crop for which profitability increased with more than 5 inches of irrigation.

Table 2. Net return to land, irrigation equipment, and management for four crops in 2004, as affected by irrigation amount.

Irrigation amount	Corn	Sorghum	Soybean	Sunflower
inches	- - - - - - - - - - annual net return, $/acre - - - - - - - -			
5	166	24	92	109
10	219	-11	85	96
15	228	-24	53	98

In 2004, the original plots in the limited irrigation study were split, and a ~20% higher seeding rate for each crop was added. The original seeding rates were 30,000 for corn, 80,000 for sorghum, 150,000 for soybean, and 23,500 for sunflower. The same hybrids were used for each crop except for sorghum, for which a longer-season hybrid was planted at the higher population. For soybean, the higher seeding rate tended to increase yields at the higher irrigation amounts (Table 3). For corn, the higher seeding rate tended to reduce yield at the lower irrigation rate, but had no effect at the higher irrigation amounts. With sunflower, results were mixed, with slightly lower yields at both the low and high irrigation amounts with higher seeding rate. Sorghum yields were greater with the higher seeding rate, but because this also involved a different hybrid, it is not possible to determine which factor affected yield. With the alternate sorghum hybrid, profitability was increased $30-60/acre.

Table 3. Grain yield of four crops in 2004, as affected by irrigation amount and seeding rate.

Irrigation amount	Corn	Sorghum	Soybean	Sunflower
inches	- - - - - - - - - - - - bu/acre - - - - - - - - -			lb/acre
5	204 (178)	111 (134)	49 (43)	2532 (2253)
10	245 (240)	103 (140)	52 (55)	2607 (2748)
15	260 (256)	106 (126)	49 (56)	2775 2482)

The values in parentheses are with a ~20% greater seeding rate.

Crop Rotation Study: Grain yields of all crops except wheat were very good in 2004. The wheat in all rotations followed corn and received 5 inches of irrigation. Wheat yields were severely reduced by a freeze in mid-May (Table 4). All rotations were limited to 10 inches of irrigation, but the corn following wheat received 15 inches, because the wheat only received 5 inches. This extra 5 inches of irrigation increased corn yields about 30 bu/a, compared with yield of the continuous corn (which only received 10 inches of irrigation). Corn yields were similar following wheat, sorghum, or soybean, as were sorghum yields in the 3- and 4-yr rotations.

Table 4. Grain yield of four crops, as affected by rotation in 2004.

Rotation	Corn	Sorghum	Soybean	Sunflower
		- - - - - - - - - - - - bu/acre - - - - - - - - -		
Cont. corn	210	--	--	--
Corn-wheat	243	28	--	--
Corn-wheat-sorghum	239	27	138	--
Corn-wheat-sorghum-soybean	239	29	145	58

An economic analysis was performed to determine returns to land, irrigation equipment, and management for all four rotations. Because of the poor wheat yields and good corn yields, all returns for the multi-crop rotations were less than for continuous corn. The economic return to continuous corn was $160/a, compared with $80 to $94/a for all other rotations.

SIGNIFICANCE OF RESULTS:
Because of differences in growing conditions, the most profitable crop changes from year to year, so that there is not a single best crop. Growing different crops when irrigation is limited can reduce risk and increase profitability. In 2004, corn was the most profitable crop at all irrigation amounts. In multi-crop rotations, relatively poor results with one crop can reduce profitability, compared with a monoculture, when the monoculture crop does very well. But the multi-crop rotation may reduce economic risk when the monoculture crop does not perform so well.

Breeding Grain Sorghum for Improved Dryland Production

RESEARCHERS AND UNITS:
M.R. Tuinstra, Dept. of Agronomy, Manhattan, KS; M. Claassen, Dept. of Agronomy, Hesston, KS; L.E. Claflin, Dept. of Plant Path, Manhattan, KS; W.B. Gordon, Dept. of Agronomy, Belleville, KS; K.A. Janssen, Dept. of Agronomy, Ottawa, KS; K.D. Kofoid, KSU Agricultural Research Center, Hays, KS; V.L. Martin, Dept. of Agronomy, St John, KS

FUNDS: $45,500 **Completion Date:** 6/30/05

JUSTIFICATION: Sorghum is economically important in areas where low and erratic rainfall and high temperature limit the production of other summer crops. The United States is the largest producer of grain sorghum in the world, with 8 million acres of grain production in 2004. Improving the yield potential of sorghum under dryland conditions will have a tremendous impact on the Kansas farm economy.

OBJECTIVES:

1. *Recombinant inbred line population development for stalk rot resistance:* A K-State pollinator parent that produces hybrids with outstanding yield potential and lodging resistance will be used to develop several large mapping populations to identify, characterize, and tag genes for lodging resistance in pollinator parent genetic backgrounds, particularly in food-grade sorghum backgrounds.
2. *Parent line development and germplasm enhancement:* Applied plant-breeding efforts will focus on parent line development enhancement to incorporate genetic sources of stalk rot resistance and other important agronomic traits into lines that produce high-yielding hybrids with broad adaptation across environments.

RESULTS:

Lodging resistance: Lodging resistance in sorghum is associated with increased stalk strength and resistance to infection by stalk rot pathogens. A bioassay was developed to quantify variation in resistance to infection by *Fusarium* and *Macrophomena* pathogens. This assay was used to evaluate an array of genetically diverse sorghum landraces from around the world. Sources of genetic resistance were identified and used to breed for improved lodging resistance.

An elite pollinator line (00MN7645) with outstanding yield potential and lodging resistance was released in 2003. Hybrids produced by using 00MN7645 have above-average yield, compared with conventional sorghum hybrids, and express much higher levels of lodging resistance. Breeding efforts to transfer these characteristics into the broader pollinator parent germplasm pool including feed and food-grade sorghum backgrounds has had limited success. In an effort to make more rapid gains in breeding for this important trait, we have initiated quantitative trait loci mapping (QTL) and marker-assisted selection (MAS) projects to develop a better understanding of the genetic bases for hybrid grain yield and drought tolerance:

- A large recombinant inbred line (RIL) population is being developed from a cross between 00MN7645 and Tx436, a widely-used, tan-plant pollinator line used in U.S. hybrid seed production. More than 1000 RIL were advanced to the F5 generation in 2004-05. This population

will be used to confirm map locations of QTL for drought tolerance and relationships with increased yield potential.

- The four major genes have been identified for staygreen (*Stg1* to *Stg4*). Transfer of the stay-green trait into high-yielding lines with good grain quality through conventional breeding has been challenging due to the polygenic nature of the trait and difficulties in producing the most appropriate selection environments. Ongoing studies at Texas A&M funded by NSF are producing DNA markers for these genes. These researchers recently have agreed to work with KSU to provide use of these markers for marker-assisted selection (MAS) for the staygreen trait. Approximately 800 lines from each of the following 14 populations will be produced at Manhattan in 2005:

  Tx430 x 00MN7645, 86EO361 x 00MN7645, 91BE7414 x 00MN7645, 02MN5035T x 00MN7645, Tx2737 x 00MN7645, SC35 x Tx436, SC35 x Macia, SC35 x MR732, SC35 x K886, Tx643 x (Wht//B35-22-44), AHF14 x QL41, AHF14 x OK11, AHF14 x 03MN952, AHF14 x 03MN960

- In 2006, approximately 200 elite lines selected from each population will be analyzed with DNA markers for each of the *Stg* loci. Lines containing all of the staygreen loci will be tested for hybrid performance under field conditions.

Parent line development and germplasm enhancement: Applied plant-breeding efforts focus on parent line development and germplasm enhancement to incorporate genetic sources of stalk rot resistance and other important agronomic traits into lines that produce high-yielding hybrids with broad adaptation across environments. The bulk of the research effort will focus on development of high-yielding food- and feed-grade parent lines with outstanding lodging resistance. Some key results are shown below:

- Seven conventional red-grain R-line pollinator parents were advanced from hybrid yield trials in 2004-05. These lines produced hybrids with outstanding yield potential and lodging resistance. In 2005, experimental hybrids were planted in yield trials for additional testing and the lines were planted for seed increase, with potential release in the fall.
- Three conventional red-grain A/B-lines were advanced from hybrid yield trials in 2004-05. These lines produce hybrids with outstanding lodging resistance and yield potential. In 2005, experimental hybrids were planted in yield trials for additional testing and the lines were planted for seed increase, with potential release in the fall.
- 382 A/B-line pairs were advanced for continued sterilization in the Manhattan-2005 nursery. Many of these represent a new cycle of staygreen, tan-plant, seed parent lines that may help to resolve the problem of poor dryland adaptation of food-grade hybrids. The first set of experimental hybrids with these materials should be evaluated in 2006.
- Attempts are being made to convert 00MN7645 for use as a tan-plant pollinator parent. Twenty-eight white-grain, tan-plant, mold-resistant lines were selected from the Tx436x00MN7645-RIL mapping population. These lines were backcrossed to 00MN7645 in the 2004-05 winter nursery. BC1 or BC2 derivatives from these populations should provide a useful source of pollinators for production of staygreen food-grade hybrids.

SIGNIFICANCE OF RESULTS: Our research focuses on applied germplasm enhancement and parent line development to deploy genes for stress tolerance into Kansas adapted sorghum hybrids. We emphasize research activities that fill in gaps not being addressed in commercial programs, including germplasm diversification and “high-risk” technologies that may provide unique solutions to problems that farmers are facing throughout the region. Since 2001, we have released and licensed 2 pollinator

lines and one seed parent. After viewing testcross hybrids in field trials around the region, the private seed industry was quick to access this material. Furthermore, we have had several requests for greater access to early-generation materials in our program. The eagerness of the private industry to access and use materials from our program demonstrates the value and impact of these activities.

The development of stress-tolerant cultivars will reduce production problems and contribute to improved management and production strategies. These breeding efforts are crucial to technology transfer because the commercial seed industry generally is not prepared to use “raw” germplasm sources identified through basic research activities. The development of lines with improved drought tolerance should translate into improved yield potential and stability of hybrids that are adapted for production in Kansas.

KANSAS SOYBEAN COMMISSION

Biology and Management of the Soybean Stem Borer in Kansas

RESEARCHERS AND UNITS:
Lawrent Buschman, Dept. of Entomology, SW Res./Extn. Center; Phillip E. Sloderbeck, Southwest Area Extension Office; Harold Trick, Dept. of Plant Pathology; William Schapaugh, Dept. of Agronomy; and Merle Witt, SW Res./Extn. Center.

FUNDS (FY 04): $25,901 **Completion Date:** April 30, 2005

JUSTIFICATION: The soybean stem borer has caused severe lodging problems to soybean in some parts of Kansas, but research on the basic biology and management options for this pest have been very limited.

PROJECT OBJECTIVES:

1. Evaluate the efficacy of feeding and oviposition scars to detect differences in host plant resistance in soybean varieties.
2. Evaluate the efficacy of KSC-sponsored, KSU-produced genetically engineered soybeans containing chitinases in reducing soybean stem borer feeding, oviposition, and infestation.
3. Evaluate the efficacy on soybean stem borers of systemic insecticides applied to plants when first-instar larvae begin feeding in the plants.
4. Study the impact of stubble management practices on stem borer over-wintering success.
5. Expand web pages associated with soybean insect pests.

RESULTS:

Objective 1: We planted 10 varieties to represent the range of short-season to full-season maturities at three irrigated locations with soybean stem borer infestations: Scandia, St. John, and Garden City. The Garden City site was dropped because some varieties did not recover from iron chlorosis caused by high soil pH. Beetle activity was heavy at St. John. At Scandia, the beetle activity was light. Oviposition scars seemed to be a usable parameter to measure Dectes activity on the plants, but none of the variables had strong correlations among varieties across locations. Entry nodes or tunneling in the plant base may be usable parameters to measure larval survival in plants. All variables were inconsistent across locations. These results demonstrate the difficulty in assessing host resistance to Dectes stem borers in soybean. Future studies will examine optimum sample size and should include a truly resistant plant (perhaps simulated through insecticide protection) to determine if a "real" treatment can be identified consistently.

Objective 2: This work will be done this spring in the greenhouse by the new graduate student.

Objective 3: We have conducted two small-plot trials with systemic insecticides near Garden City: We tested eight insecticides as soil treatments, and Regent and Provado gave significant reduction in numbers of larvae per 20 plants. The Aug. 3 treatments seemed more effective than the 19 July treatments. We tested seven insecticides as foliar treatments, and Regent and Poncho gave significant reduction in numbers of larvae per 20 plants. The 22 July treatments seemed more

effective than the 13-17 Aug. treatments. Regent provided up to 100% control and a significant yield improvement of 6.6 bu/acre. This implies a yield loss of 10% for Dectes stem borer infestations. We also conducted an aerial trial of Furadan on three cooperator fields in Pawnee Co. Unfortunately, the beetle activity in these fields was light. After harvest, we evaluated Dectes tunneling, numbers of larvae, and girdling activity in 400 plant bases. Check plots averaged 16.9 and 20.1 plants tunneled per 100 bases. The half-pint and one-pint Furadan treatments averaged 15.8 and 9.9 plants tunneled per 100 bases. The one-pint treatment resulted in significantly less tunneling than that the check plots (P = 0.015), but only provided 46% control.

Objective 4: This experiment was installed in soybean stubble from 2003. A bush-hog mower was used to mow the stubble in fall or in spring. A blade was used to undercut the stubble at two depths and a rolling packer was used to break the soybean stubble. There was no impact of these treatments on any of the stem borer variables.

Objective 5: We have developed a series of web pages based on our Soybean Insect Management Guides. This will allow us to link images and other documents to the short descriptions and control options given in that document.
http://www.oznet.ksu.edu/entomology/extension/InsectInfo/Soybean/Soybean%20Insects.html

SIGNIFICANCE OF RESULTS: We have developed two new options for managing Dectes stem borers in soybean with insecticides: beetle sprays and systemic insecticides. We can use registered insecticides for beetle sprays. The systemic insecticides are experimental at this time, and the new use will need be registered before it can be used by producers. Producers are also encouraged to make sure harvest is timely in areas where infestations are detected. Information from these studies is used to update and expand our web pages, management guides, and presentations on soybean pest management. Data from these studies are also used to guide future research.

International Grains Program Support Project

RESEARCHERS AND UNITS:
John Howard, International Grains Program

FUNDS (FY 05): $36,000 **Completion Date:** Ongoing

JUSTIFICATION: Worldwide, the feed manufacturing industry faces increased competition. Ingredient costs are one of the factors determining profit or loss. Other factors include the nutritional benefits to the animals being fed. Many ingredient buyers are unaware of the U. S. grain grading system, quality-control procedures, and proper storage, shipping, handling, and sanitation processes. Foreign buyers of soybeans and soybean meal often fail to properly use pricing, basis, futures markets, and price-discovery tools because they are not trained in these fundamentals. Consumer sensitivities to genetically modified organisms (GMOs) also complicate the process.

OBJECTIVES:

1. To identify potential buyers of U.S. soybeans and soybean meal in cooperation with the American Soybean Association (ASA), the United Soybean Board (USB), and the USDA's Foreign Agricultural Service (FAS).
2. To solicit potential buyers and users to participate in short courses at the International Grains Program (IGP) that address the above issues both in the United States and overseas.
3. To identify opportunities in specific targeted markets, with the ASA and USB, where specifically designed IGP courses could be conducted in the country or countries targeted.
4. To maintain contact with individual participants to continually provide them with the latest information concerning soybean and soybean meal utilization.

RESULTS: More than 185 persons participated in IGP's regularly scheduled short courses. Four of the five short courses cover soybean, soybean meal, and soy oil.

SIGNIFICANCE OF RESULTS: Buyers of U.S. soybeans, soybean meal, and soy oil have gained a better knowledge of our grade, contracts, and price-discovery mechanisms. They are able to purchase U.S. soy products with more confidence and are able to obtain the exact product they need, thus enhancing their margins.

A Soybean Extension Educational Program in Southeast Kansas

RESEARCHERS AND UNIT:
Gary L. Kilgore and Sarah Fogleman, Southeast Area Extension Office

FUNDS: 3/1/04 to 2/28/05 $11,180 **Completion Date:** 2/28/05

JUSTIFICATION: In an average year, soybean producers in the 26 counties that make up the Southeast KSU Extension Administration Unit produce over 21 million bushels of soybeans. Eight of the top ten soybean-producing counties are in Southeast Kansas, and Southeast Kansas produces over 50% of the state's soybean crop.

Southeast Kansas has special problems. Shallow soils result in reduced yields, but by managing planting date, tillage systems, and variety selection, yields have improved. Most of the production efficiencies were first learned by research, then transferred to the farm. Southeast Kansas has the most rainfall of any place in Kansas. Water quality and crop production are REAL issues. Water runoff response is different in East Central and Southeast Kansas from anywhere else in Kansas. Because of lack of topsoil thickness, we experience more water runoff on no-till than on tilled fields. About 16 years ago, Soybean Cyst nematode (SCN) was discovered in Cherokee County. Today, more than 19 counties report infestation. We have shown good variety difference with research, but producers are slow to accept the new varieties. Shallow soils and long, wet periods affect seedbed preparation. Research shows that only one or two passes of a tillage tool is necessary for optimum yields. Soybean row spacing and plant population has been shown to affect yields in research trials. Some producers have started using drills for planting, but are planting too much seed for optimum yields. Actual seeding rates with drills must be demonstrated on farms.

PROJECT OBJECTIVES: This program reduces the time that proven practices, developed at our experiment stations, take to be implemented by producers on their farms. We will:

1. Establish on-farm trials to show the best management practices (BMPs) for soybean production already proven at the water quality IAMS sites located in Crawford and Franklin counties. This will include weed control, fertilizer placement, and minimizing soil loss.
2. Conduct tours of these and other on-farm trials.
3. Continue to demonstrate proper plant populations, row spacing, and inoculation procedures.
4. Continue to conduct on-farm trials using soybean varieties, double-crop varieties, and SCN-resistant varieties.
5. Use the data collected in winter soybean schools.
6. All data produced will be subjected to economic analysis to determine profitability.
7. New soybean economic budget worksheets will be prepared.

This grant will allow me to hire part-time labor to assist me in establishing on-farm trials and gathering data throughout the growing season.

RESULTS:

- More than 700 people attended county crop tours in the fall of 2004.
- More than 1,300 producers attended county or multi-county soybean schools in 2004.
- 2004 yields were 15 bushels above average because of excellent summer rains.

- Fungicides applied to soybeans increased yields 4 bushels/a (10%). Controlled brown spot and bacterial pustule.
- A new KSU Farm management Guide with cost of production for soybean production in Southeast Kansas was completed.
- Soybean yields based on KSU fertilizer recommendations were equal to yields from commercial company recommendations at significantly lower fertilizer rates.
- On-farm trials with seeding rates showed that planting more than 120,000 seeds/acre did not increase yields.

SIGNIFICANCE OF RESEARCH: This program reached more than 2,000 producers directly in 2004. Many more read about results in news articles and heard it on radio programs. If a producer followed soil test recommendations from a commercial company and not KSU, they could spend an additional $16.00/acre and not increase yields. Dropping 120,000 seeds/acre instead of 160,000 seeds results in a savings of 14 pounds of seed/acre, which equals a savings of $8.40/acres ($30.00/50 lb = 0.60/lb, 14 lb $\times$ 0.60 = $8.40). If 1/3 of soybean acres applied these results, producers would save over $6.5 million. A significant program indeed.

DATE RUN 03/01/05
TIME RUN 00:21:23
FBM090 - A1

KANSAS STATE UNIVERSITY
FINANCIAL RECORDS SYSTEM
ACCOUNT STATEMENT FOR 02/28/05

REPORT PAGE 3804
PROGRAM ID FBM090
ACCOUNT PAGE 1

ACCT: 5-37048
DEPT: 35270

SEAOF A SOYBEAN EDUCATIONAL PROGRAM IN SOUTHEAST KANSAS

TO: KILGORE G

SUB CODE	DESCRIPTION	BUDGETS ORIGINAL	BUDGETS REVISED	ACTUALS CURRENT MONTH	ACTUALS FISCAL YEAR	ACTUALS PROJECT YEAR	OPEN COMMITMENTS	BALANCE AVAILABLE	PERC USED
1000	SALARIES EXPENSE	8,025.00	2.06					2.06	0
1011	CLASSIFIED TEMPO		6,491.68		4,147.92	6,491.68			100
1076	SL RA CLASS		27.22		17.85	27.22			100
1091	CLASS FICA		496.61		317.32	496.61			100
1097	CLASS WORKMENS C		61.51		40.04	61.51			100
1098	CLASS UNEMP TAX		20.92		15.76	20.92			100
	SUBT CLASS SAL/B	8,025.00	7,100.00		4,538.89	7,097.94		2.06	99
2000	OPERATING EXP PO		336.20					336.20	0
2091	CELLULAR PHONES		622.05	109.61	433.50	622.05			100
2190	OTH FREIGHT/EXPR		6.88			6.88			100
2230	DUPLICATING & RE		.45		.45	.45			100
2410	REPAIR PASSENGER		49.42		49.42	49.42			100
	SUBT CONTRACT SE		1,015.00	109.61	483.37	678.80		336.20	66
2500	TRAVEL POOL	2,155.00	632.97					632.97	0
2511	PRIV CAR MILE-IN		359.12		34.04	359.12			100
2581	SUBSISTENCE-IN/S		162.91	162.91	162.91	162.91			100
	SUBT TRAVEL	2,155.00	1,155.00	162.91	196.95	522.03		632.97	45
2600	OTHER CONTR SER		142.50-					142.50-	0
2650	LABORATORY FEE		142.50			142.50			100
	SUBT OTH CONTR S					142.50		142.50-	0
3000	COMMODITIES POOL	1,000.00	721.75					721.75	0
3510	GASOLINE		878.17	372.07	878.17	878.17			100
3590	OTHER VEHICLE PA		310.08	310.08	310.08	310.08			100
	SUBT SUPPLIES	1,000.00	1,910.00	682.15	1,188.25	1,188.25		721.75	62
	TOTAL OPERATING	3,155.00	4,080.00	954.67	1,868.57	2,531.58		1,548.42	62
	TOTAL DIRECT COS	11,180.00	11,180.00	954.67	6,407.46	9,629.52		1,550.48	86
	ACCOUNT TTL (REV	11,180.00	11,180.00	954.67	6,407.46	9,629.52		1,550.48	86

See Statement of Monthly Transactions for detail.
Please refer questions to Ext. 2-7089.

Water Savings from Crop Residues in Irrigated Soybeans

RESEARCHERS AND UNITS:
Norman L. Klocke and Troy J. Dumler, Southwest Research-Extension Center

FINAL REPORT for March 1, 2004 to February 28, 2005

FUNDS (FY05): $9,500 **Completion Date:** Ongoing

JUSTIFICATION: Soybean producers who use irrigation in western Kansas continue to plant in 30-inch rows. This practice allows for the use of row crop headers at harvest and reduced shattering losses with the dry humidity of the area. The wide row spacing and later ground coverage, compared with drilled beans, reduces the advantages of evaporation suppression by crop canopy. Crop residues resulting from no-till management in widely spaced rows could overcome this disadvantage.

Soybean growers who irrigate face restrictions in available water, either from lower well capacities or from water allocations. Water savings, even a few inches, can convert into yield increases. Research has shown that each inch of water captured or saved in the root zone can potentially be transformed into soybean yield through evapotranspiration at a rate of 4 bushels for each acre-inch of water saved.

Evapotranspiration is a two-part process. The transpiration part, or water consumed by the crop, is the positive part of the process that relates directly to grain yield. The evaporation part, or water directly vaporizing into the air from the soil, can be reduced without reducing crop yield.

Reducing evaporation from the soil is the goal of this project. Past projects have demonstrated that reducing soil evaporation under irrigated corn canopies is possible with flat wheat stubbles. Irrigators need to know the value of stubbles, including corn stalks and standing wheat stubble. They need this information in terms of the amount of water these stubbles potentially retain in the soil for use by a soybean crop.

PROJECT OBJECTIVES:
Determine the water-savings value of crop residues in irrigated soybean production.

1. Measure evaporation beneath crop canopy of fully irrigated and limited-irrigated soybean production.
    a. Measure evaporation from bare soil
    b. Measure evaporation from soil with no-till corn residue
    c. Measure evaporation from soil with standing wheat residue
2. Calculate the relative contribution of evaporation and transpiration to evapotranspiration, based on each of the measurement variables listed in Objective 1.
3. Convert any potential savings in evaporation due to crop residues to equivalent grain yield gains and economic impacts in water-limited areas in western Kansas.

RESULTS: Soil water evaporation was measured during the summer of 2004 with mini-lysimeters, which are undisturbed soil cores 12 inches in diameter and 5.5 inches deep. Two lysimeters are placed across from one another in a 30-inch row under the crop canopy. There were four replications of bare,

corn-stover, and wheat-stubble surface treatments, and two irrigation treatments (full and limited irrigation), which combined for a total of 48 lysimeters in the field at one time. Evaporation measurements started on June 9 and continued until September 20.

Residue cover had a strong effect on soil water evaporation (Table1). The corn stover ended the season with 87% ground cover, which may help explain its effect. This relatively high percentage of surface cover for corn stover is equivalent to very good no-till management, which is the maximum reduction in evaporation that could be expected from corn stover. The next trend was that crop canopy diminished the effects of soil water evaporation as the season progressed. This would be predicted, and our measuring technique confirmed this trend. Third, differences in soil water evaporation resulted from watering frequency. Due to the wet year (17.5 inches of rain from May 15 through September 30), full irrigation had only 6 more watering events (rain and irrigation) than the limited treatment.

The cropping-season summation of the daily data is in figure 1. Table 2 has the difference in soil water evaporation between the bare soil and the mulched treatments. This would represent the savings in water from corn stover or wheat stubble during vegetative, reproductive, and grain fill growth stages. Data for 2003 and 2004 are shown for full irrigation, because only that treatment was conducted in 2003.

Figure 2 represents soil water evaporation as a percentage of evapotranspiration (ET) for both 2003 and 2004. The influence of canopy closure is evident in the percentage of evaporation (E) as ET during full canopy. This is not surprising, but the study has quantified the magnitude of E throughout the season.

Table 1. Soil water evaporation as influenced by soil surface conditions under soybean canopy, measured with mini-lysimeters during 2004.

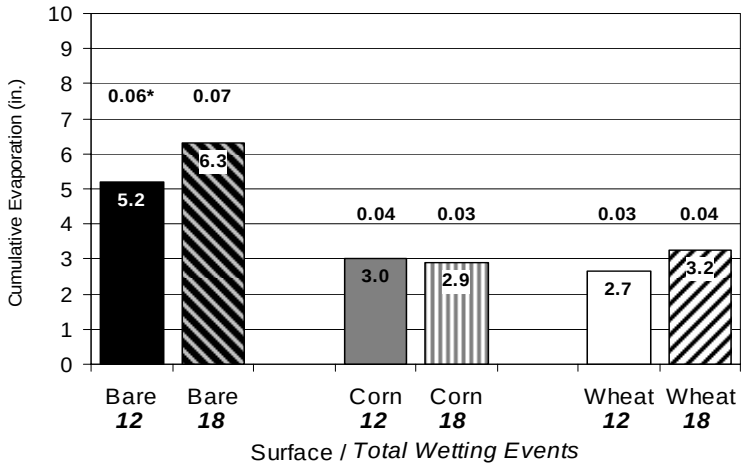
	June 9 to July 12			July 13 to August 5			August 13 to September 20		
	34 of 34 days recorded			17 of 24 days recorded			34 of 39 days recorded		
Soil Surface	Bare	Corn	Wheat	Bare	Corn	Wheat	Bare	Corn	Wheat
a. Cumulative Evap. (in)		(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
Watering Frequency									
12 Events	2.41	1.22	1.09	1.47	0.84	0.74	1.32	0.95	0.84
18 Events	3.02	1.32	1.46	1.94	0.82	0.95	1.34	0.78	0.83
b. Daily Average	in/day	in/day	in/day	in/day	in/day	in/day	in/day	in/day	in/day
Watering Frequency									
12 Events	0.07	0.04	0.03	0.09	0.05	0.04	0.04	0.03	0.02
18 Events	0.09	0.04	0.04	0.11	0.05	0.06	0.04	0.02	0.02

Table 2. Soil water evaporation and savings from crop residue surface cover, compared with bare soil, for 2003 and 2004 (in parentheses) growing seasons for full irrigation.

	Vegetative Period		Reproductive &Grain Fill		Season
Surface Cover	Total (in)	Savings (In)	Total (in)	Savings (in)	Savings (in)
Bare Soil	4.1* (3.0)		3.1(4.0#)		
Corn Stover	2.4* (1.3)	1.7 (1.7)	1.8 (2.0)	1.3 (2.0)	3 (3.7)
Wheat Straw	2.1* (1.5)	2 (1.5)	1.5 (2.0)	1.6 (2.0)	3.5 (3.5)

*Estimated from past research

#Days with missing data due to irrigation or rainfall events were filled with average daily values for the crop growth period.



* Daily evaporation rate (in./day)

Figure 1. Cumulative soil water evaporation as influenced by crop residue surface cover, measured during 85 of 97 days during growing season in soybean canopy, June 9 through September 20, 2004.

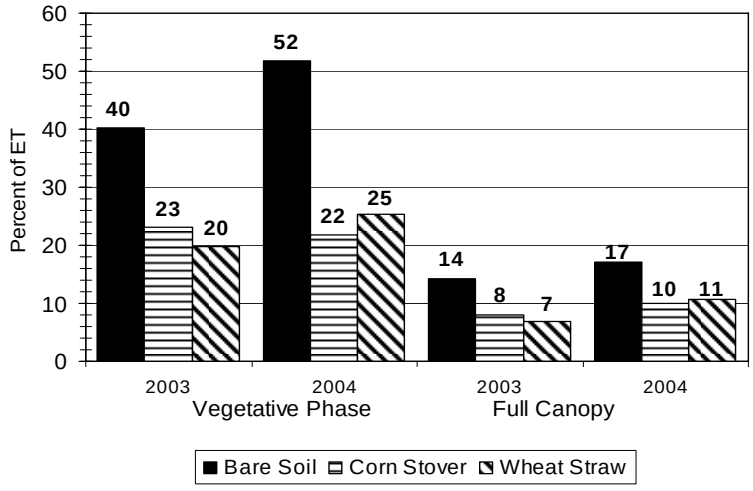


Figure 2. Soil water evaporation as a percentage of crop evapotranspiration, with the influence of crop residue surface cover, during vegetative and full canopy growth stages of soybean in 2003 and 2004 growing seasons.

SIGNIFICANCE OF RESULTS: These data indicate that there may be a 3- to 4-inch savings in water from evaporation if savings were extended over the growing season. There are also benefits outside the growing season and benefits due to erosion control, enhancement of infiltration, and runoff control. The 3- to 4-inch water savings alone could have a significant impact on the soybean industry in Kansas if crop residue management techniques were further adopted. In 2002, there were 126,500 ac of irrigated soybeans in the western third of Kansas and 180,800 ac in the central third, for a total of 307,300 ac. If 80% were irrigated with center pivots, 246,000 ac of soybeans in the western 2/3 of Kansas could apply this research. (Statistics on narrow-row and wide-row acreages were not available for this analysis).

Water savings would impact the soybean industry in two ways. Irrigation pumping costs have risen to $3 to $5/ac-in recently, which means the operating cost of the evaporation savings would be impacted by $9 to $20/ac. For irrigators with limited water supplies the water savings translates into crop production because the water becomes available to the crop. For top producers, an inch of water could be translated into 4 bushels of soybeans if water is the limiting factor. This would mean an extra 12 to 16 bushels of production per acre from the management of crop residues for evaporation suppression.

Assuming that soybean production in western Kansas is predominately in 30-inch rows, the overall economic impact of this research, if adopted, could be significant. The impact on pumping costs would be $1,156,500 to $2,570,000 over 128,500 acres. The impact on production would be $7,710,000 to $10,280,000 for soybeans at $5.00/bu over the same acreage.

Non-growing-season benefits combine with the growing-season benefits of crop residues for soil water evaporation suppression, infiltration enhancement, runoff reduction, and snow entrapment. Dryland research indicated that these characteristics may be worth at least 2 inches annually in water conservation in the Central Plains states.

The outcome for this project is to give irrigators concrete data to justify saving crop residues on the surface for suppression of soil evaporation. Policy makers will have information on the economic impact of crop residues on water savings from irrigation in western Kansas. This will be important for conservation programs and water-allocation programs in the future.

SPENDING REPORT

019 SL ACCOUNT SUMMARY SWREC KS SOYBEAN
DATE: 03/11/05 FY: 05
SCREEN: ACCT: 526219 SUBTOTAL OPTION: A1 PRINT SUBTOTAL: O
FUND: 2697 1100
DEPARTMENT: 10235 RESP PERSON: KLOCKE N / DUMLER T
MAP CODE: 26219 FLAGS: DEL FRZ RVW DRP SUP ABR
0 0 0 0 1 5

OBJ	DESCRIPTION	BUDGET	ACTUAL	ENCUMB	AVAIL
	SALARIES,WAGE	3,300.00	3,257.63	0.00	42.37
	CONTRACTUAL S	0.00	1,681.24	0.00	1,681.24-
	TRAVEL	1,000.00	426.52	0.00	573.48
	OTH CONTR SER	1,750.00	122.28	0.00	1,627.72
	MATERIALS & S	3,000.00	3,560.33	0.00	560.33-
	TOTAL DIRECT	9,050.00	9,048.00	0.00	2.00
	TOTAL EXPENSE	9,050.00	9,048.00	0.00	2.00
	ACCOUNT TOTAL	9,050.00	9,048.00	0.00	2.00

Management of the Soybean Aphid: A Proactive Approach to a New Pest

RESEARCHERS AND UNITS:
John C. Reese, Randall A. Higgins, and C. Michael Smith, Dept. of Entomology; William T. Schapaugh, Dept. of Agronomy; Phillip E. Sloderbeck, Southwest Area Extension Office; Robert E. Wolf, Dept. of Biological and Agricultural Engineering; Douglas J. Jardine, Dept. of Plant Pathology.

FUNDS (FY '05): $ 23,157 **Completion Date:** June 30, 2005

JUSTIFICATION: The soybean aphid has proven to be a severe pest of soybeans in many northern states. In Kansas, it may be most serious in years with slightly milder temperatures, but is always a threat to soybean productivity.

The results of the many-pronged approach in this project enhanced awareness of the pest, fine tuned treatment recommendations to reduce the likelihood of treating unnecessarily, and has laid the foundation for increasing the resistance levels of commercially available varieties.

OBJECTIVES:

1. To produce a color brochure that aids producer awareness on identification, life history characteristics, and damage caused by the soybean aphid.
2. To confirm the presence of the soybean aphid in Kansas and establish a laboratory colony.
3. To collect information evaluating feasibility of controlling soybean aphid with foliar insecticides in Kansas.
4. To screen soybean germplasm accessions for sources of resistance to the soybean aphid so that future research can identify molecular markers for resistance.
5. To conduct experiments to identify the category (antibiosis, antixenosis, or tolerance) of resistance in selected lines.
6. To determine in more detail the behavioral components of resistance of selected lines, by using the electronic monitoring system (EPG.

RESULTS: The first objective was completed during the first year, resulting in both a quick, initial brochure, and then a more detailed one on just the soybean aphid. These publications were widely distributed. We continue to provide information to producers, crop consultants, researchers, and others in a variety of settings. For instance, posters were shown or presentations delivered at the Soybean Expo in Topeka, the S-1010 meetings on soybean insect management in Virginia, the North Central Branch of the Entomological Society of America in Indiana, the national meetings of the Entomological Society of America in Salt Lake City, and were shared at a number of Extension meetings around the state of Kansas. And because we had our first confirmed reports of economic levels, as opposed to the minor infestations found earlier, of soybean aphids in Kansas during 2004, revisions were made in our Soybean Insect Management publication (http://www.oznet.ksu.edu/library/ENTML2/Mf743.pdf) to provide information on insecticides that are labeled for treating soybean aphid populations. This information is also available on our web site at: http://www.oznet.ksu.edu/entomology/extension/InsectInfo/Soybean/Soybean%20Aphid.html, which highlights the support of the Kansas Soybean Commission.

The second objective was also completed during the first year of the project, and we are continuing to watch the progress of this pest. In 2004, Kansas soybean growers experienced the earliest infestations, the largest number of counties affected, and the heaviest per-plant populations of aphids yet seen in the state, so we continue to watch the progress of this pest, and to keep growers aware of the current situation, as described previously.

For the third objective, evaluations of the spray process during the first two years of this project indicated difficulties in getting the spray droplets to adequately penetrate into the lower portions of the soybean canopy. This has been true for both the aerial and ground application scenarios evaluated. We expanded the spray droplet collection process by traveling to areas where soybean canopies were fully developed, and that gave us a lot more material to work with this year due to more favorable moisture levels. Conventional, electrostatic, and aerial application systems were tested to determine abilities to get spray droplet penetration into the lower portions of a dense soybean plant canopy for late-season control of the soybean aphid. For each system, typical spray operation parameters were used as treatments, while comparing application volumes and/or deposition aid products. For all trials, kromekote paper was positioned near the top, middle, and bottom of the canopy to collect the spray droplets, and DropletScan™ was used to measure and compare the coverage differences.

We conclude that, when using the application systems evaluated in these studies, applicators will have limited success in placing droplets into the lower parts of full-canopied soybean plants. With the conventional spray system, nozzle type had little effect. For the conventional and aerial trials, coverage improved with increased application volumes. The addition of deposition aids tends to improve the total amount of coverage into the lower parts of the canopy. Adding an electrostatic charge to the spray does not provide significant improvement. Thus, with challenges in spray technology of this crop, good, accurate treatment thresholds become even more critical than usual.

The money from the Kansas Soybean Commission has made it possible to obtain additional funding from industry for work closely related to the fourth objective. We are currently using the following protocol as we start a new project, in collaboration with Bill Schapaugh, which is also funded by the Kansas Soybean Commission. Seven conetainers are planted for each entry, plus KS 4202 as the control. When the plants are at the V1 stage, the five healthiest of each entry are infested with six mature aphids (three on each unifoliate). Seven days later, the resulting nymphs are counted as a measure of antibiosis levels. From this protocol, quite a number of entries look very promising, even though other institutions have screened thousands of entries and have found fewer promising entries, so we are very pleased with our techniques. K1639, from Bill Schapaugh's program, looks as good as any material anywhere in the United States. And, some of the work at other institutions was based on clones of individual aphids, whereas we made an effort to get as many individual aphids as possible for starting our colonies, and thus have some genetic diversity representing the situation in the field.

Most of the resistance we have identified this year has been antibiosis, just as in the past. Further, we have tried a number of variations of the SPAD chlorophyll meter technique to assess tolerance, without much success. At this time, we believe that tolerance will not be a useful category of resistance for the soybean aphid.

In the sixth objective, the electronic monitoring system (EPG) is up and running. We are looking at the behavioral components of resistance of those materials that showed the Nonpreference category of resistance.

SIGNIFICANCE OF RESULTS: The K-State Research and Extension and Kansas Soybean Commission co-sponsored efforts facilitated during the course of this grant made it possible for growers, crop consultants, and county agents of Kansas to have educational materials needed so they could respond appropriately if a serious soybean aphid outbreak had developed locally. The importance of this preparedness can be appreciated by considering the results of a survey conducted by Iowa State University. Iowa is not that far away, and during 2003 farmers in that state sprayed a total of 2.9 million acres of soybeans with insecticides targeting soybean aphids. Overall, it was estimated that Iowa producers lost 57.7 million bushels to the soybean aphid that year, for an average of 11.1 bushels per infested acre. For 2005, our Kansas Soybean Pest Management recommendations also include guidelines for determining when the economic threshold has been exceeded - along with a list of insecticides registered for controlling soybean aphid. Coverage improved as conventional and aerial application volumes increased. These trials did not reveal significant improvement when an electrostatic charge was added to the spray pattern.

Increasing the level of host-plant resistance will reduce costs of chemical treatments. In addition, host-plant resistance is compatible with natural enemies.

Enhancing Soybean Germplasm Development

RESEARCHERS AND UNITS:
W. Schapaugh, Dept. of Agronomy; T. Todd, Harold Trick, Dept. of Plant Pathology; J. Long, Southeast Research/Extension Center

Department Heads: David Mengel, Scott Hulbert, Lyle Lomas

FUNDING: $200,000 **Final Report:** May 2005

An aggressive cultivar development program represented the focal point of this project. Experimental lines in maturity groups III through V were tested at breeding nurseries located throughout Kansas. Agronomy Experiment Fields, Branch Experiment Stations, farmer cooperators, and soybean variety performance-test locations served as resources to conduct trials. The K-State soybean breeding program participated in the Uniform Testing program, including the soybean cyst nematode (SCN) Uniform Tests. Depending upon the focus of the population, evaluations included traits such as seed yield, maturity, lodging, height, seed quality, seed size, protein and oil concentration, shattering, disease or insect resistance, herbicide resistance, tofu yield, and tofu quality. We also were involved in the evaluation of genetic differences in Soybean Stem Borer infestation and screening for aphid resistance. Through these activities, we have developed new soybean varieties, procedures to improve the selection efficiency of important traits, and strategies for enhancing the durability of resistance to such pathogens as SCN, through deployment of diverse resistance genes.

VARIETY DEVELOPMENT:
Funding for this project has enabled Kansas State University to develop several special-purpose soybean varieties that are available to growers for planting. Specifically, for the past fiscal year, KS5005sp, a new large-seeded variety, was released. Those releases available in the spring of 2005 are listed below. Descriptions and performance data on these varieties available for release or testing are presented in the following pages and in Tables 1 through 4.

2005 K-State Special-Purpose Soybean Variety Descriptions:
KS4103sp High Protein Variety
KS4103sp is an F4 single plant selection from the cross Flyer x BARC 6. BARC 6 is high-protein soybean variety developed by the USDA. KS4103sp has purple flowers, tawny pubescence, brown pods at maturity, indeterminate growth habit, and seeds with black hila. KS4103sp is an early maturity group IV variety with above-average protein content.

KS4302sp Small Seeded, Yellow Hila Variety
KS4302sp is an F4 plant selection from the cross of Hutcheson x Nattosan. Nattosan is a small-seeded food variety. KS4302sp has purple flowers, gray pubescence, tan pods at maturity, indeterminate growth habit, and seeds with yellow hila. KS4302sp is an early maturity group IV variety with small seed.

KS4303sp Small Seeded, Yellow Hila Variety
KS4303sp is an F4 plant selection from the cross of Jack x Mercury. Mercury is a small-seeded food variety from the Univ. of Nebraska. KS4303sp has purple flowers, gray pubescence, tan pods at

maturity, determinate growth habit, and seeds with yellow hila. KS4303sp is an early maturity group IV variety with small seed.

KS4402sp High Protein Variety
KS4402sp is an F4 single plant selection from the cross Hutcheson x BARC 6. BARC 6 is a high-protein soybean variety developed by the USDA. KS4402sp has purple flowers, indeterminate growth habit, and seeds with black hila. KS4402sp is a mid-group IV maturity variety with above-average protein content.

KS4702sp Large Seeded, Yellow Hila, Soybean Cyst Nematode (SCN) Resistant Variety
KS4702sp is an F4 plant selection from the cross of Saturn x Jack. KS4702sp has white flowers, gray pubescence, tan pods at maturity, determinate growth habit, and seeds with yellow hila. KS4702sp is a late group IV variety with large seed. KS4702sp is resistant to SCN race 3.

KS5001sp Small Seeded, Yellow Hila Variety
KS5001sp is an F4 plant selection from the cross Hutcheson x SS201. SS201 is a small-seeded food variety from Iowa State University. KS5001sp has white flowers, gray pubescence, tan pods, determinate growth habit, and seeds with yellow hila. KS5001sp is an early group V maturity variety with small seed.

KS5003sp Small Seeded, Yellow Hila Variety
KS5503sp is an F4 single plant selection from the cross KS5292 x Mercury. KS5003sp has white flowers, gray pubescence, tan pods at maturity, determinate growth habit, and seeds with yellow hila. KS5003sp is an early group V maturity variety with small seed.

KS5005sp Large Seeded, Yellow Hila, High Protein Variety
KS5005sp is an F4 single plant selection from the cross Saturn x SS1386-5-2. KS5505sp has white flowers, gray pubescence, tan pods at maturity, determinate growth habit, and seeds with yellow hila. KS5505sp is an early group V maturity variety with above-average seed size and protein content.
NEW for 2005. Performance data in Tables 2, 3 and 4.

KS5201sp Small Seeded, Yellow Hila Variety
KS5201sp is an F4 plant selection from the cross Camp x Sherman. Camp is a small-seeded variety from Virginia Polytechnic Institute and State University. KS5201sp has white flowers, gray pubescence, tan pods, determinate growth habit, and seeds with yellow hila. KS5201sp is an early group V maturity variety with small seed.

KS5202sp High Protein Variety
KS5202sp is an F4 single plant selection from the cross Hutcheson x BARC 9. BARC 9 is a high-protein soybean variety developed by the USDA. KS5202sp has white flowers, determinate growth habit, and seeds with buff hila. KS5202sp is an early group V maturity variety with above-average protein content.

Table 1. 1999-2004 Kansas early-season specialty performance

Entry	Yield	Rank	Maturity	Lodging	Height	Seed Qual.	Seed Size	Seed Wt.	Protein	Oil
	bu/a			score	in	score	no / lb	g/100	%	%
KS4103sp	37.4	9	6	2.1	39	2.2	2781	16.3	49.4	16.8
KS4302sp	34.5	10	10	1.5	26	2.1	5033	9.0	41.4	18.1
KS4303sp	45.5	2	4	2.3	35	2.4	4472	10.2	39.9	19.7
KS4402sp	43.0	5	9	1.1	34	2.4	2735	16.6	44.2	18.5
KS4702sp	43.3	4	8	2.1	32	2.3	2311	19.6	41.4	18.8
MACON	44.7	3	9-29	1.3	32	2.5	2739	16.6	39.8	20.1
KS4202	45.7	1	5	1.1	33	2.9	2683	16.9	41.2	20.3
BUBBA	38.5	7	9	1.3	35	2.4	2509	18.1	41.1	19.1
FG1	37.9	8	4	1.4	32	3.2	2219	20.5	41.7	19.6
KS4694	41.3	6	12	1.4	36	2.1	2822	16.1	40.4	19.3
LSD (.05)	5.3		3	1	3	1		2	2	1

Maturity = days earlier (-) or later than Macon Protein and oil % on a dry matter basis.

Table 2. Regional Quality Traits Test V over 2 years

		2003-2004							
		Yield	Yield Rank	Maturity	Lodging	Plant Height	Seed Size	Seed Quality	Yield vs. Checks
		17	17	12	16	17	10	14	
Entry	Strain	Bu/Ac	no.	Days	Score	Inches	g./100 seeds	Score	%
1	5601T	53.4	2	43	1.9	34.1	13.1	1.4	
3	**KS5005sp**	**48.1**	**5**	**39**	**2.0**	**23.2**	**25.5**	**1.6**	**89.9**
8	R95-1705	38.5	8	43	2.0	29.8	14.5	1.5	72.0
10	S00-9980-22	54.4	1	48	1.9	31.5	13.8	1.3	101.9
12	S01-9364	49.4	3	49	3.1	34.4	13.9	1.5	92.5
15	V98-9005	49.2	4	42	2.3	31.2	16.2	1.5	92.1
16	00WNV-07	45.0	6	45	2.3	28.3	14.1	1.5	84.3
17	99WNV-5	42.5	7	46	2.3	28.1	14.7	1.7	79.6

Table 3. Regional Quality Traits Test V over 2 years

		2003-2004						
			Composition, 13% moisture basis					
		Protein Content	Oil Content	Fiber Content	Carbohydrate Content	Meal Protein	EPV	EPVA Yield x EPV
Ent.	No. of Tests	13	13	13	13	13	13	13
#	Strain	%	%	%	%	%	$/bu	$/acre
1	5601T	38.1	17.7	4.8	21.4	51.2	8.05	430.22
3	**KS5005sp**	**39.2**	**17.2**	**4.7**	**20.9**	**52.1**	**8.04**	**386.57**
8	R95-1705	42.5	15.6	4.5	19.4	54.7	8.34	320.77
10	S00-9980-22	39.0	17.9	4.7	20.5	52.3	8.19	446.02
12	S01-9364	37.7	17.0	5.0	22.3	50.4	7.87	388.98
15	V98-9005	38.4	18.2	4.8	20.7	52.0	8.17	401.96
16	00WNV-07	36.7	18.8	4.8	21.6	50.3	8.01	360.87
17	99WNV-5	38.1	18.0	4.8	21.1	51.4	7.99	339.62

Table 4. 1999-2004 Kansas late-season specialty performance

Entry	Yield	Rank	Maturity	Lodging	Height	Seed Qual.	Seed Size	Seed Wt.	Protein	Oil
	bu/a			score	in	score	no / lb	g/100	%	%
KS5005sp	30.8	5	-9	1.2	24	2.5	1940	23.4	43.3	17.0
KS4702sp	31.0	4	-19	1.5	22	2.8	2271	20.0	41.0	18.4
KS5001sp	27.1	7	-6	0.9	24	2.0	4527	10.0	39.9	18.9
KS5003sp	27.8	6	-13	1.2	26	2.3	5023	9.0	40.4	19.8
KS5201sp	26.5	8	-7	1.6	36	2.0	4634	9.8	41.0	18.3
KS5202sp	32.0	1	-6	1.0	27	2.2	3707	12.2	42.3	18.7
KS5502N	31.2	3	Oct. 27	1.3	31	2.4	3545	12.8	38.1	18.8
MANOKIN	31.8	2	-9	1.7	32	2.5	3702	12.3	38.4	18.9
LSD (.05)	4		3	0.5	3	ns		2	2	1

Maturity - days earlier (-) or later than KS5502N Protein and oil % on a dry matter basis

2005 Conventional General-Use Soybean Varieties (NON-GMO):

While it is not a high priority for this project, we have continued to develop conventional, general-use varieties, where non-GMO production is needed or preferred. These elite varieties also serve as parents to develop new Roundup Ready® varieties. Because of funding of this project, we released KS5004N in this fiscal year. The sources of resistance to SCN in KS4602N, KS5004N, and KS5502N are unique to more than 90% of the private SCN-resistant varieties sold and in Kansas.

KS4202 is an F4 plant selection from the cross of KS4694 x C1842. KS4202 has purple flowers, gray pubescence, brown pods at maturity, indeterminate growth habit, and seeds with imperfect black hila and shiny seed coats. KS4202 is an early maturity group IV with resistance to Phytophthora root rot Race 7.

KS4602N is an F4 plant selection from the cross of Delsoy 4710 x KS4694. KS4602N has purple flowers, tawny pubescence, tan pods at maturity, indeterminate growth habit, and seeds with black hila and dull seed coats. KS4602N is a mid-group IV with resistance to Soybean Cyst Nematode Race 3 and Stem Canker.

KS5004N is an F4 plant selection from the cross of KS5292 x SC91-2007. KS5004N has white flowers, gray pubescence, tan pods at maturity, determinate growth habit, and seeds with imperfect brown hila and shiny seed coats. KS5004N is an early-group V with resistance to Soybean Cyst Nematode Race 3 (HG Type 0). KS5004N was evaluated in the Preliminary V regional trials in 2001, and in Uniform V trials in 2002 and 2003 (Table 5).

KS5502N is an F4 plant selection from the cross of Hartwig x KS4895. KS5502N has purple flowers, gray pubescence, brown pods at maturity, determinate growth habit, and seeds with imperfect black hila and shiny seed coats. KS5502N is a mid-group V with resistance to Soybean Cyst Nematode Races 2, 3, 4, and 14.

Table 5. Performance of KS5004N in Preliminary and Uniform V Tests, 2001-2003. (yield averages based on 41 locations)

	KS5004N (K1530)	MANOKIN
PARENTAGE	**KS5292 X SC91-2007**	L70-L3048 X D74-7824
YIELD (bu/a)	**45.0**	41.8
PROTEIN (%)	**41.0**	40.0
OIL (%)	**20.7**	20.6
MATURITY INDEX	**1+**	0
LODGING SCORE *	**1.8**	2.1
HEIGHT (in.)	**30**	29
SEED SIZE (g/100)	**12.3**	12.8
FLOWER COLOR	**White**	White
PUBESCENSE COLOR	**Gray**	Tawny
POD COLOR	**Tawny**	Tawny
STEM CANKER 2001, 2002, 2003	**R, R, R**	R, R, R
Soybean Cyst Nematode (SCN) Race 2 **, 2003, 2002, 2001	**5.0, 3.8, 3.3**	5.0, 4.7, 1.3
SCN Race 3, 2003, 2002, 2001	**1.0, 1.4, 1.7**	1.0, 1.0, 1.0
SCN Race 14, 2003, 2002, 2001	**5.0, 4.9, 2.4**	5.0, 4.7, 3.8
Meloidogyne incognita (M.I.)***, 2003, 2002	**1.0, 1.3**	1.5, 2.3
Meloidogyne arenaria (M.A.) , 2003, 2002	**5.0, 4.5**	3.8, 3.0
Soybean Mosaic Virus, 2003, 2002	**R, R**	S, S

* Lodging score, 1= erect and 5 = prostrate. ** SCN scores, 1 = 0-5 female cysts on roots, 2 = 6 to 10 female cysts on roots, 3 = 11-20 female cysts on roots, 4 = 21-40 female cysts on roots and 5 = > 40 female cysts on roots. *** M.I. and M.A. scores, 1 = resistant and 5 = susceptible.

2005 K-State Roundup Ready Soybean Lines:
This project has also provided support for the development of Roundup Ready® soybean varieties. The first two varieties from this program released in 2004 are now available for non-exclusive commercial licensing through the Kansas State University Research Foundation (KSURF). In addition to the two releases, several Roundup Ready® soybean lines are under evaluation and increase. Descriptions and performance data on the Roundup Ready® varieties available for release or testing in 2005 are presented in the following pages and in Tables 6 through 8.

Releases:
KS4404RR is an F3 plant selection from the cross of K1235///K1235//(Resnik2/40-3-2). KS4404RR has purple flowers, tawny pubescence, brown pods at maturity, indeterminate growth habit, and seeds with brown hila. KS4404RR is susceptible to soybean cyst nematode. KS4404RR is a mid-group IV (RM4.4) variety. A summary of its performance in Kansas is shown in Table 6.
KS4704RR is an F3 single plant selection from the cross KS4895///KS4895//(Resnik2/40-3-2).
KS4704RR has white flowers, tawny pubescence, brown pods at maturity, indeterminate growth habit, and seeds with brown hila. KS4704RR is susceptible to soybean cyst nematode. KS4704RR is a late group IV (RM 4.7) variety. A summary of its performance in Kansas is shown in Table 6.

Experimental Lines Available for Testing Only:
K1623RR, K1630RR, and K1631RR are selections from the cross Pioneer 9352////K1235///K1235//Resnik2/40-3-2. K1623RR is and early group III line; K1630RR and K1631RR are early group IV lines. The performance of these lines in Kansas and the Uniform Regional trials is shown in Tables 6 through 8.

K4202RR is a backcross-derived Roundup Ready® version of the early group IV Kansas release KS4202.

K4602NRR is a backcross-derived Roundup Ready® version of the mid-group IV Kansas release KS4602N which carries soybean cyst nematode (SCN) resistance from PI209332.

K1463NRR is a backcross-derived Roundup Ready® version of an early-group V Kansas line K1463 which carries SCN resistance from Hartwig.

K5502NRR is a backcross-derived Roundup Ready® version of the early-group V Kansas release KS5502N which carries SCN resistance from Hartwig.

Table 6. Performance of K-lines in Kansas trials.

Entry	Yield	Mat.	Lod.	Ht.
a. 2002-2004 Eastern KS Trials, 36 tests				
KS4404RR	43.5	35	1.5	31
KS4704RR	43.5	36	1.5	31
K1630RR	46.1	32	1.0	29
K1631RR	45.5	33	1.4	33
ASGROW AG4403	44.8	35	1.3	33
PIONEER 93B85	42.0	29	1.3	31
LSD (0.1)	2.0	1	0.3	2
b. 2001-2004 Kansas Statewide Trials, 48 tests				
K1623RR	47.8	28	1.1	29
ASGROW AG3702	45.8	27	1.2	31
PIONEER 93B85	47.4	28	1.3	32
LSD (0.1)	NS	NS	NS	1

YIELD IN BUSHELS PER ACRE
MAT - MATURITY IS DAYS AFTER AUGUST 31
LOD - LODGING A SCORE FROM 1(GOOD) TO 5(POOR)
HT - PLANT HEIGHT IN INCHES

Table 7. UNIFORM TEST III Roundup-Ready, 2004

REGIONAL SUMMARY

	Yield	Rank	Maturity	Lodging	Plant Height	Seed Size	Seed Quality	Composition Protein	Composition Oil
No. of Tests	13	13	12	14	13	12	12	5	5
Strain	bu/a	No.	Date	Score	In.	g/100	Score	%	%
AG3401	62.2	3	9/23	1.7	36	15.4	3.0	40.7	18.9
AG3003	59.8	9	-3.8	1.3	32	14.3	3.0	40.6	18.8
AG3201	60.7	7	-5.3	1.5	33	14.9	3.0	40.2	18.6
DKB38-52	62.0	5	0.6	1.3	32	15.0	2.7	40.1	18.9
LD01-11410	56.6	10	-6.3	1.4	31	14.1	2.8	38.6	19.4
K1623RR	62.8	1	-2.3	1.5	32	16.3	2.9	40.3	19.6
NEX3003JR	60.3	8	-5.3	1.5	33	16.4	2.9	40.8	19.2
NEX3203HR	62.5	2	-3.4	1.2	29	15.3	2.9	39.6	19.0
NEX3301H2R	60.9	6	-4.9	1.4	29	17.4	3.3	39.7	19.0
NEX8903	62.1	4	-3.7	1.3	32	15.2	2.9	40.0	18.6

Table 8. UNIFORM TEST IV Roundup-Ready, 2004

REGIONAL SUMMARY

	Yield	Rank	Maturity	Lodging	Plant Height	Seed Size	Seed Quality	Composition Protein	Composition Oil
No. of Tests	15	15	15	16	16	14	14	5	5
Strain	bu/a	No.	Date	Score	In.	g/100	Score	%	%
AG4201	63.6	2	9/26	1.8	36	16.6	1.7	41.1	18.8
DKB38-52	58.7	9	-6.0	1.3	33	14.5	1.7	39.5	19.6
MPV 457RR	60.8	4	3.0	2.0	39	16.1	1.7	41.3	18.4
AG4403	64.6	1	0.5	1.6	38	14.6	1.5	40.1	20.1
K1594RR	57.6	12	1.2	2.0	35	15.6	1.7	41.9	19.1
K1624RR	57.7	11	2.9	2.4	36	13.5	1.8	41.5	19.2
K1625RR	57.4	13	-0.2	2.3	40	14.7	1.6	41.0	19.6
K1626RR	59.1	7	-2.5	1.5	33	15.9	1.8	40.1	20.6
K1627RR	56.8	14	-0.7	2.3	38	13.7	1.7	39.8	20.5
K1628RR	58.9	8	0.8	1.7	37	15.1	1.6	39.9	20.1
K1629RR	58.1	10	-1.2	2.0	36	13.3	1.6	41.2	19.2
K1630RR	61.6	3	-1.3	1.3	33	17.3	1.8	40.1	19.9
K1631RR	60.1	5	0.6	1.9	38	15.2	1.7	38.7	19.6
Md 01-014 RR	53.0	18	-7.1	2.2	36	16.4	1.7	41.9	18.9
Md 01-017 RR	53.9	17	-7.4	2.2	34	16.7	1.7	42.0	19.2
Md 01-063 RR	55.9	15	-1.4	1.5	37	16.4	1.5	42.8	18.4
Md 01-329 RR	59.4	6	-3.4	1.3	36	15.0	1.6	41.8	18.9
S02-670CR	55.5	16	4.7	2.3	42	16.6	1.7	40.9	19.3

GERMPLASM DEVELOPMENT:

We have continued to use genetic engineering technology to reduce or eliminate phospholipids degradation and preserve the amount of phospholipids (PLD) in soybean seed. Post-harvest degradation of PLD deteriorates the nutrient quality of soybean oil during the long-distance shipment or long-term storage of seed. Phospholipase D may be involved in the first step of phospholipids degradation. To date, we have obtained ten transgenic lines through T_0 to T3 generations. Two T_2 transgenic lines showed accumulation of PLD proteins and PLD enzyme activities in soybean seed that were 27% to 80% less than those in non-transgenic soybeans. From reports in model systems, we assume that transgenic soybean seed may be stored for a longer period without degrading phospholipids and cell membranes. To confirm this assumption, phospholipids and fatty acid profiling of transgenic soybean seed is under evaluation. We have also submitted an application to conduct the first evaluation of this genetic material in the field. If our application is approved, the transgenic lines will be evaluated for agronomic characteristics in replicated plots in the field in 2005.

Irrigated Cropping Systems to Reduce Groundwater Depletion while Sustaining Profitability

RESEARCHERS AND UNITS:
Alan J. Schlegel, Southwest Research-Extension Center; Loyd Stone, Dept. of Agronomy; Troy Dumler, Southwest Area Extension Office

FUNDS (FY05): $8,000

FINAL REPORT: March 1, 2004 to February 28, 2005

JUSTIFICATION: Most groundwater pumped from the High Plains (Ogallala) Aquifer in western Kansas is used for irrigation, with corn being the predominant crop. Groundwater withdrawal from the aquifer has reduced saturated thickness and well capacities. Although corn responds well to irrigation, it also requires substantial amounts of water to maximize production. Alternative crop-management practices are needed to reduce the amount of irrigation water required while striving to maintain economic returns sufficient for producer (and community) sustainability. To prepare for less water being available for irrigation in the future, whether from physical constraints (reduced well capacities and declining water tables) or from regulatory limitations, information on crop productivity and profitability with less irrigation water will be beneficial for agricultural sustainability.

PROJECT OBJECTIVES:

1. Determine crop rotations that can be used with limited irrigation to reduce irrigation water use while maintaining producer profitability.
2. Determine the impact of limited irrigation on crop yield and profitability.

RESULTS:

Limited Irrigation study: Crop yields were good in 2004, particularly for corn. Precipitation from June through August was 11.49inches (47% above normal). Corn yields were 40 bu/a greater with 10 inches than with 5 inches of irrigation (Table 1), but there was little or no increase in yields of the other crops with increased irrigation (<10%). Sorghum yields were lower than expected, possibly partly due to wet weather delaying harvest until late November.

Table 1. Grain yield of four crops in 2004, as affected by irrigation amount.

Irrigation amount	Corn	Sorghum	Soybean	Sunflower
inches	- - - - - - - - - - - - bu/acre - - - - - - - - -			lb/acre
5	204	111	49	2532
10	245	103	52	2607
15	260	106	49	2775

An economic analysis found that, at the lowest irrigation rate, net returns were best for corn in 2004 (Table 2) because of the exceptional corn yields of more than 200 bu/a with only 5 inches of irrigation. At the lower irrigation rates, the next-most-profitable crops were soybean and sunflower. At the highest irrigation level, corn was also the most profitable crop. Corn was the only crop for which profitability increased with more than 5 inches of irrigation.

Table 2. Net return to land, irrigation equipment, and management for four crops in 2004, as affected by irrigation amount.

Irrigation amount	Corn	Sorghum	Soybean	Sunflower
inches	- - - - - - - - - - annual net return, $/acre - - - - - - - -			
5	166	24	92	109
10	219	-11	85	96
15	228	-24	53	98

In 2004, the original plots in the limited irrigation study were split, and a ~20% higher seeding rate for each crop was added. The original seeding rates were 30,000 for corn, 80,000 for sorghum, 150,000 for soybean, and 23,500 for sunflower. The same hybrids were used for each crop except for sorghum, for which a longer-season hybrid was planted at the higher population. For soybean, the higher seeding rate tended to increase yields at the higher irrigation amounts (Table 3). For corn, the higher seeding rate tended to reduce yield at the lower irrigation rate, but had no effect at the higher irrigation amounts. With sunflower, results were mixed, with slightly lower yields at both the low and high irrigation amounts with higher seeding rate. Sorghum yields were greater with the higher seeding rate, but because this also involved a different hybrid, it is not possible to determine which factor affected yield.

Table 3. Grain yield of four crops in 2004, as affected by irrigation amount and seeding rate.

Irrigation amount	Corn	Sorghum	Soybean	Sunflower
inches	- - - - - - - - - - - - bu/acre - - - - - - - - -			lb/acre
5	204 (178)	111 (134)	49 (43)	2532 (2253)
10	245 (240)	103 (140)	52 (55)	2607 (2748)
15	260 (256)	106 (126)	49 (56)	2775 2482)

The values in parentheses are with a ~20% greater seeding rate.

Crop Rotation study: Grain yields of all crops except wheat were very good in 2004. The wheat in all rotations followed corn and received 5 inches of irrigation. Wheat yields were severely reduced by a freeze in mid-May (Table 4). All rotations were limited to 10 inches of irrigation, but the corn following wheat received 15 inches because the wheat only received 5 inches. This extra 5 inches of irrigation increased corn yields about 30 bu/a, compared with yield of the continuous corn (which only received 10 inches of irrigation). Corn yields were similar following wheat, sorghum, or soybean, as were sorghum yields in the 3- and 4-yr rotations.

Table 4. Grain yield of four crops, as affected by rotation in 2004.

Rotation	Corn	Sorghum	Soybean	Sunflower
		- - - - - - - - - - - - bu/acre - - - - - - - - -		
Cont. corn	210	--	--	--
Corn-wheat	243	28	--	--
Corn-wheat-sorghum	239	27	138	--
Corn-wheat-sorghum-soybean	239	29	145	58

An economic analysis was performed to determine returns to land, irrigation equipment, and management for all four rotations. Because of the poor wheat yields and good corn yields, all returns for the multi-crop rotations were less than for continuous corn. The economic return to continuous corn was $160/a, compared with $80 to $94/a for all other rotations.

SIGNIFICANCE OF RESULTS:

Because of changes in growing conditions, the most profitable crop changes from year to year, so that there is not a single best crop. Growing different crops when irrigation is limited can reduce risk and increase profitability. In 2004, corn was the most profitable crop at all irrigation amounts. In multi-crop rotations, relatively poor results with one crop can reduce profitability, compared with a monoculture, when the monoculture crop does very well, but the multi-crop rotation may reduce economic risk when the monoculture crop does not perform so well.

SPENDING REPORT

019 SL ACCOUNT SUMMARY SWREC KS SOYBEAN
DATE: 03/14/05 FY: 05
SCREEN: ACCT: 526218 SUBTOTAL OPTION: A1 PRINT SUBTOTAL: O
FUND: 2697 1100
DEPARTMENT: 10235 RESP PERSON: SCHELGEL A
MAP CODE: 26218 FLAGS: DEL FRZ RVW DRP SUP ABR
0 0 0 0 1 5

OBJ	DESCRIPTION	BUDGET	ACTUAL	ENCUMB	AVAIL
	SALARIES,WAGE	3,923.00	1,931.63	0.00	1,991.37
	CONTRACTUAL S	1,500.00	2,250.39	0.00	750.39-
	TRAVEL	1,000.00	1,261.19	0.00	261.19-
	OTH CONTR SER	600.00	46.20	0.00	553.80
	MATERIALS & S	977.00	2,353.77	0.00	1,376.77-
	TOTAL DIRECT	8,000.00	7,843.18	0.00	156.82
	TOTAL EXPENSE	8,000.00	7,843.18	0.00	156.82
	ACCOUNT TOTAL	8,000.00	7,843.18	0.00	156.82

Enhancement of Soybean through Genetic Engineering

RESEARCHERS AND UNITS:
Harold N. Trick, Dept. of Plant Pathology; Subbaratnam Muthukrishnan, Dept. of Biochemistry; and William T. Schapaugh, Dept. of Agronomy; Tim C. Todd, Dept. of Plant Pathology

FUNDS (FY 04): $56,369 **Completion Date:** 6/06

JUSTIFICATION: Decreasing yield loss and increasing the value of soybeans is part of KSU's mission to improve Kansas agriculture. Our proposal is taking a genetic engineering approach to this mission, allowing us to utilize traits outside the scope of conventional breeding.

OBJECTIVES:

1. Continue to produce and evaluate genetically engineered soybean for **increased fungal resistance.**
2. Introduce and evaluate two separate approaches to **increase Soybean Cyst Nematode (SCN) and insect resistance** in transgenic soybean.

RESULTS: Gene expression profiles continue for lines with multiple pathogenesis genes. We have identified three lines that express two or more potential antifungal genes at the second generation. These plants have been harvested and protein analyses are being performed on the seeds. The NPR1 gene from Arabidopsis has been subcloned behind the actin promoter for soybean expression. Transformation with this gene is expected to begin in August.

The three transgenic lines containing the male sterility gene continues to show partial resistance to SCN. A total of eight lines have been placed in the field for seed increase. Although our intent is for seed increase, we will also look at nematode infections, as compared with that in the non-engineered control plants. We have been actively working on two separate molecular biology projects associated with enhancing our methods to screen potential SCN resistance genes by using our RNAi (interference RNA) approach. First we are developing a new approach to rapidly clone SCN sequences into a RNAi vector. Rather than using our previous method of using multiple subcloning steps to introduce two separate parts of our transgene into a soybean expression vector, we now can directly clone a PCR fragment into a new expression system in two steps. Our previous method could take up to three months to complete the vector ready for transformation; this new approach can take less than a week. We have successfully used this technique in a similar project in rice. The first soybean construct completed was the male sterility gene. Repeating this gene will show proof of concept, based on data compiled from our current research. We have also identified multiple genes for this method and are beginning to design PCR primers to amplify the gene sequences.

The second approach to increase efficiency is to infect seedlings by using *Agrobacterium* with the transgenes, and to have the *Agrobacterium* genetically modify the roots. Although the entire plant will not be genetically modified, this method has the potential to generate genetically engineered roots in as fast as two months, and they should be ready for a simple SCN assay shortly after that. We should be able to greatly boost our efficiency, compared with the current time of over a year, once this approach is fully developed.

SIGNIFICANCE OF RESULTS: Resistance to soybean cyst nematode can be found in some germplasms of soybean, but these traits have not been put into Kansas-adapted varieties, and most traits do not provide a broad-spectrum resistance to all races of SCN. Our RNAi approach to SCN protection may give us broad-spectrum resistance. Our synthetic DNA sequences developed for SCN control are designed to affect all races of SCN. If successful, this will stabilize yield losses due to SCN infestations. Fungal pathogens are another biotic stress on Kansas soybeans, and eliminating them will also stabilize yield loss. Potential yield gains by the elimination of both fungal pathogens and SCN could exceed 10 of millions of bushels per year in Kansas alone.

Development of Barley Yellow Dwarf-Resistant Wheat Cultivars for Kansas

RESEARCHERS AND UNITS:
William W. Bockus, Dept. of Plant Pathology

Cooperators: In addition to K-State Research and Extension, funding is from the Kansas Wheat Commission. Cooperating departments include Plant Pathology, Agronomy (Dr. Fritz), and the USDA/ARS (Drs. Bowden and Brown-Guedira).

IMPACT REPORT: July 1, 2001 – June 30, 2005

PROGRAM: Barley Yellow Dwarf (BYD) is an important virus disease of small grains, including wheat. As a result of extensive surveys that were begun in Kansas in 1976, losses due to various wheat diseases have been estimated each year. From 1976 through 1986, there was only one year in which BYD caused a loss greater than 1%; during nine of the past 16 years, however, BYD has caused a loss greater than 1%. In addition, it was the most important wheat disease in the state in 2000 and 2002, and measured losses on individual susceptible cultivars can exceed 35%. Because of the increasing importance of this disease in Kansas and the potential for significant damage, control measures should be sought to help producers reduce losses from BYD. Although there are cultural and chemical control methods for BYD, they either are not very effective, are expensive, or do not fit into popular cropping practices. As an example, late planting helps reduce BYD, but growers frequently desire to plant early for grazing purposes or because soil moisture is adequate early in the fall. Similarly, seed treatment with a systemic insecticide can kill the aphid vectors of the pathogen and help reduce BYD, but seed treatment is expensive and only provides about 50% control. Therefore, genetic resistance offers the best hope for economic management of this disease.

OBJECTIVES:

1. Develop an accurate, useful method to identify the reaction of wheat germplasm to barley yellow dwarf.
2. Determine the reaction of common commercial wheat cultivars in Kansas to barley yellow dwarf.
3. Assemble, from other states and countries, wheat germplasm lines that are reported to be resistant to barley yellow dwarf, and verify the resistance.
4. Establish screening nurseries for wheat breeders and geneticists to screen Kansas breeding lines for reaction to barley yellow dwarf.

RESULTS: Field experiments were planted in mid-September during each year of the study at a site that routinely has moderate to severe pressure from barley yellow dwarf (BYD). The experiments included four winter wheat cultivars chosen for their differing levels of reaction to BYD. There were two treatments and five replications for each cultivar. The treatments included a “healthy check” and a “diseased check” to allow calculation of yield loss from BYD. The healthy treatment involved protecting the wheat with seed-treatment and foliar insecticides and covering plots during the fall with

wood and metal frames covered with insect-proof screens. This provided a way to protect wheat from inoculation of the BYD virus by aphids during the important fall infection period. Plant tissue from each plot was sampled several times, and ELISA diagnostic tests were used to determine the amount of virus in the tissue at those times. During all years, the most prevalent strain of the BYD virus was pav, although strain rpv was also abundant. In addition, the percentage plants in each plot showing symptoms, percentage stunting, head density, average head length, and the percentage darkened heads were determined several times each year. After harvest, the various methods and times to assess disease reaction were correlated with yield loss from BYD. On the basis of the results, the assessment method with the greatest utility to predict yield loss was an estimation of the amount of stunting and loss of head density. This method is being used in small breeding plots to quantify the reaction of Kansas cultivars to BYD and to begin the selection of breeding germplasm for resistance. Finally, 14 researchers around the world were contacted with a request to obtain wheat germplasm that shows resistance to BYD. Small amounts of seed from some of those cooperators were received and were increased in the greenhouse. Some of these lines have been used by the KSU breeding program in a "crossing block" to attempt to combine resistance genes from several sources and incorporate increased levels of resistance to BYD into germplasm adapted to Kansas.

SIGNIFICANCE OF RESULTS: The greatest constraint to developing wheat cultivars for Kansas with increased resistance to BYD is the lack of a disease assessment method that is a good predictor of the amount of damage that BYD has done to a wheat line. Therefore, the first objective to solving this problem was to develop an accurate, practical method to screen breeding material in the field for reaction to BYD that correlates with yield loss. After comparison of numerous methods to evaluate BYD, the following procedure has been developed. A split-plot design works the best, in which "healthy" and "diseased" plots are placed side by side. A technique for maintaining healthy plots was developed in which the seed is treated with a systemic, seed-treatment insecticide (Guacho) that protects emerging plants from the insect vector. This is followed by a foliar insecticide (pyrethrin) to protect plants after establishment. With such side-by-side comparisons, the amount of stunting and density reduction can be rapidly visually estimated. This assessment method is now being used in small plots to test current commercial Kansas cultivars, breeding material, and germplasm from around the world that has been reported to be resistant to BYD. Results will be disseminated to wheat producers by current KSU Extension bulletins and disseminated to wheat breeders. Genes from promising lines will be incorporated into Kansas breeding programs. The long-term goal of this research is to develop high yielding, high quality, hard, red or white winter wheat cultivars adapted for Kansas with improved resistance to barley yellow dwarf.

NEXT STEPS: Numerous wheat lines will be screened for reaction to BYD. Lines will include common commercial Kansas cultivars, breeder's seed, and entries from around the world. The disease assessment method developed and described above will be used to evaluate the reaction of these lines.

Faculty Time Invested 15%

Potential Economic Impacts from the Introduction of Genetically Modified Wheat on the Export Demand for U.S. Wheat

RESEARCHERS AND UNITS:
John Crespi, Andrew Barkley, and Sean Fox, Dept. of Agricultural Economics; Thomas Marsh, formerly of KSU Agric. Econ., now at Washington State; Sarah Grunewald, Graduate Student, Dept. of Agricultural Economics

FUNDS (FY 04): $12,627 **Completion Date:** May 5, 2005

JUSTIFICATION: The introduction of GMOs may affect the demand for Kansas and U.S. wheat. This study sought to determine whether the benefits from introducing the new wheat outweighed the potential costs from a decline in trade with nations whose consumers oppose the technology.

OBJECTIVES: Because genetically modified wheat has not yet been adopted, no data exist to discern the effect of the product on consumer demand and, hence, international trade. As such, this study uses an economic model of U.S. wheat trade that incorporates data and findings from previous research on the wheat market to provide an "educated guess" about any potential trade impact. Once the model has been developed to simulate the current status of U.S. wheat trade in the absence of genetically modified wheat, counterfactual simulations are performed under two different trade scenarios. Under the first scenario, both genetically modified and conventional wheat are mixed upon the world market. Under the second scenario, there is some type of segregation so that only wheat from the United States is implicated by the biotechnology adoption. In both of these scenarios, various hypotheses of cost savings from the new technology are coupled with hypothetical demand changes overseas in both short- and long-run simulations.

RESULTS: The results show that if wheat is not segregated, the gains to U.S. wheat producers from the adoption of genetically modified wheat are more likely to be favorable than if the wheat is segregated. Specifically, if the cost savings are similar to what Monsanto has predicted, then the fall in importers' willingness to pay for mixed wheat must be rather large to erase U.S. producers' gains from using the technology. Even in a long-run scenario in which U.S. wheat may be more substitutable, with per-unit cost savings greater than 10 percent, importers' willingness to pay for mixed wheat must fall by more than 42 percent before the profits to U.S. producers are erased. This seems to us to be a rather large and unlikely decline in willingness to pay for wheat and is greater than that predicted by other research.

On the other hand, if wheat is allowed to be segregated, then the utility of genetically modified wheat becomes questionable. Under this scenario, because U.S. wheat would be identifiable, the export demand for U.S. wheat is clearly more heavily implicated than in the no-segregation scenario. In this case, for example, if the per-unit cost savings are 10 percent, importers' willingness to pay for U.S. wheat need only fall a rather modest 15 percent in the long run to erase any profits from the adoption of the new technology. Even if cost savings are on the order of 20 percent per unit, given predicted willingness-to-pay declines of 35 percent in other studies, the adoption of genetically modified wheat seems unwise.

SIGNIFICANCE OF RESULTS: Of course, the two most important hypotheses in this study are based upon the two pieces of information for which the most uncertainty exists: how much will the cost savings be, and how much will demand be affected by the introduction of the genetically modified product into the food supply? In this study, we investigate a variety of possibilities, but no one will know the real answer to these questions until the product comes to market. This obviously is true of any marketing enterprise. Because the potential gains, as well as the potential losses, are so large, perhaps caution and study are more prudent at this time. We recommend that although U.S. wheat producers continue to push biotech companies and research institutions for better and better data of the effects of genetic modification on yields and costs of production, producers should also seek more answers to demand-side questions. Funding studies that try to determine consumer acceptance and willingness to pay for genetically modified foods, as well as funding greater education of the public about these foods, seems like money well spent at this time.

Consumer Acceptance of Genetically Modified Wheat

RESEARCHERS AND UNITS:
Sean Fox, John Crespi, Thomas Marsh, and Andrew Barkley. Dept. of Agricultural Economics

FUNDS (FY 04): $15,127 **Completion Date:** 6/30/2005

JUSTIFICATION: The introduction of genetically modified wheat has the potential to reduce production costs but may also decrease the value of wheat if consumers reject wheat products made from GM varieties.

OBJECTIVES: Use a mail survey to investigate consumer acceptance of GM wheat products, and to estimate the impact of negative information about GM disseminated by opponents of biotechnology.

RESULTS: Our survey of Kansas City metro-area consumers investigated the impacts of - (a) negative information about GM, and (b) informing respondents that most wheat-based products already include some GM ingredients – on consumer acceptance of GM wheat.

Results indicate that 68 % of respondents would likely continue to purchase the bread they currently buy if they discovered that it contained GM wheat. Only 7% would not buy bread containing GM wheat. Negative information about GM had a significant impact - respondents who received negative information were 17% less likely to purchase GM bread. Informing respondents about GM ingredients already in wheat products did not counter the impact of that negative information.

SIGNIFICANCE OF RESULTS:
Our results suggest that adoption of GM wheat would not significantly impact U.S. domestic demand for wheat-based products. Only 7% would not buy "GM bread." Furthermore, we found that respondents who reported higher levels of wheat product consumption were significantly more likely to accept GM. This is an important finding because it indicates that surveys measuring the proportion of consumers who would accept/reject GM wheat will tend to overstate any potential negative impact on demand. Because the potential impact on domestic demand seems relatively small, the decision on whether to adopt GM wheat should be guided by potential impacts in export markets.

Developing Multiple Pest Resistant Wheat Germplasm

RESEARCHERS AND UNITS:
Allan Fritz and G.L. Brown-Guedira, Agronomy

FUNDING: $6,000 **Completion Date:** Ongoing

Progress Report: Final--FY05 (July 1, 2004-June 30, 2005)

JUSTIFICATION:
Continued improvement by plant breeding requires the utilization of new sources of variation. This project has focused on the introgression of new resistances from wild and unadapted sources into germplasms that are useful to wheat breeders in the Great Plains. An increasing focus has been placed on the development of germplasm lines with resistance to multiple pests.

OBJECTIVES: Develop germplasms with resistance to key disease and pests in the Southern Great Plains.

RESULTS: Materials with minor gene resistance to leaf rust continue to be evaluated and are very promising. Progress has also been made on the mapping of some of these genes. Also, progress has been made on development of germplasms that combine resistance to leaf rust, Septoria leaf blotch, and wheat curl mite. Other germplasm in the program provides resistance to powdery mildew, leaf rust, stripe rust, Hessian fly, and other wheat pests. The lines developed in this program are prominent in the pedigrees of experimental lines in the Kansas State wheat breeding program and other breeding programs in the region.

SIGNIFICANCE OF RESULTS: This research is focused on the development of new sources of resistance to combat major pests of wheat in the Great Plains. Among the varieties that have been released that have used germplasm developed in this program are Thunderbolt, Overley, and Fannin.

019 SL ACCOUNT SUMMARY AGRON KS WHEAT COMM
DATE: 12/20/04 FY: 05
SCREEN: ACCT: 521041 SUBTOTAL OPTION: A1 PRINT SUBTOTAL: O
FUND: 2697 1100
DEPARTMENT: 10040 RESP PERSON: FRITZ A
MAP CODE: 21041 FLAGS: DEL FRZ RVW DRP SUP ABR
0 0 0 0 1 5

OBJ	DESCRIPTION	BUDGET	ACTUAL	ENCUMB	AVAIL
	SALARIES,WAGE	5,000.00	1,376.08	0.00	3,623.92
	OTH CONTR SER	0.00	141.80	0.00	141.80-
	MATERIALS & S	1,000.00	0.00	0.00	1,000.00
	TOTAL DIRECT	6,000.00	1,517.88	0.00	4,482.12
	TOTAL EXPENSE	6,000.00	1,517.88	0.00	4,482.12
	ACCOUNT TOTAL	6,000.00	1,517.88	0.00	4,482.12

4-⌐ 1 KSUVM 129.130.12.1 4/10

019 SL ACCOUNT SUMMARY AGRON KS WHEAT COMM
DATE: 07/01/05 FY: 05
SCREEN: ACCT: 521041 SUBTOTAL OPTION: A1 PRINT SUBTOTAL: O
FUND: 2697 1100
DEPARTMENT: 10040 RESP PERSON: FRITZ A
MAP CODE: 21041 FLAGS: DEL FRZ RVW DRP SUP ABR
0 0 0 0 1 5

OBJ	DESCRIPTION	BUDGET	ACTUAL	ENCUMB	AVAIL
	SALARIES,WAGE	5,000.00	3,882.41	0.00	1,117.59
	OTH CONTR SER	0.00	523.08	0.00	523.08-
	MATERIALS & S	1,000.00	366.00	0.00	634.00
	TOTAL DIRECT	6,000.00	4,771.49	0.00	1,228.51
	TOTAL EXPENSE	6,000.00	4,771.49	0.00	1,228.51
	ACCOUNT TOTAL	6,000.00	4,771.49	0.00	1,228.51

Improvement of Hard Red Winter Wheat for Kansas

RESEARCHERS AND UNITS:
Allan Fritz, Dept. of Agronomy, and Joe Martin, Fort Hays Branch Experiment Station

FUNDING: $107,000 **Completion Date:** Ongoing

Progress Report: Final Report FY05 (July 1, 2004-June 30, 2005)

JUSTIFICATION: More than two-thirds of the wheat planted in Kansas in 2005 was planted to varieties developed at KSU. Continued effort is needed to deliver varieties that meet the changing needs of Kansas wheat producers.

OBJECTIVES: Develop hard red winter wheat varieties adapted to Kansas.

RESULTS: Overley performed very well in its primary area of adaptation in 2005 and should increase in acreage for 2006. Significant progress has also been made on the introgression of minor gene resistance for leaf and stripe rust. The minor gene lines entered in the 2005 KIN did not perform as well as expected, but still are good parental material, and minor gene resistance in an Overley background performed well in 2005. The leaf/stripe rust nursery in Texas continues to be a critical location for the selection of improved resistance to these diseases. Lines derived from the shuttle selection scheme using a location in Lane County performed very well in 2005, and will be tested on a larger scale in 2006. Several promising lines are entering advanced yield testing. One line (KS00F5-14-7) may be put on increase in July of 2005, pending harvest results. This line has yield performance similar to Overley in central Kansas, stronger resistance to leaf rust, and the potential to be adapted to a larger geographic area. Research projects within the breeding program identified QTL for tolerance to heat and drought. Experiments to confirm these results are under way and groundwork for future marker-assisted selection work is being laid. Progress has also been made on the introgression of key traits into Kansas germplasm. These include, but are not limited to, barley yellow dwarf virus resistance, high grain protein content, resistance to Karnal bunt, and wheat streak mosaic virus resistance.

SIGNIFICANCE OF RESULTS: This research is part of a continuing effort to develop new wheat varieties for Kansas wheat producers and the wheat industry. Continued effort is needed to address production constraints and improve quality parameters.

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 019 SL ACCOUNT SUMMARY                          AGRON KS WHEAT COMM
 DATE: 12/20/04                                                    FY: 05
 SCREEN:     ACCT: 521042      SUBTOTAL OPTION: A1  PRINT SUBTOTAL: O
             FUND: 2697 1100
       DEPARTMENT: 10040      RESP PERSON: FRITZ A / MARTIN T
         MAP CODE: 21042            FLAGS: DEL FRZ RVW DRP SUP ABR
                                            0   0   0   0   1   5
 OBJ  DESCRIPTION           BUDGET          ACTUAL          ENCUMB          AVAIL
 ---- ------------- --------------- -------------- -------------- --------------
      SALARIES,WAGE      89,042.00      29,266.75           0.00      59,775.25
      CONTRACTUAL S       2,000.00         814.31           0.00       1,185.69
      TRAVEL              3,958.00         698.50           0.00       3,259.50
      OTH CONTR SER       2,000.00         170.00           0.00       1,830.00
      MATERIALS & S      10,000.00       1,365.54           0.00       8,634.46
      TOTAL DIRECT      107,000.00      32,315.10           0.00      74,684.90
      TOTAL EXPENSE     107,000.00      32,315.10           0.00      74,684.90
      ACCOUNT TOTAL     107,000.00      32,315.10           0.00      74,684.90
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4-⌐               1 KSUVM     129.130.12.1                              4/10
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 019 SL ACCOUNT SUMMARY                          AGRON KS WHEAT COMM
 DATE: 07/01/05                                                    FY: 05
 SCREEN:     ACCT: 521042      SUBTOTAL OPTION: A1  PRINT SUBTOTAL: O
             FUND: 2697 1100
       DEPARTMENT: 10040      RESP PERSON: FRITZ A / MARTIN T
         MAP CODE: 21042            FLAGS: DEL FRZ RVW DRP SUP ABR
                                            0   0   0   0   1   5
 OBJ  DESCRIPTION           BUDGET          ACTUAL          ENCUMB          AVAIL
 ---- ------------- --------------- -------------- -------------- --------------
      SALARIES,WAGE      79,042.00      59,409.39           0.00      19,632.61
      CONTRACTUAL S       2,000.00       2,466.92           0.00         466.92-
      TRAVEL              3,958.00       5,902.23           0.00       1,944.23-
      OTH CONTR SER       2,000.00         598.00           0.00       1,402.00
      MATERIALS & S       6,000.00       5,163.14           0.00         836.86
      EQUIPMENT          14,000.00      15,500.00           0.00       1,500.00-
      TOTAL DIRECT      107,000.00      89,039.68           0.00      17,960.32
      TOTAL EXPENSE     107,000.00      89,039.68           0.00      17,960.32
      ACCOUNT TOTAL     107,000.00      89,039.68           0.00      17,960.32
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4-⌐               1 KSUVM     129.130.12.1                              4/10
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Improvement of Hard White Winter Wheat for Kansas

RESEARCHERS AND UNITS:
Allan Fritz and G.M. Paulsen, Dept. of Agronomy

FUNDING: $52,000 **Completion Date:** Ongoing

Progress Report: Final--FY05 (July 1, 2004-June 30, 2005)

JUSTIFICATION: More than two-thirds of the wheat planted in Kansas in 2005 was planted to varieties developed at KSU. Continued effort is needed to continue to deliver varieties that meet the needs of Kansas wheat producers.

OBJECTIVES: Develop hard white winter wheat varieties adapted to Kansas.

RESULTS: Several new promising white-seeded lines were identified and tested in 2005. The changes instituted in the nursery program continue to be beneficial to the breeding effort. The races of leaf rust that emerged on a large scale in 2005 were present in our Texas leaf rust nursery as early as 2002. This allowed us to adjust our parental selection for crossing, saving at least two years of breeding work. The nursery in Lane County was a success; we were able to select plants that performed well under drought conditions and were less prone to shatter. This nursery will help us to identify wheats with better adaptation to all of Kansas. Populations with sources of tolerance to preharvest sprouting continue to progress through the program. Promising materials with tolerance based on both the Cayuga source of tolerance and tolerance from the Hays materials were evaluated in head rows in 2005. Once we confirm tolerance to sprouting, these materials will be crossed with other white wheats with adaptation to central Kansas in the Fall of 2005. We experienced some sprouting in the fields at Hutchinson and Manhattan in 2005, but will rely primarily on artificial screening methods. Research projects within the breeding program identified QTL for tolerance to heat and drought. Experiments to confirm these results are under way, and groundwork for future marker-assisted selection work is being laid. A series of three white wheats with tolerance to barley yellow dwarf virus were tested in 2005 and performed well enough to be submitted for quality analysis. The program has more high-yielding white wheat lines with critical characters for adaptation to central Kansas than at any time since the PI arrived in 2000. The program is well positioned to transition toward more white wheats once issues with preharvest sprouting are addressed.

SIGNIFICANCE OF RESULTS: This research is part of a continuing effort to develop new wheat varieties for Kansas wheat producers and the wheat industry. Continued effort is needed to address production constraints and improve quality parameters.

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 019 SL ACCOUNT SUMMARY                          AGRON KS WHEAT COMM
 DATE: 12/20/04                                                  FY: 05
 SCREEN:     ACCT: 521040      SUBTOTAL OPTION: A1  PRINT SUBTOTAL: O
             FUND: 2697 1100
       DEPARTMENT: 10040      RESP PERSON: FRITZ A
         MAP CODE: 21040            FLAGS: DEL FRZ RVW DRP SUP ABR
                                            0   0   0   0   1   5
 OBJ  DESCRIPTION          BUDGET          ACTUAL         ENCUMB          AVAIL
 ---- ------------ -------------- -------------- -------------- --------------
      SALARIES,WAGE      35,957.00       8,093.41           0.00      27,863.59
      TRAVEL              2,000.00           0.00           0.00       2,000.00
      OTH CONTR SER       4,000.00           0.00           0.00       4,000.00
      MATERIALS & S       8,043.00         259.93           0.00       7,783.07
      TOTAL DIRECT       50,000.00       8,353.34           0.00      41,646.66
      TOTAL EXPENSE      50,000.00       8,353.34           0.00      41,646.66
      ACCOUNT TOTAL      50,000.00       8,353.34           0.00      41,646.66



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4-⌐               1 KSUVM     129.130.12.1                              4/10

 019 SL ACCOUNT SUMMARY                          AGRON KS WHEAT COMM
 DATE: 07/01/05                                                  FY: 05
 SCREEN:     ACCT: 521040      SUBTOTAL OPTION: A1  PRINT SUBTOTAL: O
             FUND: 2697 1100
       DEPARTMENT: 10040      RESP PERSON: FRITZ A
         MAP CODE: 21040            FLAGS: DEL FRZ RVW DRP SUP ABR
                                            0   0   0   0   1   5
 OBJ  DESCRIPTION          BUDGET          ACTUAL         ENCUMB          AVAIL
 ---- ------------ -------------- -------------- -------------- --------------
      SALARIES,WAGE      35,957.00      39,971.85           0.00       4,014.85-
      CONTRACTUAL S           0.00         219.55           0.00         219.55-
      TRAVEL              2,000.00       1,726.46           0.00         273.54
      OTH CONTR SER       4,000.00         473.00           0.00       3,527.00
      MATERIALS & S       8,043.00       4,503.74           0.00       3,539.26
      TOTAL DIRECT       50,000.00      46,894.60           0.00       3,105.40
      TOTAL EXPENSE      50,000.00      46,894.60           0.00       3,105.40
      ACCOUNT TOTAL      50,000.00      46,894.60           0.00       3,105.40



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4-⌐               1 KSUVM     129.130.12.1                              4/10
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Wheat Genetics Resource Center and Its Contributions to the Kansas Wheat Industry

RESEARCHERS AND UNITS:
Bikram Gill, Dept. of Plant Pathology

FUNDS (FY 05): $90,000 **Completion Date:** Ongoing

JUSTIFICATION: The Wheat Genetics Resource Center (WGRC) was established in 1984 at Kansas State University to collect, maintain, 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 the development of genetic and cytogenetic stocks for the rapid and efficient gene transfer for breeding superior wheat cultivars. Resistance genes are incorporated into wheat lines through interspecific hybridization and released as germplasm. The WGRC also develops new cytogenetic stocks and chromosome and DNA-based assays for plant genome analysis and efficient germplasm development.

OBJECTIVES:

1. To collect, conserve, evaluate, and distribute wheat germplasm for crop improvement.
2. To develop wheat germplasm with improved resistance to wheat streak mosaic virus (WSMV), leaf rust, and other pests.

RESULTS:

New germplasm introduced and evaluated: We import germplasm to meet the new demands of the Kansas wheat industry. During the past year, we introduced new sources of germplasm with excellent resistance to Karnal bunt, Fusarium head scab, stripe rust, and leaf rust. Principal Investigator Gill also visited the international agricultural center, ICARDA, in Syria, and developed a collaborative project on stripe rust and heat-tolerant germplasm. B. Friebe visited CIMMYT for participation in an international project on sharing of wheat genetic stocks. A large collection of wild wheats (*Aegilops tauschii*) was evaluated for adult-plant resistance to leaf rust (all lines were susceptible to leaf rust as seedlings) in our field nursery.

Releases of new and improved germ plasm: In the past year, five improved germplasm lines have been released. These new germplasm lines bring the total number of releases from the WGRC to 47. KS04WGRC45 is homogeneous for resistance to leaf rust at the seedling and adult plant stages, derived from *Elymus trachycaulus* accession TA12052. When evaluated in the field under heavy inoculum pressure at Manhattan, Kansas, in the 2003–04 growing season, a trace of leaf rust was detected on adult plants of KS04WGRC45. KS04WGRC46 has Fusarium head blight resistance derived from accession TA960 of *T. timopheevii* subsp. *armeniacum.* Significantly less disease was observed on plants of KS04WGRC46 in growth chamber tests with point inoculations of *Fusarium graminearum.* KS04WGRC47 is a hard red winter wheat with leaf rust resistance from TA1836 of *Aegilops speltoides*. Leaf rust resistance in KS04WGRC47 is due to a single dominant gene from TA1836. KS04WGRC48 is a line developed from a bulk selection having the *Aegilops tauschii*-derived gene *Lr21* conferring resistance to leaf rust and a from spring wheat line, developed at Nanjing Agricultural University, having the gene *Pm21* conferring resistance to powdery mildew present on a translocation chromosome, T6VS·6AL, which consists of the short arm of *Haynaldia villosa* chromosome 6V translocated to the

long arm of wheat chromosome 6A. KS04WGRC49 was selected based on the presence of unique *Ae. tauschii*-derived, high-molecular-weight gliadin protein subunits and novel HMW-glutenin protein subunits designated 43 (allele *Glu-D1-1j*) and 44 (allele *Glu-D1-2i*). These data indicate that the novel glutenin and gliadin protein subunits in KS04WGRC49 can have the effects of increasing loaf volume while slightly decreasing mixing time.

Potential breakthrough in WSMV disease control: Wheat streak mosaic virus (WSMV) is a devastating disease of the wheat crop. We have identified a distal *A. intermedium* segment transferred to the tip of the short arm of wheat chromosome 4D. In two other lines, the *A. intermedium* segment is too small to be detected. The progenies of these plants will be screened for resistance to WSMV. We are now quite optimistic about the genetic control of this disease.

Transfer and characterization of leaf rust and stripe rust resistance from *Aegilops ovata* into Kansas wheats: Leaf and stripe rusts are severe foliar diseases of wheat in Kansas. In a continuous search, related wild species such as *Ae. ovata* were found to be a large reservoir of useful genetic variability for disease resistant genes. Previously, in a collaborative research project with scientists of Punjab Agricultural University in India, we transferred leaf rust and stripe rust resistant genes from *Ae. ovata* into elite Indian cultivar WL711 through induced homoeologous chromosome pairing achieved by *PhI* gene of *Ae. speltoides*.

Here, we report the genomic location and characterization of the alien introgression conferring rust resistance by using genomic *in situ* hybridization (GISH) and mapped RFLPs and ESTs. The resistant line with smallest introgressed segment was used for backcross breeding to transfer rust resistance genes into Kansas wheats.

By using *Ae. comosa* DNA as a probe, three different kinds of rust-resistant introgression lines were identified. Of the three resistant lines, one line(T550) showed the complete $5M^g$ chromosome with a small terminal segment derived from short arm of wheat, another line(T598) was found to be a Robertsonian translocation involving $5M^g$ of *Ae. ovata* and 5L of wheat. No introgression could be detected with GISH in the other resistant line (T756).

We screened all three types of introgression lines with Kansas leaf and stripe rust races; all three lines showed complete and similar resistance to the most prevalent races of leaf (PNMQ and PRTUS35) and stripe rust (03 and 04).

The resistant line (T756), whose introgression could not be detected with GISH, was characterized with genetically mapped RFLPs and physically mapped ESTs, which show distinct homoeoalleles among A, B, and D genomes. A set of two RFLPs (bcd873 and Fbb276) and four ESTs (BE637485, BF293016, BF293305, and BF200555) with six different enzyme combinations identified diagnostic polymorphism between the alien segment and the recipient parent, which further revealed that the alien segment that conferred resistance to leaf and stripe rusts was transferred to 5DS of wheat. From the information from physically mapped ESTs on deletion lines, the introgressed segment was less than 5 % of 5DS. This line, which is agronomically as good as the recipient parent WL711, was used to transfer the leaf and stripe rust resistance to Kansas wheat cultivars Jagger and Wichita. The F_1 between Jagger and T756 was crossed again with Jagger to produce BC_1F_1. These BC_1F_1 plants are being screened for rust resistance and backcrossed to Jagger. Additional STS (sequence tagged sites) and/or CAPS (cleaved

amplified polymorphic sequences) markers will be developed from the diagnostic RFLPs/ESTs, which will be useful for the marker-assisted breeding for rust resistance in wheat.

SIGNIFICANCE OF RESULTS: The WGRC uses, or provides to others, immune and resistant strains of wild wheats for the development of improved germplasm for wheat breeding. Maintaining genetic stocks and wild wheat ancestors will assure material for genetic studies and gene transfer. Leaf rust and WSMV are two of the most important diseases of wheat, and their control will significantly improve the yield and quality of the harvested crop. Germplasm from WGRC contributed to the development of Overly wheat, and this cultivar seems quite promising for our Kansas wheat producers.

Acknowledgements: Scientists from WGRC/KSU include Bill Bockus, Bernd Friebe, Li Huang, Vasu Kuraparthy, Lili Qi, Jon Raupp, Duane Wilson, and Holly Worth; USDA–ARS, Bob Bowden and Gina Brown-Guidira; and PAU, Parveen Chuneja and H.S. Dhaliwal, contributed to this research.

Hard White Winter Wheat for Dual-purpose Use – Second Year

RESEARCHERS AND UNITS:
Ron Hale, Curtis Thompson, and Troy Dumler, KSU Southwest Area Extension Office; Timothy J. Herrman, Dept. of Grain Science and Industry; Alan J. Schlegel, SW Research Extension Center

FUNDS (FY 05): $11,503.33 **Completion Date:** October 2005

JUSTIFICATION: It is expected that the use of white wheat varieties in southwestern Kansas will continue to increase. Little is known, however, about the use of white winter wheat for grazing. Limited research has been done to examine the effect of grazing on subsequent grain production and quality, or on forage yield and quality, which in turn affects animal performance. This research has only been conducted with hard red winter wheats.
Milling tests, which enhance test-weight and kernel-size information, are needed to further determine the economic value of the grain. Variety and grazing comparisons will aid in evaluating economic returns for producers and the milling industry.
This study will provide information needed to begin the development of a wheat optimization model, based on grain and livestock production for grain or dual-purpose wheat producers. There is currently no known information of this type for white wheats. Inclusion of hard red winter wheat varieties will also enable producers to make better comparative decisions based on their experiences with popular red wheats.

OBJECTIVES:
Improve the reliability of the data obtained from the current Kansas Wheat Commission FY2004 project by repeating the plot work, basic wheat quality and forage quality. This will be accomplished by:

1. Determining the effect of grazing on hard white winter wheat grain yield and quality.
2. Determining the potential performance of cattle grazing white wheat in dual-purpose or graze-out programs.
3. Determining the potential economic differences among white wheat grain production only, dual-purpose, and graze-out programs.
4. Comparing hard white winter wheat varieties to popular red wheat varieties in each of the prior three objectives.

Expand on the basic grain yield and quality analysis, which consists of moisture, crude protein, test weight, and 1000-kernel weight, by:

1. Conducting a physical quality evaluation.
2. Evaluating milling performance.

RESULTS: Laboratory results are not yet complete for the wheat forage, which was harvested twice during 2005. Grain harvest occurred on June 22 and 27, 2005. The samples are currently being processed for submission to the laboratories for grain evaluation and milling tests. It is anticipated that forage and grain analysis will be completed during the next month. Although it is likely that the milling tests will require more time to complete, the expected date of the final report is October 2005.

SIGNIFICANCE OF RESULTS:

Results of the first year's (2004) study have been published in the 2005 KSU Cattlemen's Day Report or have been submitted for publication in the 2005 KSU Southwest Research-Extension Center Field Day Report. The following summary statements are taken from those papers.

Forage samples were collected from each plot during December 2003, March 2004, and April or May 2004. Dry matter content, dry matter yield/acre, crude protein, acid detergent fiber, neutral detergent fiber, relative feed value, total digestible nutrients, net energy for maintenance, net energy for gain, and nitrate nitrogen were determined. Forage yields differed among the cuttings, depending on the county. The highest yields in Clark and Stanton Counties occurred at the December and May harvests, respectively. Forage quality was higher at the first two cuttings in each county. Crude protein and energy content of the third cutting at Clark County may not support maximum gain, depending on animal age and weight.

Cattle were allowed to graze the wheat after it was well established, and were removed before the wheat began jointing. Grain was harvested from the grazed and ungrazed plots. Grazing did not influence grain yields in Stanton County. In Clark County, the yield of two varieties was improved with grazing, whereas the yield of two other varieties decreased. Test weight differed for grazing by variety in Clark County, but was not affected by grazing in Stanton County. Grazing reduced crude protein content in Clark County, but did not affect protein content in Stanton County. Grazing seemed to more significantly affect grain quality in Clark County than in Stanton County.

Grain sprouting occurred in Stanton County because of continuous, heavy rainfall before harvest. There was an interaction between grazing and wheat variety wherein grazing significantly reduced sprouting for NuFrontier, NuHills, and NuHorizon, but did not affect the other varieties. The white wheats were 3.5 times more susceptible to sprouting than were the red wheats. The quality of wheat from Stanton County was lower than the quality of Clark County grain, as indicated by test weight, 200-kernel weight, and the single-kernel characteristics, but crude protein was greater in Stanton County than in Clark County.

Although there were equal numbers of white and red varieties in this study, they are not representative of all wheats, but were selected for their popularity or potential in southwestern Kansas. Although variety differences occurred, there did not seem to be any forage or grain traits, other than sprouting, that were strongly related to wheat color.

International Grains Program Support Project

RESEARCHERS AND UNITS:
John Howard, International Grains Program

FUNDS (FY 05): $200,000 **Completion Date:** Ongoing

JUSTIFICATION: The world's wheat exporters are fiercely competitive and the world's wheat buyers are very demanding. Marketing U.S.-grown wheat requires partnerships and joint activities to successfully compete for these customers. Buyers need to be keenly aware of grade standards, price-discovery mechanisms, contracting, shipping, storage, quality control, sanitation, fumigation and many other aspects of the grain business.

OBJECTIVES: Buyers need to be identified. IGP works with U.S. Wheat Associates and the Foreign Agricultural Service to know flour millers and grain traders worldwide. These buyers are encouraged to attend IGP training programs in the United States or overseas. Select specific targeted markets for solution of specific problems with IGP partners. A key marketing objective is market maintenance. That is, to continue providing the latest information to the customers.

RESULTS: More than 185 key grain buyers and traders were exposed to IGP programs during the year. U.S. Wheat Associates directly sponsored almost twice as many participants than the previous year. Total IGP grew for the fifth year in a row. IGP faculty and staff attended functions in 19 countries; IGP faculty and staff worked directly with U.S. Wheat's overseas offices. Trade teams sponsored by USDA and U.S. Wheat were hosted, met, and briefed by IGP faculty and staff.

SIGNIFICANCE OF RESULTS: Buyers of U.S. wheat have a better knowledge of the numerous details involved in making sure the wheat they purchase is of the quality needed. Buyers are better informed and are more comfortable with the U.S. wheat markets. They are able to purchase with more confidence and are able to obtain the exact product they need, thus enhancing their margins.

Kansas Dual-purpose Pest-resistant White Wheats

RESEARCHERS AND UNITS:
Joe Martin, Dallas Seifers, and Tom Harvey, KSU Ag. Research Center–Hays.

FUNDS (FY 05): $88,709 **Completion Date:** Ongoing

JUSTIFICATION: The world wheat market is demanding the increased production of hard white wheat. If Kansas producers are going to take advantage of this situation, we must supply them with the very best hard white varieties possible.

OBJECTIVES: Our objectives are to develop new hard white wheat varieties that will meet the quality demands of our domestic and international customer, while simultaneously giving our producers top agronomic performance and provide protection from our major diseases and insect pests.

RESULTS: During the July meeting of the Crop Variety Review committee, I will be requesting permission to release KS02HW34. We were able to produce about 4800 bushels of Foundation seed in 2005. This seed will be made available to category-one seed producers for planting this fall. KS02HW34 has greatly improved sprouting tolerance, compared with its Trego parent. In our tests, KS02HW34 has been equal to the red wheat Jagger in sprouting tolerance. KS02HW34 has also been highly resistant to stripe rust, which has been a major problem for Trego.

I also will seek permission to increase two additional hard white experimentals in 2006 for possible release in 2007. KS03HW6 is a Trego-type hard white that carries BASF's Clearfield technology for herbicide resistance, which allows producers to control annual grasses in wheat with Beyond herbicide. KS03HW6 also carries a much improved level of stripe rust resistance, relative to that of Trego.

Permission to increase KS03HW158 will also be requested. This white wheat will be the first wheat available that carries a high level of resistance to wheat streak mosaic virus. In addition, it also carries a good level of protection from stripe rust.

SIGNIFICANCE OF RESULTS: The availability of these three new cultivars should have a positive influence on producers when they are making the decision as to whether they produce white wheat or not.

SPENDING REPORT

019 SL ACCOUNT SUMMARY HAYRC KS WHEAT COMM
DATE: 06/29/05 FY: 05
SCREEN: ACCT: 526052 SUBTOTAL OPTION: A1 PRINT SUBTOTAL: O
FUND: 2697 1100
DEPARTMENT: 10220 RESP PERSON: MARTIN J / SEIFERS D
MAP CODE: 26052 FLAGS: DEL FRZ RVW DRP SUP ABR
0 0 0 0 1 5

OBJ	DESCRIPTION	BUDGET	ACTUAL	ENCUMB	AVAIL
	SALARIES,WAGE	69,509.00	67,080.01	0.00	2,428.99
	CONTRACTUAL S	6,000.00	3,430.90	0.00	2,569.10
	TRAVEL	7,700.00	1,171.93	0.00	6,528.07
	OTH CONTR SER	0.00	4,909.89	0.00	4,909.89-
	MATERIALS & S	5,500.00	6,858.22	0.00	1,358.22-
	TOTAL DIRECT	88,709.00	83,450.95	0.00	5,258.05
	TOTAL EXPENSE	88,709.00	83,450.95	0.00	5,258.05
	ACCOUNT TOTAL	88,709.00	83,450.95	0.00	5,258.05

No-till Wheat Production in County Variety Trials

RESEARCHERS AND UNITS:
Brian Olson, Extension Agronomist – NWREC; Jeanne Falk, Multi-county Crops & Soils Specialist; Dan O'Brien, NW Area Director and former NW Area Agricultural Economics Specialist; Northwest Research & Extension Center, Colby, KS

FUNDS: $19,993 (direct) **Completion Date:** Ongoing

JUSTIFICATION: The majority of northwest Kansas wheat producers do not leave enough crop residue on the soil surface for adequate soil conservation before wheat planting. This was evidenced in three recent events. On Dec. 18, 2000, state highways in many western Kansas counties were closed because soil blowing off recently planted wheat fields had reduced visibility, causing unsafe driving conditions. Street lights came on at mid-afternoon in Colby and many other towns due to the dust-darkened skies. If the winter of 2000/2001 had been as dry as the previous winter, there would have been a modern day dust bowl. In contrast, a nearby no-till wheat field had no erosion and retained snow to the depth of milo stubble left from the previous crop. In addition, the no-till field had enough moisture for planting two to three weeks earlier than surrounding conventionally tilled fields. On May 29, 2004, some producers had started tilling, preparing their fields for winter wheat planting this fall, when a dust storm blew through the area, causing similar conditions as previously described.

Rainfall on Sept. 17 and 18, 2001, came rapidly, resulting in major erosion of wheat fields. Roadside ditches and county streams were filled with topsoil, and many gullies were formed or deepened. Tillage to repair gullies and replanting were necessary in most instances. In contrast, a nearby no-till wheat field suffered no erosion, and achieved a complete stand and total ground cover. Improved soil and moisture conservation provide cleaner air and water for everyone.

Fallow-treatment herbicide costs have decreased dramatically in the last three years, due primarily to the expiration of the "Round-Up" patent. To illustrate, per-unit costs of Round-Up© in K-State crop planning budgets have declined from $44.75 per gallon in 1998 to $37.60-$37.80 in 1999-2000 to $22.00 per gallon in 2003. In addition, many producers are reducing herbicide costs through improved sprayer technology and more timely applications. Tight profit margins have plagued wheat and other dryland crop enterprises in recent years. Equipment, fuel, and labor cost continue to increase. The combination of these economic forces is motivating producers to consider more efficient uses of cropland. No-till wheat production is perhaps the most effective practice available to meet these constraints.

Planter technology has improved in recent years such that acceptable stands can be achieved in most planting conditions with a shower after planting. Most manufacturers offer a no-till planter, but there is considerable variation in equipment configuration and confusion among producers as to which configuration they might need. The cost of such equipment is often a barrier to adoption of the practice.

An increasing number of producers are intensifying rotations by eliminating fallow periods after summer crops, and planting winter wheat, or sometimes planting spring wheat after the fall harvest. The success of this practice is dependant on moisture conservation and residue management. No-till planting should be the critical success factor.

On the topic of yield response, a ten-year study at Tribune, Kansas, showed an eight bu/a advantage for no-till wheat production, compared with conventional tillage in a wheat-sorghum-fallow rotation. If costs can be maintained or decreased while adopting the technology, it would increase net profit. Wheat research done at the USDA-ARS unit at Akron, Colorado, has shown a more than four bu/a yield increase for each additional inch of moisture. The same research showed up to three additional inches of available moisture resulting from no-till management. Thus, adopting no-till management should result in an additional eight to twelve bu/a while improving soil conservation.

OBJECTIVES:

1. Add no-till wheat variety plots to existing county wheat variety plots in northwestern Kansas to demonstrate the feasibility of no-till wheat production and increase educational opportunities of existing county extension events.
2. Gain insight and better define no-till management changes necessary as annual precipitation decreases from 24 inches in north central Kansas to 16 inches in western Kansas, especially as it relates to frequency of wheat in the rotation.

RESULTS: Unlike 2004, growing conditions in Northwest Kansas in 2005 allowed for wheat to be harvested with respectable yields. Fourteen sites initially were planted, with the conventional-till versus no-till comparison. Of these sites, data from twelve sites have been collected. After looking at the management practices from these twelve sites with respect to fertility, two sites were eliminated because an extremely marginal fertility program was used by the farmer. A third site was removed from the analysis because of poor growing conditions, 10 to 15 bu/a wheat.

Of the nine sites analyzed, most of the fields averaged between 40 and 60 bu/a. All sites had six varieties planted: T-81, Stanton, 2137, Jagger, Cutter, and Jagalene, at 85 lbs/a. No-till yielded 58 bu/a across the six varieties, whereas conventional-till yielded 51 bu/a, with an LSD (0.05) of 4.6 bu/a. This information is from only one year, but there are data from many sites. The same six varieties will be used in the comparisons planted this fall.

At four sites, Decatur, Sheridan, Gove, and Trego, fourteen varieties and one blend were planted in both tillage systems. Variety yield from these sites indicates there was no tillage-by-variety interaction. Therefore, there was no difference in how a particular variety responded to a tillage system. If the variety was high yielding in conventional-till, it also performed well in no-till. In addition, there were no differences across the nine sites that had the six varieties with respect to how those varieties yielded across tillage systems. This is an important piece of information because the Kansas Crop Performance Tests are routinely conducted on conventionally tilled ground. Therefore, these preliminary results would indicate farmers should have confidence that a variety that yielded well in conventional-till will also yield well under no-till. There would be a few exceptions. These exceptions would include disease and insect pressure. Tan spot, for example, is more prevalent in no-till fields, as is Hessian fly.

A secondary result from the data collected indicated a significant reduction in bu/a if a susceptible variety was used versus a resistant one. There are obvious variety differences between the six varieties used across the nine sites, but the average yield for the resistant varieties to stripe rust (Jagger, Jagalene, Cutter, and T-81) was 57.8 bu/a, with these varieties yielding within two bu/a of the average. For the susceptible varieties of 2137 and Stanton, the average yield was 47.8 bu/a. Although as previously stated there are differences in varieties, their resistance or susceptibility to stripe rust likely influenced yield.

A seeding rate study was also included at all the sites. Jagalene was seeded at 68, 85, 102, and 120 lbs/a in both tillage systems. When looking at the data across the nine sites, there was no difference in seeding rate in either tillage system or across the tillage systems. More than likely, the wet fall in 2004 and the mild temperatures through November allowed for good stand establishment and ample tiller development to occur, which masked any possible differences from seeding rate.

In summary, I am pleased to finally provide the Wheat Commission with the information they were looking for when the project was initially funded. We hope that next year will provide many sites with good data also. The data presented here has been, and will be, discussed at many preplant wheat schools across Northwest Kansas, along with winter meetings and conferences such as the Cover Your Acres Winter Conference in Oberlin on February 2. In addition, the importance of nitrogen management with respect to having high-quality no-till wheat, along with other management practices, was stressed at many county wheat plot tours across Northwest Kansas this past spring (attendance - 563). Thank you for your continued support.

Bright-white Wheat: Origin and Food Products

RESEARCHERS AND UNITS:
P. A. Seib, Professor, Dept. of Grain Science and Industry; Hongxin Jiang, Graduate Research Assistant, Dept. of Grain Science and Industry

FUNDS (FY 04): $25,762 **Completion Date:** June 30, 2005

JUSTIFICATION: Dr. Joe Martin has developed hard white winter wheat lines with extra bright kernels at the Kansas Agricultural Research Center in Hays, and experimental lines are currently in their second year of yield trials. The 2004 harvest provided a sufficient quantity of the bright-white hard winter (B-W HW) wheat to begin determining whether the extra brightness makes a color difference in selected wheat products. Color is an important criterion for the selection of grains and foods in the marketplace.

OBJECTIVES:
The objective of this work was to compare the color of flour, bran, vital wheat gluten, whole-wheat pan bread, alkaline noodle-dough sheets, and fried wheat kernels made from the B-W HW, Trego, and Lakin wheats. At the same time, the qualities of those wheat products were measured.

RESULTS:
Samples of three white wheats, Trego, Lakin, and an advanced line of B-W HW wheat were composited from two growing locations in Kansas in 2004. All three wheats were sound, as evidenced by their falling number values of 379~406s. The brightness or lightness (L*) of B-W HW wheat kernels (L* 57.6) was higher than Trego (L* 55.5) and Lakin (L* 56.8), whereas the hardness index of the B-W HW wheat (71) was somewhat lower than for both Trego (81) and Lakin (83) wheats. The test weights (61.7–63.5 lb/bu), mean kernel diameters (2.34–2.49 mm), mean kernel weights (31.1–34.2 mg), and protein contents (13.1–13.8%, 14% mb) of the three wheats differed by no more than 7%. The B-W HW and Lakin wheats contained a low level of enzymatic browning (PPO) activity, but that of Trego was ~1.5 times higher. The three wheats were milled to produce whole-wheat flours, straight-grade (ash ~0.46%, 14% mb) flours of ~73% extraction, and short-patent (ash ~0.39%, 14%mb) flours of ~55% extraction. The lightness (L*) values of the straight-grade and short-patent flours from all three wheats were the same, but the lightness value (L* 86.7) of the whole-wheat flour made from B-W HW wheat was higher than that of Trego (85.9) and Lakin (86.2) wheats. In addition, the L* value of the bran from the B-W HW wheat was higher by ~1 unit. Preliminary baking tests indicated that the color of whole-wheat breads made from the three wheats were indistinguishable., but alkaline noodle doughs (32% absorption on 14 % mb) made from the short-patent and whole-wheat flours of B-W HW and Lakin wheats showed greater lightness and yellowness than Trego. The cooking yield and texture properties of noodles indicate that Lakin and the B-W HW wheats are of the wild-type in regards to the waxy gene, whereas Trego is a partial waxy wheat. The yield of cooked noodles was elevated for Trego wheat, and the noodles gave higher tensile strength but lower compression strength. Those properties are consistent with increased swelling of Trego noodle strands. The low swelling of alkaline noodles made from the bright-white wheat creates a hard-textured noodle over a wide range of protein contents. The lightness (L*) value of dry-powered vital gluten isolated from straight-grade B-W HW wheat flour and of fried wheat kernels of B-W HW wheat were also higher than Trego and Lakin by ~1 unit.

SIGNFICANCE OF RESULTS:

The increased bright appearance of an advanced experimental line of Kansas hard white winter, compared with Trego and Lakin white wheats, was carried over into its whole-wheat flour, bran, and kernels fried in oil. Other products made from the bright-white hard winter wheat also were brighter, compared with the two control white wheats, including raw alkaline Asian noodles and powdered vital wheat gluten. Any improvement in the color of Kansas white wheats and foods derived therefrom would be a marketing advantage for Kansas wheat.

Wheat Production in Kansas: Extension and Applied Research

RESEARCHERS AND UNITS:
James P. Shroyer, Dept. of Agronomy

FUNDS (FY'05): $2,500 **Completion Date:** Ongoing

JUSTIFICATION: Wheat is the most widespread crop grown in Kansas, with approximately 10 million acres planted annually. There is a need for an ongoing, statewide wheat extension education program 1) to educate producers and agri-business on best management practices for wheat production; 2) to conduct applied research based on suggestions and questions from producers and agri-business; 3) to stay current on national and international wheat production topics that are applicable to Kansas; and 4) for timely communication with producers and agri-business.

OBJECTIVES:
Present information to producers and agri-business on wheat production at extension meetings, field tours, and training sessions. Conduct applied research on producers' fields and experiment fields. Attend national meetings (e.g. NAWG) to obtain latest research results to be shared with producers and agri-business. I am available through the use of a cell phone at all times for consultation and possible farm visits. This is a technology-transfer project, and funding will allow for travel across the state to conduct an applied research and extension wheat program.

RESULTS:
1. Several preplant wheat schools were developed and delivered to producers in late summer, and several agribusiness training sessions were delivered.
2. Developed news and radio releases regarding planting dates, seeding rates, replanting recommendations, topdressing, and freeze damage, and maintained the KSU Wheat Page and other websites.
3. The no-till wheat after wheat studies found there were no yield differences in seeding rates from 60 to 120 pounds per acre. Increasing nitrogen rates from 60 to 90 pounds N per acre increased yields by 3.5 bushels per acre, and increasing N rates from 90 to 120 pounds N per acre increased yield by 4.5 bushels per acre. A fungicide check treatment revealed only a 4 bushel per acre increase over the non-fungicide treatment.
4. Yields of the on-farm fungicide studies were quite variable, due in part to freeze damage, and differences were not as clear as last year's results. We observed only a 2-bushel difference in Marion County, a 5-bushel advantage in McPherson County, and a 14-bushel advantage in Saline County.

SIGNIFICANCE OF RESULTS:
Due to the timely delivery of educational information, producers and agribusiness personnel were better able to make informed decisions throughout the year.
The results from no-till wheat study indicates that increasing nitrogen rates for no-till systems is very important because nitrogen is generally broadcast applied, compared with more conventional wheat plantings in which nitrogen is incorporated into the soil. These findings verify field observations across the state, where we saw nitrogen deficiency symptoms in many no-till fields. If no-till wheat plantings

increase, it will be important that producers inject nitrogen into the soil, either before or at planting, to optimize the nitrogen response. The results from the fungicide studies indicate that yields are being lost to wheat diseases, but a fungicide application does not necessarily guarantee a significant or economic return on the investment.

019 SL ACCOUNT SUMMARY AGRON KS WHEAT COMM
DATE: 12/20/04 FY: 05
SCREEN: ACCT: 537069 SUBTOTAL OPTION: A1 PRINT SUBTOTAL: O
FUND: 2697 1100
DEPARTMENT: 10040 RESP PERSON: SHROYER J
MAP CODE: 37069 FLAGS: DEL FRZ RVW DRP SUP ABR
0 0 0 0 1 5

OBJ	DESCRIPTION	BUDGET	ACTUAL	ENCUMB	AVAIL
	CONTRACTUAL S	300.00	140.56	0.00	159.44
	TRAVEL	2,200.00	18.00	0.00	2,182.00
	OTH CONTR SER	0.00	180.00	0.00	180.00-
	TOTAL DIRECT	2,500.00	338.56	0.00	2,161.44
	TOTAL EXPENSE	2,500.00	338.56	0.00	2,161.44
	ACCOUNT TOTAL	2,500.00	338.56	0.00	2,161.44

4-⌐ 1 KSUVM 129.130.12.1 4/10

019 SL ACCOUNT SUMMARY AGRON KS WHEAT COMM
DATE: 07/01/05 FY: 05
SCREEN: ACCT: 537069 SUBTOTAL OPTION: A1 PRINT SUBTOTAL: O
FUND: 2697 1100
DEPARTMENT: 10040 RESP PERSON: SHROYER J
MAP CODE: 37069 FLAGS: DEL FRZ RVW DRP SUP ABR
0 0 0 0 1 5

OBJ	DESCRIPTION	BUDGET	ACTUAL	ENCUMB	AVAIL
	CONTRACTUAL S	300.00	148.99	0.00	151.01
	TRAVEL	2,200.00	18.00	0.00	2,182.00
	OTH CONTR SER	0.00	180.00	0.00	180.00-
	TOTAL DIRECT	2,500.00	346.99	0.00	2,153.01
	TOTAL EXPENSE	2,500.00	346.99	0.00	2,153.01
	ACCOUNT TOTAL	2,500.00	346.99	0.00	2,153.01

4-⌐ 1 KSUVM 129.130.12.1 4/10

Developing DNA Markers for Breeding Karnal Bunt Resistant Bread Wheat

RESEARCHERS AND UNITS:
Sukhwinder-Singh, Dept. of Plant Pathology

FUNDS (FY 04): $ 16,500 **Completion Date:** June 2007

JUSTIFICATION: This is the kind of disease for which we need molecular markers for selection of resistant plants because we can not afford to introduce this dreaded pathogen into U.S. soils, and expression of the disease symptoms is highly influenced by environmental conditions. This piece of research will lead us to the development of KB-resistant wheats and, finally, insight of a possibility that this disease may be genetically managed to a level that matches stringent requirements such as those imposed by global trade. The development of KB-resistant varieties is thus an essential requirement in the United States. The rationale for gene pyramiding for developing KB-resistant genotypes seems quite strong. Gene pyramiding, however, may not be a straightforward matter. In context of gene tagging and pyramiding, the situation implies the need for extensive phenotyping by using appropriate mapping populations such as RILs or NILs. It would require extensive screening of materials to identify all the genes for resistance, which will be tagged by molecular markers for transfer of resistance genes to winter wheats. Because the pathogen is neither present nor can be introduced into the United States, screening and breeding work will have to done in collaboration with PAU, India, where such facilities already exist. Keeping all these facets of KB in mind, appropriate crosses and populations have been developed and are being used to facilitate molecular-marker-aided development of KB-resistant winter wheats in the proposed research project.

OBJECTIVES:

1. Marker-assisted selection for KB resistance in backcross progenies. Test resistance of selected advanced lines from KB introgression materials, and confirm performance of markers for selecting KB resistance by comparison to field nursery test at PAU, India.
2. Targeted mapping of chromosome regions carrying QTLs for KB resistance in RIL populations (WL711/HD29 and WH542/HD29) that will identify tightly linked and flanking markers for resistance.

SUMMARY: KBRL22 (KB-resistant line) was crossed with winter wheats, and potential candidate markers revealed polymorphism between donor and most of the recurrent parents. We have identified homozygous BC1F2 progenies with the desired profiles with SSR markers associated with KB resistance. Plants from each cross having desirable marker alleles were selected and are being advanced. Quantitative trait loci (QTL) associated with Karnal bunt (Tilletia indica) resistance were identified in two recombinant inbred mapping populations derived from the cross WH542/HD29 (population-1) and WH542/W485 (population-2). These populations were evaluated for reaction to T. indica in three seasons at Punjab Agricultural University (PAU), India. Disease incidence ranged from 0 to 6 % on resistant (HD29, W485) and from 25 to 78% on susceptible (WH542) parents. KB resistance QTLs were identified in population-1 on the chromosomes 5B (R2 = 7-30 %) and 6B (R2 = 6-32 %), and

chromosomes 4B (R2= 10-26 %), and 6A (R2 = 9-22 %) in population-2. Chromosome regions for KB resistance QTLs on 4B and 6B were flanked with PCR-based DNA markers suitable for marker-assisted selection (MAS).

RESULTS:

Marker-assisted selection of backcross progeny with markers:

Backcrosses and three-way crosses of KBRL22 with several hard red and hard white winter wheat cultivars were made. Marker GWM538-SNP revealed polymorphism between donor and all recurrent parents except Trego and KS94U206, whereas the GWM58 marker was polymorphic except with Trego and Cutter. Two hundred and thirty-six progenies were screened with two markers (GWM538-SNP and GWM58) linked with KB resistance (Figure 2). We identified 90 plants from a total of 236 BC1F1 progenies with the desired marker profiles. Plants from each cross having desirable marker alleles were selected and advanced. The BC1F2 progenies homozygous for resistant parent alleles were selected and selfed and backcrossed with elite breeding lines.

Phenotypic evaluation of KB disease:

The parental lines differed for mean incidence of disease in three years of experiments. Mean incidence of KB on resistant lines HD29 and W485 over the years were 5.0 % and 1.0 %, respectively. The range of disease on population-1 was 0 to 94 %, whereas in the population-2 population it was 0 to 82 %. Significant variation for disease incidence was observed among RILs. Analysis of variance revealed that all effects (genotype, environment (year), and genotype by environment interaction) were highly significant ($P<0.0001$). Forty-six RILs were considered moderately resistant because they showed a range of variation covering between susceptible and resistant categories. The RILs fall into a ratio of 1 resistant : 2 moderately resistant : 1 susceptible category, and indicated two major additive genes in the population. Similar results were obtained in the population-2 population.

Polymorphism assay and linkage analysis:

A survey of polymorphism between resistant (HD29, W485) and susceptible (WH542) parents was done with SSR and EST-STS markers. Primer pairs for SSR markers revealed 29% and 27% levels of polymorphism between the parents of population-1 and population-2 populations, respectively. Sequence tag site (STS) markers designed from the wheat ESTs showed 8 to 10% polymorphism among the parental lines used in this study. A total of 57 and 150 PCR-based DNA markers were evaluated on the population-1 and population-2 populations, respectively. Two-point linkage analysis of the scored fragments yielded 30 linkage groups containing 125 loci. Twenty-one groups (99 loci) were assigned to individual chromosomes of wheat, with five chromosome maps (3B, 5A, 6B, 7A, and 7B) represented by more than one linkage subgroup. The orders of markers in linkage groups generally agreed with those in the published map.

Quantitative trait analysis:

The two most consistent QTLs, detected in all three years in population-1, were mapped on chromosomes 6B (R2= 6 to 32 %), and 5B (R2= 7 to 30 %). Six PCR-based DNA markers were associated with KBQ-6B, and resistance was mapped between marker loci X6BLBF300 (EST-STS) and XBARC146 (SSR). KBQ-5B was placed between X5BL174 (EST-STS) and XGWM335 (SSR). The LOD scores ranged from 2.12 to 4.26, and the corresponding R2 ranged from 7.0 to 32.0%. Total adjusted R2 reached 37%.

Similarly, population-2 population markers from chromosomes 4B (R2= 8 to 26 %) and 6A (R2= 9 to 22%) consistently revealed KB QTLs in all three years. Five SSR markers showed significant association with KB resistance from chromosome 4BL. The most significant region was flanked by marker loci Xgwm6 and Xwmc125. KB QTL-6A mapped between SSR loci Xgwm200 and Xgwm383. The LOD scores ranged from 1.89 to 4.56, and the corresponding R2 ranged from 6.0 to 26.0 %. Total adjusted R2 reached 51%.

SIGNIFICANCE OF RESULTS:

1. Introgression of Karnal bunt resistance into U.S. wheats germplasm will directly be used in wheat breeding program to develop KB-resistant varieties that would meet the requirement of international trade.
2. Employed markers for identifying Karnal bunt resistance at KSU, and its further validation will be done at PAU, India.
3. PCR-based tagging of genes can be of direct use for marker-aided selection for the disease. Karnal bunt resistance would be an ideal target for marker-aided selection because of (i)oligogenic genetic basis (b) screening process being highly prone to environmental influence and (c) tedious screening methods.

Quality Evaluation from KAES Wheat Breeding Programs

RESEARCHERS AND UNITS:
Virgil Smail and Richard Y. Chen, Dept. of Grain Science and Industry

FUNDS (FY05): $79,050 **Completion Date:** Ongoing

JUSTIFICATION: The wheat breeding program is to generate genetic variability from which desirable individuals can be selected to produce improved cultivars. Most breeding programs are based on the premise that large populations must be assessed to provide an acceptable probability that individuals with the desired combinations of parental characteristics will exist in the population. Breeding groups can measure factors that determine agronomic performance among the segregating progeny. But 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, bread-baking, and Asian-noodle properties.

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 oriental noodles.

RESULTS: Data collected on wheat samples harvested in 2004 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. A total of 177 samples of about 1000 grams each were analyzed for chemical constituents, test weight, kernel size characteristics, milling performance, and test baking. In addition, noodle color stability was determined. An additional 226 samples were milled and analyzed for mixing characteristics.

SIGNIFICANCE OF RESULTS: As a result of testing experimental lines in the wheat quality evaluation program, the 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. Many varieties, like Jagger, 2137, Karl 92 Trego, and others being developed, will make significant contributions to the Kansas economy.

Protein/Hardness Screening of Early Progeny Wheats

RESEARCHERS AND UNITS:
Virgil Smail, and Richard Y. Chen, Dept. of Grain Science and Industry

FUNDS (FY05): $18,415 **Completion Date:** Ongoing

JUSTIFICATION:
Wheat kernel hardness and protein content are heritable properties important in domestic and export markets. Protein content is a primary factor determining baking performance of hard wheat. Per-acre yield increases are usually accompanied by decreases in protein content of the grain. As a consequence, breeders must select for increased genetic protein potential as they increase yield potential. KAES wheat research has historically emphasized improved milling and bread-baking quality, along with improved field performance. Varieties and germplasm released by the KAES have improved overall quality of Kansas wheat and are used as "quality parents" in breeding programs of private seed companies, as well as other state experiment stations.

In the 1960s, protein content of hard red winter wheat produced in the Great Plains decreased rapidly due to grower management practices that improved retention of soil moisture and increased pre-acre yields. Protein content of the 1969 Kansas winter wheat crop averaged only 10.7%. The Department of Grain Science and Industry initiated NIR protein screening for KAES wheat breeding programs in about 1976. In 1989, NIR hardness testing was added for KAES samples.

OBJECTIVES:
1. To identify early-generation winter wheat lines and germplasm having above-average protein content.
2. To identify early-generation winter wheat lines and germplasm that are too hard or too soft.

RESULTS: Data collected on wheat samples harvested in 2004 were used by KAES wheat breeders to make quality selections among agronomically promising early generation lines. A total of 2343 samples of about 15 grams each were analyzed for protein content and kernel hardness.

SIGNIFICANCE OF RESULTS:
The wheat varieties like Jagger, Trego, Jagalene, Overley, Lakin, Betty, and Heyne exist as a result of testing experimental lines in the protein/hardness screening program. These varieties and others being developed will make significant contributions to the Kansas economy.

Developing Recommendations for No-till Wheat After Wheat

RESEARCHERS AND UNITS:
Scott Staggenborg and Jim Shroyer, Dept. of Agronomy; Jim Stack, Dept. of Plant Pathology, Kevin C. Dhuyvetter, Dept. of Agricultural Economics; Alan Schlegel, Western Kansas Agricultural Research Center

FUNDS (FY 05): $29,500 **Completion Date:** June 30, 2005

JUSTIFICATION: Planting no-till wheat into wheat stubble currently is a weak link in a farm-wide no-till system. Two years of wheat is often preferred because of the transitioning costs between summer crops and because wheat after soybeans often yields less than continuous wheat in a conventionally tilled system. The desire to have two years of wheat while maintaining a true no-till system has prompted producers to inquire about no-till planting wheat into old wheat stubble, but at the present time we do not have extensive research to establish suitable recommendations.

The primary problem that creates resistance to recommending continuous no-till wheat is the disease tan spot (caused by the fungus Pyrenophora triticirepentis), which overwinters on the previous wheat residue and then infects the new wheat. Tan spot is one of the reasons that caused the tradition of extensive tillage in continuous wheat areas. Unfortunately, there are only a few varieties that have adequate levels of tan spot resistance that can be used in a continuous no-till system. Several recent variety releases that have excellent yield potential (Jagalene, Cutter, and 2145) are moderately susceptible to susceptible to tan spot.

OBJECTIVES:

1. Evaluate the impact of variety resistance/susceptibility to tan spot in a continuous no-till wheat scenario
2. Determine the expected yield loss if wheat is no-till planted into standing wheat stubble
3. Determine management decisions required to maximize no-till wheat yields following wheat
4. Conduct an economic analysis of these management options

RESULTS: Field sites at Marysville and Tribune were identified the past spring. Before heading, fungicide applications were made to one-half the plots to create different levels of disease inoculum on the straw for the following year. The plots at Marysville have been harvested and we are waiting the results. The plots were planted to a tan spot susceptible variety (2145 or Jagalene) and a tan spot resistant variety (Jagger or Overley) last October.

A field site in Cloud county near Miltonvale and one here in Manhattan were identified to evaluate to a tan spot susceptible variety (2145 or Jagalene) and a tan spot resistant variety (Jagger or Overley) at a range of fertilizer and seeding rates under no-till conditions. We also included a sprayed treatment to determine how much disease pressure existed in this no-till environment. The plots have been harvested and we are still processing data.

Field sites were planted near Tribune, Salina, Manhattan, and Marysville, where no-till, tilled, and burned blocks were established. A tan spot susceptible variety (2145 or Jagalene) and a tan spot

resistant variety (Jagger or Overley) were planted at all locations at three seeding rates and two nitrogen rates. Head counts and disease ratings were taken at approximately anthesis, and all plots have been harvested. Only the Manhattan results have been briefly summarized; spraying the susceptible 2145 resulted in a 5 bu/acre increase in yields, compared with yields of the tan spot resistant Overley, which did not respond to the spray treatments. Initial results suggest that seeding rates did not have an impact on wheat yields, regardless of residue treatments.

SIGNIFICANCE OF RESULTS: It is difficult to judge the significance of these results because they have not been fully analyzed. Early indications are such that continuous no-till wheat yields were not significantly different than yields from systems in which the straw was removed.

Risk and Management of Clearfield Winter Wheat

RESEARCHERS AND UNITS:
P.W. Stahlman and T.J. Martin, KSU Agricultural Research Center-Hays

FUNDS (FY05): $11,000 **Completion Date:** Ongoing; will complete June 30, 2007

JUSTIFICATION: Selective control of jointed goatgrass (Aegilops cylindrica Host) and control or suppression of winter annual bromes (Bromus spp.) and feral rye (Secale cereale L.) in imidazolinone-resistant (Clearfield™) winter wheat is possible with use of imazamox (Beyond™) herbicide. Because wheat and jointed goatgrass are genetically related and occasionally cross pollinate to form interspecific hybrids, there is concern that misuse of Clearfield wheat technology could result in transferring herbicide resistance from wheat to jointed goatgrass and hasten selection of herbicide-resistant biotypes in other winter annual grass weed species. Thus, there is need to evaluate the risks associated with Clearfield wheat in the Central Great Plains, to determine if integrating use of wheat and Best Management Practices lessens the risk of transferring herbicide resistance to jointed goatgrass.

OBJECTIVES:

1. Assess the risk of moving imidazolinone herbicide resistance from wheat into jointed goatgrass via crop-weed gene flow and assess the risk of resistant biotypes of other winter annual species developing through selection pressure in cropping systems using Clearfield winter wheat.
2. Investigate ways and management practices to minimize the potential risk of developing imidazolinone-resistant weed biotypes and develop Best Management Practice recommendations to prolong the utility of Clearfield wheat technology.

RESULTS: Jointed goatgrass plant density before final seedbed preparation and seeding of the 2005 crop was 0.2 to 0.8 plants/yd2, which was ~99% less than the previous year. Individual plots in 2005 contained very few jointed goatgrass plants, but jointed goatgrass was abundant in border areas between plots. Several dozen jointed goatgrass-wheat hybrid spikes were collected and will be screened for imazamox resistance during winter months. Occurrence of hybrids has been very erratic; none were found in the 2002 or 2004 wheat crops but 441 were collected in 2003. The germination rate of hybrid spikelets produced in 2003 was 1.1%. These were transplanted to pots and grown in a greenhouse. Twenty-five of 63 F1 hybrid plants (40%) survived treatment with imazamox at 0.031 lb/a to produce 139 spikes and 1360 spikelets. From these, only five seeds were recovered, three germinated, and two survived transplanting to pots in the greenhouse and were sprayed with imazamox at 0.031 lb/a. One of the two plants died and the other was severely injured and did not produce seed. Yield data for 2005 has not yet been analyzed. In all prior years, combining Best Management Practices and imazamox herbicide in Clearfield wheat dramatically reduced jointed goatgrass populations, compared with populations in conventional wheat grown using conventional production practices.

SIGNIFICANCE OF RESULTS: Use of imazamox herbicide and Best Management Practices has been highly effective for managing jointed goatgrass. Occurrence of jointed goatgrass-wheat hybrids varies widely between years. Slightly more than 1% of the hybrid florets contained a viable seed. If plants from these seed were to backcross with jointed goatgrass, then it would be possible to transfer

imazamox herbicide resistance from wheat to jointed goatgrass. Resistance in hybrid progeny has not occurred to date, however, indicating that they are backcrossing with wheat rather than jointed goatgrass.

SPENDING REPORT

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019 SL ACCOUNT SUMMARY                              HAYRC KS WHEAT COMM
DATE: 06/29/05                                                      FY: 05
SCREEN:     ACCT: 526051      SUBTOTAL OPTION: A1  PRINT SUBTOTAL: O
            FUND: 2697 1100
      DEPARTMENT: 10220      RESP PERSON: STAHLMAN P
        MAP CODE: 26051             FLAGS: DEL FRZ RVW DRP SUP ABR
                                            0   0   0   0   1   5
OBJ  DESCRIPTION           BUDGET          ACTUAL         ENCUMB          AVAIL
---- ------------- -------------- ------------- ------------- -------------
     SALARIES,WAGE      10,336.00      10,334.42          0.00           1.58
     TRAVEL                550.00          215.93          0.00         334.07
     MATERIALS & S         114.00          449.65          0.00         335.65-
     TOTAL DIRECT       11,000.00      11,000.00          0.00           0.00
     TOTAL EXPENSE      11,000.00      11,000.00          0.00           0.00
     ACCOUNT TOTAL      11,000.00      11,000.00          0.00           0.00
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Efficacy and Adoption of New Grain Protectants by Kansas Wheat Producers

RESEARCHERS AND UNITS:
Bhadriraju Subramanyam and Fangneng Huang, Dept. of Grain Science and Industry

FUNDS (FY 04): $12,488 **Completion Date:** 6/30/05

JUSTIFICATION: The loss of chlorpyrifos-methyl leaves Kansas wheat producers with little or no options for management of their stored wheat. Spinosad, a bacterial fermention product, has been shown to be effective in suppressing stored wheat insects, especially the lesser grain borer, in field and laboratory tests. Adoption of new grain protectants requires an understanding of producer perceptions about their stored-product pest management and efficacy of newly registered grain protectants such as spinosad. In addition, effectiveness of different spinosad formulations, such as a dry formulation, also needs to be determined because producers may not have electricity at certain bin sites for using powered spray equipment to use liquid spinosad.

OBJECTIVES:

1. Survey farmers in Kansas to determine their perceptions about the impacts of the 1996 Food Quality Protection Act as it relates to the availability of postharvest pesticides.
2. Evaluate efficacy of spinosad formulations in managing stored-product insects in wheat.

RESULTS: Our survey data collected from 200 wheat producers showed that many of the producers were not aware of the 1996 FQPA and its impact on availability of postharvest pesticides. But they indicated that they would be willing to use a product such as spinosad if it was effective and safe.

The dry formulation of spinosad was as effective as the liquid formulation at 1 ppm in managing a range of stored-product insects.

SIGNIFICANCE OF RESULTS:
Our work was instrumental in spinosad being registered in January 2005 for use of stored grain. In June of 2005, the international tolerances for spinosad (Codex) were approved. Commercial products of spinosad will be available for producer use by June 2006, for both organic and non-organic stored wheat. The survey information will be useful in developing product stewardship programs for spinosad once it is close to being commercialized by pesticide registrants and distributors of spinosad. The survey information will also be useful for extension educators to develop proper training programs in the use and application of spinosad to stored grains.

Wheat Improvement through Genetic Engineering

RESEARCHERS AND UNITS:
Harold N. Trick, Dept. of Plant Pathology; Subbaratnam Muthukrishnan, Dept. of Biochemistry; and Allan Fritz, Dept. of Agronomy

FUNDS (FY 04): $40,500 **Completion Date:** June 2007

JUSTIFICATION: Wheat improvement through genetic engineering has been identified as a priority program for KSU's Department of Plant Pathology, the Plant Biotech Center, and K-State Research and Extension. The work outlined in this proposal falls under this umbrella. In addition this proposal also is within the scope of the KWC RFP interest areas. The proposed research will increase pest resistance. By simultaneously working on several traits, we can improve the efficiency of our research efforts. Wheat transformation will occur year-round with little interruption. Our previous work has demonstrated that this approach works well to produce transgenic wheat plants.

OBJECTIVES:
Our overall objective is to improve wheat through the use of biotechnology. Specifically, our objectives are to:

1. Evaluate resistance genes and anti-fungal genes for disease control in transgenic wheat.
2. Enhance our existing abilities to make transgenic wheat, especially to direct gene expression to specific areas within the plant.
3. Refine our tools for wheat genetic engineering and transfer traits to elite cultivars.

RESULTS: Existing lines of wheat plants containing antifungal genes chitinase and glucanase were subjected to leaf rust bioassays, but, unfortunately, no significant resistance could be shown. Transgenic lines containing the Lipid transfer protein, a potential antifungal protein, also did not yield promising results. We have obtained three separate gene sequences that may disrupt fungal growth and have performed five separate transformation experiments in May. Selection continues with these cultures.

Evaluation of the transformation competency of 'Overly' and 'Madison' continued this funding cycle. Both varieties seem to be competent for transformation, inasmuch as we have recovered several independently transformed lines, but they are significantly more recalcitrant than our standard spring varieties of 'Bobwhite' and 'Fielder'. Other lines, such as Jagger and a few PI lines, were also evaluated and have demonstrated favorable results.

A new selection process has been initiated in the lab to determine its efficacy, compared with our current methodologies. This new selection process uses a "positive selection agent" based on the sugar alcohol arabitol. After genetically engineering the wheat cells with the arabitol dehydrogenase gene, the transformed cells are grown on medium supplemented with arabitol as its sole carbon source. The benefits of this selection method would be the elimination of herbicide and antibiotic resistance gene that are currently deployed. More than five separate experiments have been initiated, and the selection process is ongoing. To date, four putative plants have been recovered, with additional plants on the way.

SIGNIFICANCE OF RESULTS:

Transformation of model cultivars such as the spring varieties “Bobwhite” and “Fielder” has merit because of the ease of transformation and the wealth of information gained by introducing foreign genes into wheat. But these varieties are not adapted to the Kansas climate. Screening the transformation competency of several current and future cultivars adapted to Kansas will identify specific lines that are amenable to the transformation process. Using such cultivars will greatly facilitate the job of the wheat breeder when it comes time to deploy the transgenes for field application. Utilizing an alternative selection agent such as arabitol dehydrogenase will allow recovery of transgenic lines without herbicide or antibiotic resistance, which may be more readily accepted by the public and our trading partners abroad. In addition, an alternative selection process will allow additional transgenes to be incorporated at a later time.

2005 Grain Commissions Report

This publication is produced by the Department of Communications at Kansas State University. The full publication is available on CD or via the World Wide Web at:

http://www.oznet.ksu.edu/library [type Grain Commissions Report in the search box].

Printed versions of the publication are available upon request.

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

Department Report November 2006