

MINUTES OF THE HOUSE COMMITTEE ON AGRICULTURE.

The meeting was called to order by Chairperson Joann Flower at 9:00 a.m. on January 26, 1995, in Room 423-S of the Capitol.

All members were present except:

Committee staff present: Raney Gilliland, Legislative Research Department
Kay Scarlett, Committee Secretary

Conferees appearing before the committee:

Marc A. Johnson, Dean of Agriculture, Kansas State University
Gerry Posler, Department of Agronomy, Kansas State University
Curtis Kastner, Department of Animal Sciences and Industry, Kansas State University
Richard R. Hahn, Department of Grain Science and Industry, Kansas State University
Phillip Barnes, Research Engineer, Kansas State University

Others attending: See attached list

Chairperson Flower welcomed everyone and introduced Marc A. Johnson, Dean of Agriculture, Kansas State University. He is also Director of the Agricultural Experiment Stations and Cooperative Extension Service. Because agriculture and agribusiness are a substantial part of the Kansas economy, the impact of projects at KSU College of Agriculture that support business and industry help Kansas farmers and ranchers, processors, and businesses remain competitive. They strive to be sure each educational and research project is economically promising, environmentally safe, and resource sustainable. Dean Johnson and other extension faculty reviewed the economic impact of selected projects in the College of Agriculture on "Agriculture and the Kansas Economy - 1995" in the areas of crop genetics, animal industry, product utilization, and environmental impact. (Attachment 1)

Gerry Posler, Department of Agronomy, Kansas State University, reported on the importance of crop genetics. During the past 50 years productivity of basic food crops has doubled. Sixty percent of this improvement can be directly attributed to improved genetics. As we can no longer increase productivity by increasing planted acreage, the capacity to increase productivity and quality in the future will depend even more on genetics. They are working to develop varieties with genetic resistance to disease and insects, improve stress tolerance, and absorb nutrients more effectively. While improving quantity and quality of crops, plant genetics will help protect the environment by requiring the use of less chemicals and pesticides.

Curtis Kastner, Department of Animal Sciences and Industry, Kansas State University, reported that 73 percent of agricultural sales in Kansas related to livestock. In spite of the substantial impact of livestock on the economy of Kansas, the potential for growth still exists. Continuing challenges facing the industry beside profitability, include changes in consumer demand, convenience of products, nutritional needs, and safety of food production. They will continue research to improve animal product quality, range lands, product value, reproductive efficiency, and production systems.

Richard R. Hahn, Department of Grain Science and Industry, Kansas State University, reported how value-added products are a major factor in the agricultural economy and a growing part of our exports. A major effort is underway to expand the development and use of industrial products from agriculture. KSU is intensifying its efforts to develop and exploit technology for increased product utilization. He covered such areas as wheat and wheat products, sunflower and other oils, feed grains, ethanol fuel, plastic-like products, adhesives, coatings, and foods with improved nutritional qualities.

Phillip L. Barnes, Research Engineer at the KSU Kansas River Valley Experiment Field, discussed the environmental impact of agricultural chemicals, mainly atrazine, on our water supply. KSU has worked with producers and state agencies to establish the first pesticide management area in the United States on the

CONTINUATION SHEET

MINUTES OF THE HOUSE COMMITTEE ON AGRICULTURE, Room 423-S Statehouse, at 9:00 a.m. on January 26, 1995.

Delaware River in northeast Kansas. Programs include education for area farmers on management systems for safe use of agricultural chemicals, water quality monitoring programs, and research on the efficient and safe use of herbicides and plant nutrients and their impact on surface and groundwater quality. KSU is also working with personnel from Kansas, Nebraska, and the Blue River Compact to improve water quality in Tuttle Creek Reservoir.

Chairperson Flower thanked Dean Johnson and his staff for their informative presentation. She asked the committee to review the minutes of the January 24. If there are corrections or additions to please contact the secretary by 5:00 p.m. today, or they would be considered approved as presented.

The Chair asked the committee members to let the secretary know if they were planning to go to the Kansas City Board of Trade on February 3.

The meeting adjourned at 10:00 a.m. The next meeting is scheduled for January 31, 1995.



January 26, 1995

Dear Friends,

Kansas agriculture is a robust \$7.4 billion dollar industry in which multiplier effects increase the farm-gate value to \$22.2 billion. Clearly, agriculture is an important force in the state's economy and provides essential and statewide support for families, communities, and industry.

I'm genuinely pleased to share this informal report of the teaching, research, and extension efforts of faculty in the College of Agriculture which significantly enhance the state's economy. This is accomplished through their work with students, citizens, and the state's crops, livestock, and natural resources.

The economic appraisals in this publication were gleaned from existing reports where scientists and specialists "estimated" the economic impact of their work.

If there are questions or suggestions, I'd be pleased to respond.

Sincerely,

A handwritten signature in black ink that reads "Marc A. Johnson". The signature is written in a cursive, flowing style.

Marc A. Johnson
Dean and Director

*House Agriculture
Attachment 1
1-26-95*

AGRICULTURE AND THE KANSAS ECONOMY

EXAMPLES OF POTENTIAL ECONOMIC ENHANCEMENT

AN INFORMAL REPORT TO THE KANSAS LEGISLATURE

by the **College of Agriculture**
Kansas Agricultural Experiment Station
and the **Kansas Cooperative Extension Service**

January 1995

KANSAS STATE UNIVERSITY

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EXECUTIVE SUMMARY

Agriculture is a \$7.4 billion industry, and multiplier effects increase the farm-gate value to \$22.2 billion. The value of production is enhanced by processing Kansas products into food, feed, and other value-added products. Significant quantities of the state's crops are also fed to livestock.

The examples of economic impact in this document were gleaned from reports by K-State scientists, Extension specialists, or observers who estimated the impact of their work. These estimates have not been subjected to rigorous economic analysis.

Kansas Crops: In 1993, crops provided 34 percent of agriculture's cash receipts and support for many agribusinesses, including the livestock, meat-packing, and flour-milling industries.

Newton wheat, first semi-dwarf wheat in Kansas, increased state income more than \$700 million since 1980. Releases like Arkan wheat, \$40 million, and Karl wheat, \$50 million, also favorably impact the Kansas economy. This year, Karl 92, with a 4 bu/a yield advantage over Karl, was the top performing variety in Kansas, Oklahoma, Missouri, and Texas. If Karl 92 replaces Karl on just 4 million acres, the economic advantage will approximate \$12 to \$15 million annually. Wheats like Karl, Karl 92, and Jagger are replacing hard red spring wheats in flour blends.

Plant breeding provides outstanding returns in yield; flour and product quality; insect and disease resistance; and environmental quality. About \$35 is returned for every dollar invested.

The American White Wheat Producers Association is marketing Kansas hard white wheat flour at a price 5 percent to 15 percent above that of hard red wheat. Thus, sales, profit, and planting intentions increased significantly in 1994.

For other crops, scientists estimate that the use of greenbug and chinch bug resistant sorghum hybrids provides \$45 million in annual benefits to Kansas farmers. Additional benefits are also realized from new germplasms, varieties, or hybrids of soybeans, sunflowers, alfalfa, melons, barley, triticale, and other crops.

Crop Rotations and Weed Control: The wheat-sorghum-fallow rotation (2 crops in 3 years) has replaced the wheat-fallow rotation (1 crop in 2 years) and enhanced farm income in many areas. Where nematodes infest soybeans, crop rotation alone provided a \$44 per acre advantage, whereas the use of crop rotation plus a resistant variety gave a \$78 per acre advantage. Weed control research includes cultural, chemical, and biological control strategies. The payoff is substantial—

\$25 million/year for a 1 percent improvement in crop value due to better weed control.

Plant Disease and Insect Pests: Losses to insects and diseases exceed hundreds of millions of dollars annually. Losses to wheat streak mosaic virus alone approximate \$36 million each year. Newly developed K-State lines could reduce those losses by 50 percent to 90 percent. KSU scientists discovered resistance to the wheat curl mite (the carrier for wheat streak mosaic virus) in 1991 and are working to ameliorate losses from corn borers, corn rootworm, and spider mites. Entomologists have established an integrated pest management program to control stable flies. Increases in cattle gains approximate 0.2 lb/day or \$3.2 million/year.

Soil Management Research: Kansas is a national leader in implementing conservation tillage practices like stubble mulch, ridge-till, no-till, and intensified cropping systems that include a fallow period. Incorporating balanced amounts of nutrients below the soil surface has increased nutrient efficiency as much as 15 percent to 30 percent where liquid nitrogen was used with fescue or brome in southeast Kansas and as much as 20 percent to 25 percent in no-till applications.

Grains, Grain Processing, and New Products: K-State programs help market Kansas products both nationally and internationally. The International Grains Program established contacts with 58 countries that purchase U.S. grain and equipment. The DIRECT program helps individuals interested in business, economic, and rural development (1,400 development cases per year). Kice milling is marketing an innovative, efficient, low-cost, short-flow flour mill developed by K-State. Its goal is to build one new unit each month, which will increase company revenues by \$9 million annually. K-State programs also impact the development of value-added products and the use of frozen dough in bakeries and vitamin C in animal feeds.

Range Research: Kansas is an important livestock-producing state, and range is a prominent forage. Research demonstrates that prescribed burning of tall grass prairie will enhance animal gain by 32 lb/head/year. For the 375,000 cattle and 2.5 million acres affected, the annual income enhancement is \$16.2 million. Intensive early stocking has resulted in a 40 percent to 50 percent increase in the total number of cattle grazing on the Flint Hills. The annual income enhancement approximates \$38.4 million. Researchers have also developed interseeding and implanting techniques that overcome 65 percent to 83 percent of the loss induced by cattle grazing on endophyte-infected fescue pastures in southeast Kansas.

Meat and Meat Products: KSU scientists have worked to add value to beef products by developing procedures to re-

structure various cuts into higher-value, steak-like and roast-like products, by developing meat-based snack foods, and by packaging that enhances shelf life. A 3-day to 5-day increase in shelf life would increase value by \$10 to \$20 per carcass for pork and by \$100 per carcass for beef.

Livestock Programs: Training and trade exchange programs were developed with representatives from 7 countries to enhance international trade. Extension programs helped Kansas producers maximize feed efficiency and meet environmental standards. For a 500-head feedlot, annual savings can total \$750,000. Scientists also determined that the benefits from implants approximates \$30/head and from ionophores approaches \$20/head. Rations and processing procedures also were formulated to increase the efficiency of wheat and sorghum in cattle and swine rations.

Statewide, these developments are thought to add \$0.10 per bushel to the price of wheat and \$0.20 per bushel to the price of sorghum.

KSU scientists have made major advances in helping producers improve reproductive efficiency. Administering prostaglandin F_{2a} 25 to 40 days after calving increased pregnancy rates by 18 percent. Likewise, administering F_{2a} to cows that are not inseminated due to missed heats or other reasons will facilitate pregnancy. If a heifer fails to become pregnant, the net loss approximates \$250 per heifer. Repeat-breeders are common in dairy cows. Administering gonadotropin-releasing hormone at the third insemination will result in a 10 percent increase in pregnancy rates. For the 43,000 cows in the Dairy Health Improvement Program, this could increase gross income by \$806,000 annually.

OVERVIEW

Marc A. Johnson, Dean of Agriculture

Introduction

The College of Agriculture, through its teaching, research, and Extension faculty, organizes numerous projects that enhance the economic, environmental, and social well-being of Kansans. Clearly these efforts pay big dividends. Consequently, I'm genuinely pleased to present this informal report on Agriculture and the Kansas Economy—1995. These accounts were summarized from existing reports, and the economic appraisals represent the "best estimates" of project leaders and specialists.

Support for Business and Industry

Because agriculture and agribusiness drive a substantial part of the Kansas economy, we wanted to report the impact of projects that support business and industry so Kansas farmers and ranchers, processors, and businesses can remain competitive. The KSU College of Agriculture, Agricultural Experiment Station, and Cooperative Extension Service are making strategic plans, setting priorities, and asking searching questions. We want to know if each research and educational objective and the enterprise each supports is economically promising, environmentally safe, and resource sustainable. This is a continuing, long-term objective.

In this publication, I will highlight the economic impact of selected projects. My colleagues will report on the economic advances related to crop genetics, animal industry, product utilization, and environmental impact.

Crops

We are pleased with variety releases by the Agricultural Experiment Station that yield more, mill better, and enhance our competitive edge. Since 1980, the improved yield and

quality of releases like Newton, Karl, and Karl 92 have contributed more than \$790 million to the Kansas economy.

Because of high protein and excellent quality, Kansas varieties are reducing shipping costs and replacing spring wheats in flours, frozen doughs, noodles, and other products. In addition, a producer association is marketing Kansas hard white flour at prices 5 percent to 15 percent above that of hard red flour. A marketing association can now be formed to market each released soybean variety.

Livestock

Experiment Station scientists are working effectively to add value, develop new products, and improve the processing, safety, and profitability of meat and meat products. Research on low-fat, value-added, and restructuring products increased the value of Kansas products by \$210 million annually. Microbiologists are developing a vaccine to prevent liver abscesses in cattle.

Animal scientists are developing cost-effective and profitable production and protection systems for livestock. Their research (nutritive value, processing, and rations) on feeding grain sorghum and wheat to cattle increased the price per bushel and enhanced the Kansas economy by \$80 million. Systems to increase pregnancy rates in dairy herds increased annual income by \$806,000.

Grain Science

K-State is the only university in the world that offers undergraduate degrees in milling science, feed sciences, and bakery science. These programs help millers, bakers, and agribusinesses establish domestic and international markets

and expand markets and industrial uses of wheat starch and flour, formulate thermoplastics from corn starch, add value to extruded products, and add vitamin C to animal feeds. Kice Milling at Wichita is marketing an innovative, efficient, low-cost, short-flow flour mill developed at KSU.

Range Management

Kansas is blessed with 17.4 million acres of range and is an important forage and livestock producing state. K-State research demonstrated that prescribed burning has enhanced animal gains by 32 lb/head annually and that intensive-early stocking has resulted in a 40 percent to 50 percent increase in cattle numbers in the Flint Hills. The two practices enhance annual income almost \$55 million.

Revitalizing Rural Kansas

A four-phase K-State program on creating economic opportunity requires 12 to 18 months of coordinated community effort. I'm pleased to report that 13 counties and 7 communities have successfully completed this program to organize, analyze, set goals, and implement action programs. Program results include housing initiatives, job creation, and similar community improvements.

Summary

I'm genuinely pleased to share this report of programs that enhance the state's economy. KSU scientists and specialists are dedicated to programs that enhance the economic and social well-being of its citizens.

Should there be questions or suggestions, I'd be pleased to respond.

CROP GENETICS

Rollin G. Sears, Professor, Department of Agronomy

Plant Research

Plant research is one of our best investments. During the past 50 years of plant breeding, corn yields have increased approximately 2.5 percent per year, wheat about 1.5 percent per year, sorghum and soybeans about 1 percent per year, and alfalfa about 1.5 percent per year. These gradual increases have resulted in doubling productivity for our basic food crops during this period. It has been estimated that 60 percent of this improvement can be attributed directly to improved genetics.

Genetics and Productivity

Reliance on improved genetics to further increase productivity of our important food crops will be more important for the future than in the past or present. No longer can we increase productivity by increasing planted acres or expanding irrigated acres. Inputs will continue to be specific for cropping conditions and yield goals but no longer excessive or wasteful. Increases from improved seeding rates, fertilizer placement and row spacing have likely been maximized. And reliance on chemicals to control harmful weeds, insects, and diseases will be reduced in the interest of both food as well as environmental safety. Our capacity to continue to increase productivity and quality depends even more strongly on genetics than at any time in the past or present. But at the same time, our knowledge of how to utilize genetics to improve crop productivity and quality is expanding at a very rapid rate. Crop scientists certainly have the tools to continue the positive gains of the past 50 years of crop improvement.

Developing Specific Plant Characteristics

In Kansas, and throughout the nation, investing in plant improvement is arguably the best investment we can make

with our research dollars. For every dollar invested in wheat research in Kansas, we net an approximate \$35 return on that investment. That return on investment is likely to get even larger. It is much more efficient and much safer to develop varieties with genetic resistance to disease or insects and to develop varieties or hybrids that can compete more effectively against weeds, or to absorb nutrients more effectively. Likewise, it is more efficient to develop wheat varieties with better baking properties and stronger dough-mixing properties so that ingredients aren't required to bolster flour performance. How valuable is a gene added to alfalfa which would prevent the alfalfa weevil from damaging either forage or seed yields?

Targeting Stress Tolerance and End-Use Qualities

We have the capacity to genetically manipulate and improve pest tolerance and improve stress tolerances, like heat or drought stress, and improve crop quality. Plant scientists are beginning to develop crops with targeted and specific end-use qualities for both food as well as industrial uses. We have only begun to tap the potential of this genetic manipulation.

Environmental Quality

Important to all of this research is the realization that as humans we don't exist alone. Everything we do and touch impacts our environment. We are beginning to develop models that account for ecosystems and even global consequences. With this knowledge is the realization that the more we can pack into a plant genetically the less impact we will have on our environment and the more value added we can make our crops. A seed is a wonderful part of nature. It carries the capacity to germinate and develop into a

new plant as well as to feed the world. Our capacity to protect Kansas agriculture, insure a more profitable agriculture, and to insure Kansas farmers and other citizens a bright and healthy future relies, in part, to our investment in plant research and genetics.

Value-Added Seed

For plants, adding value often begins with the seed. The more we can pack into that seed to allow the plant to protect itself against its environment, the more efficient and profitable Kansas agriculture will be in the future. Plant research is one of our best investments.

ANIMAL INDUSTRY

Larry R. Corah, Extension State Leader, Animal Sciences and Industry

Introduction

Agriculture is a \$7.4 billion industry in Kansas with multiplier effects that increase the farm-gate value to \$22.4 billion. Of this total, data from the U.S. Department of Commerce show that livestock and related products generated 73 percent of agricultural sales in Kansas during 1992. The \$6.04 billion generated by livestock compares to \$2.7 billion for crops.

In spite of the substantial impact of livestock on the economy of Kansas, the potential for considerable growth still exists, particularly over the next four years. With recent legislative changes, the swine and dairy industry are poised for dramatic growth in Southwest Kansas, further contributing to the influence of animal agriculture on the state's economy.

However, the challenges facing animal agriculture are also substantial. Beef and swine prices have dropped dramatically, impacting the profitability of these operations. Equally, the demands of consumers require continued improvement in the quality of products being produced, marketed, and consumed.

Extension Focus

In its next four year programming cycle, the Kansas Cooperative Extension Service will focus on multiple issues facing animal agriculture on the farm, in the feedlot, and in the processing cycle, including renewed emphasis on low-cost production systems; additional ways of adding value to products sold; and improving product quality to satisfy consumer needs.

Research Focus—Current and Future

Research scientists will continue their work to improve animal product quality, range lands, product value, reproductive efficiency, and production systems, including:

Enhancing the Quality of Animal Products

- Support for a federally funded food safety consortium that focuses on beef and beef products.
- Quality assurance programs in beef, swine, and dairy.
- Generating new technologies to improve the uniformity and quality of products sold.

Improving the Utilization of Rangelands

- Developing new methods for determining the quantity and quality of available forage.
- Organizing and evaluating grazing systems for cow-calf and stocker operators.
- Continued enhancement of the potential role of complementary forages.

Developing Added Value for Meat and Dairy Products

- Heighten the salability of undervalued meat products.
- Improving the packaging, processing, and shelf life of red meat products.
- Developing snack, lean beef, and low salt and specialty meat-based products.

Improve the Reproductive Efficiency of Farm Animals—Beef, Dairy, Swine, and Horse

- Improving reproductive performance, including early conception and a reduction of the postpartum interval.
- Enhancing nutrition, environmental, and other factors that impact reproductive efficiency.

Production Research that Focuses on Creating Low-Cost Production Systems for Kansas Agriculture

- Emphasize the development of feed and nutrient systems for private and commercial operators to enhance efficiency, environmental quality, and profitability.
- Continue the development of production systems that more effectively utilize Kansas forages, grains, and products.

PRODUCT UTILIZATION

Richard R. Hahn, Head, Grain Science and Industry

Introduction

Value-added products are a major factor in the agricultural economy and a growing part of our exports. A major effort is underway to expand the development and use of industrial products from agriculture. Value-added food, feed, and fuel products continue to be major sources of revenue for farmers and agribusiness. KSU is intensifying its efforts to develop and exploit technology for increased product utilization in many areas.

Wheat and Wheat Products

Improved wheat genetics are contributing to utilization in several areas. New varieties such as Karl, Ike, and Jagger have significantly improved the milling and baking quality of Kansas wheats—making them more competitive in national and international markets. Several major millers and grain buyers are paying 10 to 15¢/bu premiums for Karl wheat to capitalize on its superior protein content and end-use qualities.

KSU-developed hard white wheat varieties are being exploited by the American White Wheat Producers Association through a unique production, milling, and marketing scheme that preserves the identity of the wheat. Unique baking markets are being established. Approximately 10,000 acres are under contract, and the growers benefit from margins generated through identity preservation and the milling and marketing of flour rather than grain. Work is also underway to find ways to use Kansas red or white wheats in the worldwide noodle market. Australian wheats dominate this use, but KSU scientists have demonstrated that Kansas wheats can compete.

Other Products

The desire of consumers for leaner beef and pork has led to improved diets and feed-processing systems that target leanness. Sorghum hybrids with improved feeding value are being released. After extensive research at KSU, steam flaking, pelleting, and extrusion are emerging as processing

techniques with great promise. It is now commonly held that sorghum is equivalent to corn in animal performance under recommended conditions, many of which were established by K-State research and feeding trials.

Dairy rations are being developed at K-State that employ locally grown materials for use by an expanding dairy industry in the state. The use of modified wheat gluten as a protein source for baby pigs has greatly increased its utilization in feed rations and is reducing cost, improving feed efficiency, and enhancing growth and health in baby animals. New product research and advanced processing techniques are helping Kansas entrepreneurs produce leaner, lower cost, and precooked beef and pork products for today's markets.

Oil Crops

Sunflower processing has been established by the National Sun Industries plant in Goodland as a new value-added industry in the state. Sunflower oil is in good demand, and a major effort is underway to provide the production and processing requirements for other oilseed crops, including canola, crambe, and specialty rapeseed.

Industrial Products

Research results that support the building of an expanded industrial and agricultural processing capability in the state are moving toward commercialization. The ethanol fuel industry is expanding and now uses 100 million bushels of sorghum and wheat each year. A new wheat gluten plant is under construction, which enhances Kansas' position as the world's leading gluten-producing state. New applications for wheat gluten and wheat starch are under active development for areas such as plastic-like products, adhesives, coatings, and foods with improved nutritional qualities.

Work is also underway on the utilization of straw, biomass, and the processing of by-products that could provide farmers and processors with new income.

ENVIRONMENTAL IMPACT

Philip L. Barnes, Research Engineer

Introduction

Increasingly, both policy makers and scientists are addressing costs associated with the use of herbicides, their presence in water, and their effect on municipal water treatment systems. But a recent U.S. Department of Agriculture report stated: "Banning atrazine would increase costs to farmers and consumers."

Cost of Water Treatment

The USDA report concluded "The benefit from reducing atrazine discharges is the elimination of the need for water utilities to install additional treatment systems in order to meet Safe Drinking Water Act goals. The cost of treating all surface water consumed in the Midwest would be about \$400 million each year. In reality, only a small portion of

the surface water supplies would require treatment, but this figure provides a useful upper bound of potential treatment costs.”

The study examined the long-run costs to farmers and consumers of three management strategies: 1. Completely banning the use of atrazine; 2. Restricting application to a time after the crop emerges; and 3. Restricting the use of atrazine to meet a particular water quality goal (such as not using atrazine in areas where it harms surface water).

The Cost of Banning Atrazine

Banning the use of atrazine would eliminate the need to remove that chemical in a water treatment plant. However, the cost to producers and consumers could range between \$517 million and \$665 million. Hence, a general ban would result in costs greater than the cost of water treatment. This also demonstrates a problem with chemical-specific control strategies. If the use of atrazine is eliminated, the use of alternate herbicides will increase amounts applied, residues in soil and water, and associated risks to the environment and to human health. Unlike atrazine, most of the proposed substitutes do not have an enforceable drinking water standard. Accordingly, a strategy that considers both the target chemical and its substitutes will provide more effective protection to human health and to natural ecosystems than will an iterative, chemical-by-chemical approach.

Alternates to Atrazine

Kansas farmers use atrazine to control weeds in corn and grain sorghum. If the use of atrazine were restricted, farmers would use alternative herbicides to control weeds. Other herbicides do not control weeds as effectively as atrazine, so more chemical would need to be applied in order to achieve the same level of control. As a result, the cost of production and the price of food would likely rise. Similarly, some of the environmental gains made by reduced use of atrazine could be offset by the increased use and increased discharge of other chemicals.

Delaying or Targeting Atrazine Applications

Delaying atrazine applications until after the crop emerges reduces weed control effectiveness and would likely cost producers and consumers between \$224 million and \$295 million each year. However, this option does not eliminate the risk of atrazine contamination due to runoff. This conclusion, plus the fact that only a small portion of surface water systems may actually need to install treatment systems, strongly suggests that the cost of this management practice outweighs the benefit.

Targeting atrazine management restrictions to meet water quality standards could eliminate the need to install advanced water treatment systems. Those costs are thought to approximate \$328 million to \$389 million annually. Once again, it is unlikely that benefits will outweigh the costs, although this was the most cost-efficient approach. However, this strategy, which accounts for all herbicides in the system, results in the best overall level of water quality.

KSU Programs

Kansas State University has initiated research and Extension programs designed to improve management skill and safe use of agricultural chemicals, and protect environmental quality. To further those objectives, KSU faculty worked with producers and state agencies to establish the first pesticide management area (PMA) in the United States on the Delaware River, northeast Kansas.

K-State faculty are assisting with programs in the PMA that include education for area farmers on management systems for safe use of agricultural chemicals; water quality monitoring programs for Perry Lake, the Delaware River, and its tributaries; and research on the efficient and safe use of herbicides and plant nutrients and their impact on surface and groundwater quality.

Preliminary data indicate that farmers in the PMA are using smaller quantities of herbicides, better management practices, and that the quality surface waters meet water quality standards. Continued monitoring and use of best management practices will be essential.

Programs that Involve Nebraska

KSU scientists are also working personnel from Kansas, Nebraska, and the Blue River Compact to improve water quality in Tuttle Creek Reservoir and its outflow to drinking water systems along the Kansas River.

AGRICULTURE AND THE KANSAS ECONOMY

EXAMPLES OF POTENTIAL ECONOMIC ENHANCEMENT

This report was prepared to provide examples of the economic impact of programs conducted by the College of Agriculture, the Agricultural Experiment Station, and the Cooperative Extension Service at Kansas State University. The values reported represent the judgment of knowledgeable researchers, Extension specialists, or informed observers but have not been subjected to a rigorous economic analysis. In other instances, a promising research development is cited and the reader is left to assess the economic impact.

Agriculture cash receipts rank Kansas seventh among the states, and the \$7.4 billion industry is largely due to Kansas ranking first in wheat production, sorghum production, and flour milled; second in total cropland; third in cattle and calves produced and red meat processed; and no lower than 10th in the production of alfalfa, soybeans, and corn. Multiplier effects elevate the farm-gate value to \$22.2 billion.

COLLEGE OF AGRICULTURE GRADUATES

Between 1988 and 1993, nearly 350 males and 125 females graduated each year from K-State with bachelors' degrees in agriculture. Traditionally, about 85 percent of the undergraduates in the College of Agriculture are from Kansas. After completing their degree, many graduates serve in leadership positions and make significant contributions to improved quality of life and community development.

The economic impact of a bachelor's degree can be assessed by comparing the salaries of university and high school graduates as reported to the Bureau of Census in 1990 and shown below.

Education	Average Salary	
	Men	Women
High School Graduate	\$26,653	\$18,319
Bachelor of Science	\$39,328	\$28,017

When compared to high school graduates, a bachelor's degree will increase the annual earning power of a male by \$12,675 and of a female by \$9,698. Over a 20-year period, the increase in earning power equates to \$253,500 for each male and to \$88,725,000 for 350 male graduates; to \$193,960 for each female and to \$24,245,000 for 125 female graduates.

Clearly, an agricultural graduate is a value-added product of prime importance to Kansas and the nation. The economic impact of graduates with masters' or doctoral degrees is even more significant.

EXTRAMURAL FUNDING

In 1992, agricultural scientists at K-State were awarded \$14 million in extramural funding. This research and scientific effort is the equivalent of 14 one-million dollar indus-

tries in Kansas. This adds to the body of knowledge, contributes to long-term economic development, and brings recognition to agricultural scientists and to K-State.

KANSAS CROPS

With 31 million acres in cropland, \$2.5 billion in receipts from crops, and \$2.2 billion in exports (6th in the nation), crop production is big business in Kansas. In 1993, crops provided 34 percent of agriculture's cash receipts and support for many agribusinesses, including the important livestock, meat packing, and flour milling industries.

Research programs that increase yield, efficiency, or quality have powerful multiplier effects. KSU researchers and Extension specialists work to provide superior germplasm for new hybrids and varieties; incorporate insect and disease resistance; and develop improved cropping strategies to enhance the Kansas economy.

The following summary reports represent potential economic impact as judged by researchers and specialists:

WHEAT

Newton Wheat: Large profits come from breakthroughs—for example, the development of Newton hard red winter wheat, the first semidwarf release in Kansas. This single release has increased state income more than \$700 million since 1980.

Karl Wheat: Karl hard red winter wheat, recently released, is expected to have an even greater total economic impact than Newton. Releases like Arkan wheat, \$40 million, and Karl wheat, \$50 million, also favorably impact the Kansas economy. In a single year, the yield advantage and protein premium payments for Karl added \$16.5 million to the Kansas economy.

Karl 92 Wheat: This year, Karl 92 was the top performing variety in Texas, Oklahoma, Kansas, and Missouri. It represents improvements in yield (4 bu/a) and test weight over Karl. This improved performance is at no sacrifice to milling and baking quality, which is considered excellent for both Karl and Karl 92. The milling industry continues to pay premiums for Karl, recognizing its excellent end-use properties. If Karl 92 replaces Karl on 4 million acres, the yield advantage equals \$12 million to \$15 million annually. Wheats like Karl, Karl 92, and Jagger are replacing hard red spring wheats in flour blends.

Plant breeding provides outstanding returns in yield; flour and product quality; insect and disease resistance; and environmental quality. About \$35 is returned for every dollar invested.

Ike Wheat: Ike is a hard red winter wheat variety approved for release by KSU in 1993. Adapted to western Kansas, Ike is resistant to leaf rust, Hessian fly, and soil-borne mosaic virus. Ike has higher protein (0.5 percent), better bread-making quality, and higher grain yield (13 percent) than TAM 107. If Ike can replace the highly leaf rust susceptible variety, TAM 107, Kansas farmers could save \$35 million in leaf rust losses and gain an additional \$30 million in yield increases each year.

Jagger Wheat: The KSU variety release committee approved the increase and release of Jagger hard red winter wheat at the 1994 Fall Cereal Conference. Jagger has an 8-bushel yield advantage over Karl 92 and 2163. It has an excellent combination of disease resistance and improved baking properties over Karl 92. Jagger is adapted to all growing areas of Kansas, while Karl and Karl 92 are best adapted to central and eastern Kansas.

Arlin: This year, Arlin, a recent KSU release, was grown throughout the state. Due to excellent performance and

milling and baking quality, it has allowed the American White Wheat Producers Association to expand production. Two new hard white wheat selections, KS87822-2-1 and KS85W663-11-6-1, are now in regional tests. Collectively, their performance was better than Arlin in central and eastern Kansas and slightly lower than Arlin in western Kansas. Both selections have better disease resistance than Arlin.

Hard White Winter Wheat: After five years of development, the American White Wheat Producer's Association (AWWPA) has turned the corner and will make a small profit this year. The first Kansas hard white winter wheat, Arlin, was released through AWWPA in 1992. Major markets have been developed for hard white whole wheat in:

Whole wheat tortillas	Tyson Foods
Bakery flour	Flowers Baking Company (Georgia)
Retail flour	Stafford Flour Mill and King Flour (Vermont)

The American White Wheat Producers Association is marketing Kansas hard white wheat flour at a price 5 percent to 15 percent above that of hard red wheat. In 1994, increased benefits will exceed \$144,000. Hard white winter wheat is in short supply, and planting intentions for the 1994 harvest have increased dramatically.

Disease and Insect Pests of Wheat: Each year the state's wheat crop is attacked by both disease and insect pests. In the Great Plains, leaf rust causes an estimated \$200 million in lost yields. Hessian fly reduces yields an estimated \$8 million annually. Since 1990, the Wheat Genetics Resource Center at K-State has released 7 new germplasm lines resistant to both these important pests. This is an efficient and cost-effective way to materially enhance yields and profitability.

Wheat Genetics Resource Center: The KSU Wheat Genetics Resource Center (WGRC) now catalogs more than 2,200 strains of wheat collected from around the world. Each accession has been or is being evaluated for resistance to leaf rust, stem rust, yellow rust, leaf blotch, tan spot, powdery mildew, wheat streak mosaic virus, barley yellow dwarf virus, Hessian fly, greenbug, Russian wheat aphid, and wheat curl mite.

Genes from wild wheat species in the WGRC are being transferred to domestic wheats. To date, 31 germplasms containing genes for resistance to Hessian fly and greenbug pests, leaf rust and powdery mildew fungi, and wheat soil-borne and spindle streak mosaic viruses have been released.

Chromosome Mapping: Chromosome fingerprinting helps identify individual chromosomes in wheat, whereas chromosomes and chromosome segments can be identified using DNA fragments as markers. This allows for building a more saturated map of the chromosome. The wheat

Triticum tauchii was used to make the map that now consists of 280 DNA loci; 260 of these are present as chromosome linkage groups. Additionally, eight protein markers and a leaf rust resistance gene are included in the map. Linking specific genes to specific plant traits vastly improves plant-development techniques.

Host Plant Resistance in Wheat: No wheat cultivar is immune to wheat streak mosaic virus, and good sources of resistance genes were only known in rye and wheatgrass species. Therefore, these genes were added to complementary wheat chromosomes. Subsequently, resistances to wheat streak mosaic virus and leaf rust resistance were transferred to commercial wheat cultivars. The alien chromosomes are tracked by chromosome fingerprinting techniques.

GRAIN SORGHUM

Sorghum Germplasm: Grain sorghum germplasms with resistance to chinch bugs, greenbugs, sorghum diseases, and stress tolerance have been released by the Agricultural Experiment Station. However, biological change may result in the loss of needed resistance and require scientists to develop new sources of resistant germplasm. Such releases contribute significantly to farm profitability and environmental quality. It is estimated that the use of greenbug and chinch bug resistant sorghum hybrids provide \$45 million in annual benefits to Kansas farmers.

SOYBEANS

Breeding Soybeans for Increased Productivity: Development of new, disease resistant varieties and integration of those varieties into cropping systems accounts for approximately one-half of the improvement in soybean yields in Kansas. Recent or planned K-State releases include KS5292, KS3494, KS4694, and K1192. These and other releases significantly impact the Kansas economy. For example, the genetic contribution of new varieties represents an increase of .1 to .2 bu/acre/year in productivity. In Kansas this improvement potentially increases farm revenue by \$1.2 million to \$2.4 million per year.

Soybean Variety Release Policy: To facilitate production and marketing, the Kansas Soybean Variety Release Board will release selected soybean varieties developed by Kansas State University and cooperating institutions. All eligible certified soybean growers will be informed of pending releases. Those who choose to participate will form a marketing association for each released variety. Each association will have its own leadership and considerable flexibility in producing and merchandising the soybean variety for which it is responsible. All varieties will be protected under Title V (Certification Option).

Soybean Cyst Nematode (SCN): Yield losses of 35 percent have been consistently observed in fields infested with high levels of SCN. Proper management of the pathogen

will be required to maintain soybean production as an economically viable alternative for Kansas farmers. Resistant soybean varieties, such as KS5292, are being developed that provide a high level of resistance to the pathogen. Where yield losses are only 1 percent for SCN-infested fields, resistant varieties and sound management practices will increase farm revenue by \$1 million per year.

Soybean Seeding Rates: Historically, one bag of seed per acre, or 10 seeds per row foot in 30-inch rows, is recommended for planting soybeans. Recent research indicates that soybean plant populations could be lowered 30 percent without lowering yields. The potential savings in seed costs total \$4.5 million.

ALFALFA

Alfalfa Breeding Lines: Regional research project North Central-83 assisted Kansas legume breeders to produce seed and evaluate breeding lines over a 26-year period. That was an immense service because Kansas developed at least 45 breeding lines or alfalfa cultivars during that period. The value to Kansas farmers amounted to millions of dollars. Many farmers also grow birdsfoot trefoil. The most widely grown cultivar, Norcen, was developed with help from this regional project and was named after it.

Establishing Alfalfa No-till After Wheat: Establishing alfalfa stands can be difficult because of the lack of soil moisture at seeding time. Farm plots compared establishment methods, including conventional tillage, no-till burned stubble, no-till standing stubble, and no-till baled stubble. Compared to conventional methods, excellent stands and yields were obtained with no-till planting methods. Potentially, planting no-till alfalfa could save Kansas producers \$4 million annually.

SUNFLOWERS

Sunflowers: Seedsmen and producers report that most sunflower hybrids grown in Kansas are chosen based on KSU performance tests. The 1993 Kansas crop was valued at \$30 million and totaled 248 million pounds. If informed choices based on performance tests gave a 5 percent increase in yield, the added value to Kansas farmers would total \$1.5 million.

Sunflower Pests: The control of head moth and *Rhizopus* head rot in sunflowers often requires 1 to 3 applications of insecticide (\$7 to \$11 per application). KSU researchers have produced 2 populations with improved tolerance to head moth and *Rhizopus* head rot. The transfer of these characteristics to domestic sunflower hybrids could eliminate at least one insecticide application on 100,000 to 200,000 acres. The savings would total \$0.7 million to \$2.2 million. Seed and oil quality would also be enhanced.

Sunflower Production: Sunflower acreage exploded in northwestern Kansas in response to two confectionery facili-

ties at Colby and a crushing plant at Goodland. Research shows that yields can be increased 65 percent by planting at the optimum time. Quality (oil content or seed size) also is improved. Potentially, yield increases alone could increase farm income by \$39 million. Seed quality is influenced by plant population and could enhance crop value by an additional 10 percent to 15 percent. Preliminary data suggest that yields are improved and erosion hazards are decreased by growing sunflowers in 15-inch rows and at 26,000 plants per acre.

Sunflower Seed Size: Preliminary results from tests in 1991–1992 indicate that seed size of confectionery sunflowers are significantly affected by both planting date and plant population. The best combination (early June planting at 14,000 plants per acre) yielded more large seed by weight than did the poorest combination (early May planting at 23,000 plants per acre). The increase in large seed increased gross returns \$15.84 per 1,000 lbs of seed produced.

OTHER KANSAS CROPS AND SYSTEMS

Weskan Barley: Weskan, a winter barley released in 1991 for northwest Kansas, yields 54 bushels per acre. In yield trials, Weskan averaged 10 percent higher in yield and 2 percent higher in test weight than comparable varieties. The new variety is gaining momentum as the variety of choice. If adopted by 60 percent of the producers in northwest Kansas, its economic impact, due to superior yield and winter hardiness, could reach \$270,000 annually.

Pearl Millet: Pearl millet, with production requirements and heat and drought tolerances similar to sorghum, is more drought tolerant on sandy soils than sorghum. The grain is nutritionally superior to sorghum for beef and equal to corn for poultry and swine. Hybrids produced from male-sterile and fertility restorer lines released by K-State perform well in several states and could be grown on 500,000 acres of sandy soils in Kansas within 10 years. This would enhance profitability because the price for pearl millet should equal that of corn and exceed (by 10 percent) that for sorghum. Breeding programs are centered at Hays.

In 1994, KSU pearl millet releases included a dwarf-grain type and a bird-resistant population. In 1993, the female parent for the first public-bred variety released to seed companies in India was from the KSU breeding program.

Rapeseed or Canola: Experiment Station trials reveal that none of the rapeseed or canola varieties currently available are sufficiently winter hardy to withstand Kansas winters. Researchers at Colby have examined adaptability, agronomic requirements, yield, and seed quality. Particular attention is directed to overcoming the crop's susceptibility to winter kill. A breeding program, in cooperation with other states in the Central Great Plains, is underway.

Crenshaw Melons: A high-quality melon, Earlibush Crenshaw, has been released. No bush or compact-type varieties of non-netted melons were previously available. This new variety has a light green rind color to prevent sunscald; has golden yellow ripe rind color which makes determination of stage of ripeness easy; and is attractive to the consumer. It matures two weeks earlier than any other crenshaw-type melon. All of these features make this variety suitable for growing by commercial and home gardeners.

Native Pecans: The nuts, wood, and hay harvested from native pecan groves add \$3 million to \$5 million to the southeastern Kansas economy. KSU research has focused on low-input pecan management to reduce cost and enhance profitability. Improved crop and pest monitoring techniques now allow producers to predict whether thinning by nut-feeding insects will benefit or damage the crop. If damaging insect populations occur, a biological pesticide can be used to manage the pests without disrupting naturally occurring control organisms.

Foundation Seed: The seed industry uses foundation seed to preserve genetic purity. In 1993, the Experiment Station produced 15,000 bushels of foundation seed from K-State releases. Seedsmen utilize foundation seed to produce and sell registered and certified seed with an estimated value (over grain) of \$2.9 million. This provides a valuable service to Kansas farmers and seedsmen. For example, two varieties produced at the Northwest Research–Extension Center were the genetic source for more than half the wheat grown in the northwest quadrant of the state.

Crop Performance Tests: KSU tests crop varieties and hybrids and reports their performance to producers. The 1994 tests include (number of entry-locations are given in parenthesis): winter wheat (664), short-season corn (162), full-season corn (700), and grain sorghum (763). Other tests include spring oats, winter and spring barley, spring wheat, and alfalfa. Producers utilize these results to make planting decisions that materially impact acreage and crop value. For example, if only 10 percent of the 3 million acres of grain sorghum in Kansas were planted to hybrids with a 5 percent yield advantage, the increased revenue would total \$1.8 million annually.

Forage Management: Hay type forages are an integral part of the cow/calf operation. Two-year data indicate that adapted winter triticals produce \$17 per acre more hay than winter wheat and \$31 per acre more hay than winter rye based on \$50 per ton for hay. Consequently, newly developed winter triticals are beginning to find a home in the livestock industry.

CROP ROTATIONS

Crop rotations are a time-honored practice used by farmers to add nutrients, control weeds, conserve moisture, minimize erosion, and enhance crop production. Researchers (and producers) learned early in the state's history that nitrogen deficiencies in eastern Kansas and moisture deficiencies in western Kansas were major factors that limited crop production. Researchers recommended the use of crop rotations and early plowing to counter those deficiencies. In eastern Kansas, early plowing enhanced residue decay and nitrogen release. In western Kansas, incorporating fallow periods in the crop rotation enhanced soil moisture storage and helped to stabilize crop production.

Wheat Rotations: These rotations significantly enhanced crop production and farm profitability in Kansas. However, K-State research soon made it possible to replace the wheat-fallow rotation (one crop in two years) with the wheat-sorghum-fallow rotation (two crops in three years). The wheat-sorghum-fallow rotation also increased the amount of surface residue, minimized erosion, and enhanced soil moisture storage. Other rotational and cropping strategies were instituted to enhance weed and disease control.

SOYBEAN ROTATIONS

Soybean Cyst Nematodes: At Columbus and Pittsburg research demonstrates that genetic resistance and crop rotations can ameliorate losses due to soybean cyst nematodes. Pioneer 9521, a resistant soybean variety, averaged 31 bushels per acre while Essex, a susceptible variety, averaged 18 bushels per acre. The 13 bushels an acre advantage in yield were worth \$72 per acre.

Continuous planting of the susceptible variety Bay yielded 70 percent (18 bu/a) as much as Bay following a non-host crop (grain sorghum) (26 bu/a). Nematode populations dropped by 47 percent due to crop rotation alone (a \$44 per-acre advantage). When crop rotation and a resistant variety were used, the economic advantage rose to \$78 per acre.

Cyst Nematode Control Programs: Extension specialists estimate that two percent of the state's soybean acreage is infested with the soybean cyst nematode. However, in Cherokee County the infested acreage is almost 50 percent, and yield losses average nearly 30 percent. County agents are recommending rotation, sampling, and hybrid selection programs that reduce yield losses to less than 5 percent. Virtually all farmers in the county have been reached with information about managing this pest through radio, television, demonstrations, and public meetings.

Soybean Rotations on Clay Pan Soils: In southeast Kansas, soybean yields are reduced 10 percent in the absence of crop rotations and nearly 25 percent when soybean cyst

nematodes are present. Because 500,000 acres of soybeans are grown, a 10 percent yield advantage adds nearly \$7.5 million dollars to the area economy. Results also indicate that double-cropping systems typically increase net revenue but also increase risk because of cyclic rainfall patterns.

Charcoal Rot: Crop rotations also reduce other soybean diseases in southeast Kansas. If soybeans are continuously grown, yield reductions due to charcoal rot average 12 percent. Rotations with corn increased soybean yield by 2.5 bushels or \$15 per acre.

Soybeans in South Central Kansas: Soybeans are not a major dryland crop in south central Kansas. However, growing early soybeans allows timely seeding of wheat after soybean harvest. On the zero nitrogen plots, wheat yields following soybeans were 5.4 bushels per acre greater than wheat following wheat in the rotation. Similar increases in wheat yield following soybeans also were observed where 25, 50, and 75 lb/a of nitrogen were applied. Nitrogen fixation by soybeans will allow producers to reduce applications of fertilizer nitrogen.

ROTATIONS WITH MULTIPLE CROPS

Great Bend Prairie Area: In the Great Bend Prairie, rotating corn with soybeans or a wheat-soybean double-crop increased corn yields 20 percent on an irrigated, fine, sandy-loam soil. Average yields were 185 bu/a with the rotation and 153 bu/a under continuous corn. Less nitrogen fertilizer (75 lb/a) was necessary to optimize yields (205 bu/a) with the rotation than with continuous corn. Producers can significantly increase yields and decrease nitrogen fertilizer input through crop rotations as short as two years.

Dryland Systems—Southwest Kansas: An economic analysis was conducted from 1987 through 1991 at Garden City to determine whether the one crop in a two-year, wheat-fallow system or the two crop in three-year, wheat-sorghum-fallow system was most profitable. Conventional, reduced, and no-till treatments were included. The wheat-sorghum-fallow, reduced-tillage system returned more than all wheat-fallow systems (\$15,000 more than wheat-fallow with conventional tillage at 50 percent base).

Wheat-Sorghum-Fallow Economics: When averaged over 17 years, a wheat-sorghum-fallow crop rotation returned \$4.94 more per acre than continuous sorghum, \$9.17 more than continuous wheat, \$11.07 more than sorghum-fallow, and \$21.01 more than wheat-fallow. For many producers, a higher income rotation could mean the difference between staying on the family farm or finding another source of income.

WEED CONTROL

Weeds compete with crops for light, water, and nutrients, so crop production losses from weeds are significant. Weed control research at K-State include cultural, chemical, and biological control methods. Weed control strategies are incorporated in research with crop rotations, soil management, and herbicides.

Weed Control Benefits: In Kansas, most farmers base their weed control programs on data and systems developed by the Agricultural Experiment Station. The value of lost production due to weeds in corn, soybeans, grain sorghum, and winter wheat exceeds \$400 million annually. Annual expenditures for herbicides and their application to these four crops average \$120 million, giving a 300 percent return on investment. The payoff from weed control research is significant—\$25 million annually for a one percent improvement in crop value due to better weed control.

Weed Control Research: Winter annual grasses (cheat, downy brome, Japanese brome) and jointed goatgrass infest nearly a million acres in Kansas. Winter annual grasses reduce winter wheat yields by 15 percent to 20 percent. This equates to a \$50 million to \$65 million annual loss in Kansas. K-State researchers are investigating biological control methods, utilizing indigenous microorganisms from Kansas soils to control grassy weeds in wheat. Initial laboratory screenings have identified more than 150 bacterial isolates that inhibit the root development of one or more annual bromes and jointed goatgrass without affecting wheat in laboratory studies.

Aerial Application Educational Programs: In 1993, fly-in clinics were conducted for 25 aircraft applicators of agrichemicals. They evaluated spray patterns, new equipment, drift parameters, and obtained assistance for system problems. Participants treated approximately 450,000 acres in 1993 at an average cost of \$11.25 per acre. Experience suggests that a 10 percent enhancement in crop performance will result from improvements in swath width, agrichemical efficacy, and production response. Those benefits total \$506,250 per aircraft applicator.

Shattercane and Johnsongrass: Shattercane and Johnsongrass infest large areas in southwest Kansas. KSU researchers have demonstrated the efficacy of two new herbicides (Beacon and Accent) in controlling these weeds. It is estimated that half the acreage of corn in southwest Kansas is treated for these pests. Benefits average \$50 per acre. Just 10 percent of that impact totals \$1 million annually.

Soybean Yield Losses to Weeds: Soybean yield losses (weed-free versus weedy plots) represented as much as 90 percent of the weed-free soybean yields at 12 sites. Treating the weeds at these sites as recommended by a computer program for postemergence herbicides provided net economic gains in 75 percent of the plots. Gains ranged from \$5.05 to \$140.10 per acre. Losses ranged from \$5.05 to \$39.98 per acre in the remaining plots.

PLANT DISEASE AND INSECT PESTS

Losses to insects and diseases in Kansas exceed hundreds of millions of dollars annually. Research to protect Kansas crops against disease and insect pests takes many forms but emphasizes the development of genetic resistance and biological control. The yield advantage of each new variety and hybrid release is often immense due to newly incorporated resistances to insect or disease pests. However, constant changes in diseases and insects render varieties and hybrids susceptible to attack, reduce yield, and mandate the development of new sources of resistance and new methods of control.

Pesticide Applicator Training: The KSU Chemical Task Force provides educational materials and training for private and commercial pesticide applicators, including pest identification, label reading, protective clothing, application equipment and calibration, and environmental hazards. In 1993, 1,713 private applicators and 1,803 commercial applicators were certified. The emphasis is on safe use and handling of pesticides and protection of workers, water quality and environment, and food and agricultural products.

PLANT DISEASES

Wheat Streak Mosaic Virus (WSMV): Losses to WSMV in Kansas approximates \$36 million annually. KSU researchers have developed 4 lines with resistance to WSMV. Two lines have low levels of resistance, but the combined effect resulted in germplasm with higher levels of resistance. Two wheat germplasm lines with high levels of resistance have also been derived from Agropyron sources. In commercial cultivars, the low-level resistances could decrease losses 50 percent to 75 percent (\$18 million to \$27 million); the high-level resistance could decrease losses by 90 percent (\$32 million).

Other Virus Diseases: All KSU sorghum inbred releases are resistant to Maize Dwarf Mosaic Virus and Sugarcane Mosaic Virus. The loss to those diseases averages \$6 million annually because infected plants do not produce grain. Infection occurs on about 10 percent of the sorghum crop each year (300,000 acres), a potential loss of 1.8 million bushels or \$4.5 million.

Eastern Gamagrass: Pathologists found that Eastern Gamagrass, a promising new forage crop, is susceptible to Sugarcane Mosaic Virus. This finding alerted breeders to the need to select lines resistant or tolerant to the virus to avoid losses.

Bacterial Leaf Streak: Grain sorghum seed and feed grains are routinely exported to countries that enforce stringent regulations on seed and grain importation that may contain pathogens. Determination of the presence of disease-causing bacteria in seed and grain is difficult and time consuming. KSU researchers are developing a monoclonal antibody to enhance specificity, reduce the time of diagnosis, and provide test results within 24 hours. A small, distinct protein found only in the bacterium that causes bacterial leaf streak was used to develop the antibody.

INSECT PESTS

Wheat Curl Mite: Resistance to the wheat curl mite was first discovered in common wheat in 1991. The mite is the carrier of the virus which causes wheat streak mosaic disease and causes an estimated annual loss of 15.5 million bushels in Kansas. The newly discovered resistance effectively reduces losses due to wheat streak mosaic virus, but only two varieties have resistance. When the new sources of resistance are transferred to commercial varieties, losses will be significantly reduced.

Alternatives for Controlling Wheat Pests: We need to find alternative insecticides, particularly those that are effective against greenbugs resistant to lorsban and parathion. Data show that several insecticides not currently registered on wheat can control resistant greenbugs. If a state label is needed, these data will be most helpful. Pounce and Ambush are effective against army cutworms at half the rate normally used. In an army cutworm outbreak like that in 1991, this information would save producers millions of dollars.

Greenbugs: Screening of sorghum germplasms for resistance to biotype E greenbugs resulted in three additional sources with high levels of resistance and 20 new sources of moderate resistance. Ten biotype E greenbug resistant restorer germplasm lines were released in 1989 and allowed for broadening the germplasm base of resistance. With the discovery of biotype I greenbugs in 1990, all available sources of greenbug resistance were screened for resistance to biotype I. KSU released a germplasm with resistance to biotype I (KS 96) in 1991. Research is in progress to breed new lines that tolerate greenbug feeding and avoid the development of biotypes.

Chinch Bugs: Because of monitoring programs suggested by KSU, the need for planting time insecticides applied to sorghum for chinch bugs can be predicted more effectively. As a

result of the 30-county monitoring program, which documented lower chinch bug population pressure, planting time insecticide use was reduced on 300,000 acres since 1991.

Hessian Fly: Although chemical control of Hessian fly is practiced by some growers, cultural control methods are known and are effective. In an 8-county area, 30 percent of the growers are now effectively using cultural control techniques learned through a variety of Extension educational programs.

Fall Armyworms: In mid-May 1992, there was a serious outbreak of armyworms in southeast Kansas. In many fields, the leaves were gone, and the insects were feeding in the heads. In less than 3 weeks, agents in 8 counties made 200 field inspections, handled 1,060 phone calls, prepared 14 news articles, and participated in 21 radio and television programs, all related to the armyworm problem. Agents persuaded many farmers that chemical treatment was not warranted. These recommendations saved \$1.15 million or the cost of treating 107,000 acres.

European Corn Borer: KSU-developed computer software can be used to predict European corn borer infestations 2 to 4 weeks before treatment is needed. Where corn borer populations are heavy, growers can enhance yields by \$22 per acre using these recommendations. Where populations are less severe, producers can often avoid treatment entirely, saving \$14 (or more) per acre.

Corn Rootworm: In southwest Kansas, approximately 50 percent of the corn acreage (550,000 acres) is treated for rootworms. Area farmers depend on research results from AES researchers at Garden City and Tribune in assessing the treatment benefits of available pesticides. It is estimated that the benefits of treatment with pesticides identified in K-State programs are worth \$5 per acre more than the cost of treatment.

Corn Borer and Spider Mite: Because of the damage from corn borers and spider mites, researchers at the KSU Southwest Research-Extension Center have directed research efforts at those pests. It is estimated that they have researched and provided data for registration for 60 percent of the insecticides and herbicides used on corn in the area. Benefits per acre can exceed \$37.50 and approximate \$3 million for mitigating corn borer damage and \$2.75 million for controlling damage by mites.

Stable Flies: A stable fly integrated pest management program involving 500,000 cattle has been established in southwest Kansas. It is estimated that cattle gains can be increased 0.2 lb/day for 6 weeks during the summer by use of this program. Those benefits approximate \$3.2 million each year.

SOIL MANAGEMENT

With 47.8 million acres in farms, Kansas ranks second in the nation in cropland and in prime farmland. Kansas also is a national leader in implementing conservation tillage practices to control erosion and minimize environmental hazards. Conservation tillage research has resulted in the widespread establishment of conservation tillage practices, including stubble mulch, ridge till, no-till, and intensified fallow cropping systems. Producers have also been assisted with balanced soil fertility and fertilizer placement programs.

PLANT NUTRIENT EFFICIENCY

Wheat Production: Agricultural sustainability is dependent on efficient, judicious use of inputs. Field trials were used to demonstrate that phosphorous banded with the seed in phosphorous deficient soils could improve wheat yields by as much as 18 bushels per acre. The results of these studies were presented to over 7,000 individuals to emphasize the importance of soil tests and nutrient management in producing a sustainable wheat crop in Kansas.

Soil Fertility: In a 7-year study in a 23-inch precipitation zone, there was no significant yield difference between 20 pounds of nitrogen per acre applied with grain sorghum seed versus 40 pounds of nitrogen per acre broadcast. Including application costs, this translates into nearly a \$7 per acre savings. Thus, a sorghum grower with 500 acres could save \$3,500. The treatments described above yielded 9 bushels per acre more than the control.

Balanced Fertility Programs—Tribune: Balanced applications of phosphorous and nitrogen to crops at Tribune substantially reduced nitrate accumulations in the soil compared to the nitrogen only treatment. The nitrogen rate with phosphorous required to maximize net revenue is 155 lb/a for corn and 135 lb/a for grain sorghum. Adding optimal amounts of phosphorous increased nitrogen demand by 10 lb/a for corn and sorghum but increased corn yields 60 bu/a for corn and 20 bu/a for sorghum. Net revenues were increased \$130 per acre for corn and \$40 per acre for sorghum.

Fertilizer Placement—Cool Season Grasses: In southeast Kansas, placing liquid nitrogen at a 4-inch depth increased nitrogen use efficiency of tall fescue and bromegrass by 15 percent to 30 percent. Thus, more nitrogen is recovered, less need be applied, and forage quality is enhanced, plus the environmental and economic impact is significant. For example, if just 10 lb/a more nitrogen were recovered on one-fourth of the pastures in 9 counties, 1.5 million pounds less nitrogen would be released to the environment, and forage protein would increase by 4,688 tons.

Optimizing Nitrogen Fertilizer Application: Extension agents are emphasizing the use of soil tests for profile nitrogen as a practical method to maintain yields, optimize nitro-

gen use, and to protect environmental quality. With this emphasis, and because of dry weather and increased fertilizer costs, the use of profile nitrogen tests have increased dramatically. Producers have reduced nitrogen use and the potential for groundwater contamination.

Nutrient Use Efficiency—Dryland: Using best management practices for nitrogen and phosphorous in no-till wheat, corn, or grain sorghum systems reduces costs, potential contamination, and sustains productivity. Researchers found that 60 percent to 70 percent of fertilizer nitrogen was recovered with subsurface application compared to only 40 percent to 45 percent recovery with broadcast nitrogen. Subsurface placement of phosphorous also increased fertilizer recovery compared to broadcast. Subsurface application reduced potential contamination and fertilizer cost by \$4 per acre.

Fertilizer and Lime Efficiencies: Farmers use 1.5 million tons of fertilizer and 0.5 million tons of lime to produce 20 million acres of grain and forages. This represents 35 percent of the variable production costs. Research shows that banding phosphorus fertilizer for wheat can double yields on low-phosphorus soils from 16 to 41 bu/a. Net returns were increased by \$64 per acre by identifying low-phosphorus soils, banding, and applying reduced amounts of fertilizer. More than 2,500 farmers were informed on how to improve yields and reduce fertilizer costs. The potential increase in profit was \$1.5 million to \$3 million annually.

Liming Acid Soils: Liming acid soils where exchangeable aluminum is high can double wheat yields. However, because of shipping costs, lime is a major investment. Research showed that phosphorus banded with the seed increased yields by 14 bu/a, and the use of aluminum-tolerant varieties increased returns by \$40 bu/a. The economic impact in one county was \$2.5 million.

Managing Plant Nutrient Use: Field tours held in south central Kansas demonstrated the value of integrated liming, variety selection, and phosphorus-placement programs on acid soils. On these soils, banding phosphorus with Karl wheat at planting increased yields by 14 bushels per acre and net returns by \$31 per acre. Specialists stress the importance of knifing nitrogen below residues in reduced or no-till management systems, a technique that helps control erosion yet increases net return by \$30 per acre.

Nitrification Inhibitors: In northeastern Kansas, when urea ammonium nitrate solution (UAN) or ammonium nitrate (AN) is applied without a nitrification inhibitor (NI), ammonium nitrogen is rapidly converted to nitrate nitrogen. Mixed nitrogen nutrition (ammonium and nitrate) from pre-plant applications of UAN and AN plus NI increased growth and nitrogen uptake. Corn yield was increased 4 percent to

7 percent. At yields of 160 bushels per acre, the increase in net return was \$7.40 per acre.

Nitrogen Needs After a Wet Year: During 1993, excessive rainfall, flooding, and saturated soil conditions created excessive expectations by farmers for the future need of nitrogen fertilizers. Seminars held in severely affected areas emphasized the use of soil tests to determine nitrogen needs in 1994. Without soil tests, farmers were concluding that 30 to 50 pounds of nitrogen were needed as "insurance" after such a wet year. After the seminars and because of soil tests, much less nitrogen will be applied. Thus, profit will be increased and environmental hazards will be reduced.

TILLAGE SYSTEMS

Conservation Tillage: Government mandates require producers to control wind and water erosion. Long-term research shows that wheat and sorghum grown in a reduced-tillage system leaves sufficient residue to control erosion but yields as much or more than clean- or no-till systems. The return from reduced-till in a wheat-sorghum-fallow rotation ranges from slightly less than \$1 to over \$20 per acre more than clean- or no-till systems.

Crop Residue Management: Extension specialists used a rainfall simulator at 49 locations with over 4,800 in attendance to demonstrate the use of crop residue to reduce soil

erosion and nutrient and pesticide loss. It is estimated that at least 10 percent of those in attendance subsequently adopted management practices to increase residue retention. Two counties, Osage and Coffey, organized a "Residue Rodeo" program of field tours, equipment demonstrations, and seminars. Over 160 growers were provided local solutions for managing residues and reducing chemical loss.

Intensified Cropping Systems—Northwest Kansas: A wheat-fallow rotation with stubble mulch tillage is the traditional dryland farming system in northwest Kansas. This system is criticized as being water wasteful, and more intensive cropping systems are needed. Researchers are investigating wheat-sorghum-fallow and wheat-sunflower-fallow rotations. Those rotations provide 4 crops in 6 years rather than 3 crops in 6 years with wheat-fallow. If this practice was adopted on 2 million acres in northwest Kansas, the increased production would return \$35 million annually.

Ridge-Till for Irrigated Corn: Research at the KSU Northwest Research-Extension Center suggests that adapting the ridge-till system to irrigated corn has the potential to reduce equipment, herbicide, and tillage costs approximately \$5 million. This would also provide better protection against erosion with little or no sacrifice in yield. This practice would reduce the number of spring preplant operations and allow for more timely planting.

GRAINS, GRAIN PROCESSING, AND NEW PRODUCTS

K-State assists processors and entrepreneurs in their efforts to establish domestic and international markets for wheat, flour, and value-added products. The KSU short-flow flour mill is an innovation that is making a significant economic impact in Kansas and promises to make an equal impact in international markets. K-State's emphasis on quality and the development of high-yielding, high-protein wheat also is favorably impacting the state's economy.

MARKET AND BUSINESS DEVELOPMENT

International Grains Program (IGP): The IGP program supports short courses, seminars, and market training for participants from foreign countries. Seminars for trade teams and other international visitors is a part of the program, which also includes short courses on Commodity Exchange Development; Grain Grading, Storage, and Handling; U.S. Grain Marketing System, Flour Milling; Grain Marketing; Feed Quality; Feed Manufacturing; and other workshops. IGP activities resulted in contacts with 58 countries in 1992 that are purchasers of U.S. grain and equipment.

Market Development: The International Grains Program (IGP) supports market development activities by the Kansas

Wheat, Corn, Grain Sorghum, and Soybean commissions. IGP develops short courses in grain marketing and storage and handling and feed manufacturing, as well as flour milling for U.S. Wheat Associates, U.S. Feed Grains Council, American Soybean Association, and the U.S. Department of Agriculture. The training involves domestic and international representatives and promotes good will, familiarity with U.S. grains and marketing systems, and, often, subsequent contact (and sales) with U.S. suppliers of grain and equipment.

Short Courses: In 1993, Extension feed and flour milling specialists presented 5 short courses (lasting from a few days to two weeks) to 145 government and industry representatives from 5 countries. Extension and flour milling specialists also consulted with individuals from 2 countries on grain storage and processing issues.

Risk Management: Extension economists, at the request of U.S. Wheat Associates, presented seminars in China on how to manage price risk associated with purchasing wheat from the United States. The seminars were presented to government officials and managers of private and state owned agribusiness at 3 locations over a 2-week period.

Extension economists presented similar seminars to 2 separate groups of food officials from the former USSR and to 70 government and industry officials from 20 different countries. These seminars were organized at the request of the USDA Food and Agricultural Service and several U.S. producer organizations.

Market Outlook: An Extension economist issues 2 publications used by exporters/importers of U.S. Crops. One publication, Quarterly Wheat Outlook has 160 food-agribusiness subscribers from the United States and nine foreign countries. The other, Ag Update (issued monthly), has 75 subscribers from the United States and two foreign countries.

Marketing Processed Foods: This Extension thrust originated in K-State's Margin of Excellence Program and emphasizes producing and marketing value-added products. Entrepreneurs and producers are provided educational and individualized programs concerning product development, selecting quality ingredients, and food processing techniques. Food safety, product analysis, labeling requirements, and market development are important considerations. The key is quality products that are safe, profitable, and have appeal.

INDUSTRIAL DEVELOPMENTS

KSU Short-Flow Flour Mill: A new grain processing flow design has been developed at K-State. The new technology allows white flour to be produced with a minimum amount of equipment, facilities, power, skilled labor, and capital expenditures. The versatility of the mill allows for milling small lots of identity-preserved or specialty grains with minimum clean-out and product loss. A single short flow unit operating 260 days per year, 8 hours per day, can utilize 73,000 bushels of grain. The mill can be operated by one person and can be erected and fully operable in 5 to 10 days. Flour products can be milled from wheat, barley, oat groats, sorghum, millet, triticale, and corn.

Industrial Applications—Short Flow Mill: Kice Industries, Inc., Wichita, is using the short flow milling concept to market new mills and convert existing flour mills. The goal is to build one unit per month. This will increase company revenues about \$9 million annually. Kice has already added 18 new employees to assist with this effort and expects to double that amount next year. The units are widely accepted in the United States due to simplicity, low-investment cost, ease of installation, versatility, and product quality. For the 1,000 cwt units, Kice also supplies equipment, bins, and pre-milling flows for wheat-cleaning systems. This major innovation in milling technology is making a significant economic impact. Several individual units will likely be installed in Kansas. Each unit will provide additional economic return. Kice is just beginning to explore the potential of an important export market.

Industrial Uses of Wheat Starch and Protein: K-State research on the properties and use of wheat starch has enhanced that product's economic value. Those developments led to expanded plant operations at Midwest Grain Products, Atchison, Kansas. Today, the company offers over 15 modified wheat starches with many uses. As a result of KSU developments, 4 Ph.D. technical personnel have been hired, company direction has been changed, and profitability has been enhanced. One company instituted a \$1.6 million Alternative Agricultural Research and Commercialization Center (AARC) program based on work in the company and in the KSU departments of Grain Science and Industry and Foods and Nutrition.

Corn Starch Thermoplastics: A formulation using unmodified corn starch has been developed, and extrusion conditions have been identified to produce a commercially competitive, protective, loose-fill packing material (packaging peanuts). The peanut is made without chemically modifying the starch, thus reducing costs. Negotiations are underway to license this technology. Market size is about 70 million pounds of starch.

Extrusion Potential: The digestibility of dry matter and nitrogen for feed grains was increased by extrusion. Relative feeding values were increased from 95 percent to 104 percent for sorghum, from 89 percent to 92 percent for barley, and 92 percent to 98 percent for wheat when extruded. Even with the 10 percent to 11 percent increase in processing costs, the 10 percent price advantage for sorghum versus ground corn reduced cost of gains by 3 percent to 9 percent.

BAKING QUALITY

Agronomy, Grain Science, and other KSU departments have worked together closely for many years to improve the milling and baking quality of Kansas wheat. Economic documentation is difficult, but the following information is an indication of the impact of such research:

1993 Kansas Crop: The farm value of wheat planted in Kansas in 1992 was \$1.4 billion. In 1993, KSU varieties accounted for 47.9 percent of the wheat planted in Kansas. The economic impact of those varieties due to their baking and milling quality and insect and disease resistances is significant.

Karl Wheat: Soon after its release in 1988, Karl was not only the highest yielding variety in Kansas and Oklahoma but also was the highest in overall grain protein content. Advantages include: 1. Resistance or tolerance to 9 of the 11 serious wheat diseases affecting wheat in Kansas; 2. Genetically higher in protein than other varieties; 3. Higher flour yields than most varieties; 4. More protein/unit of fertilizer applied than other varieties; and 5. Millers can buy local high protein wheats rather than more expensive high protein spring wheats.

Karl will add as much as \$16.5 million to the state's economy this year because of its improved yield and protein premium. Kansas mills are offering a premium of \$0.05 per bushel of Karl, so farm income is increased because of its superior milling and baking quality. The economic returns from this one variety over the varieties it replaced in 1993 will offset nearly 80 percent of the total cost of Phase II of the KSU Throckmorton Hall Plant Sciences Center.

Karl is the number-one variety planted in Kansas. We estimate that it has added \$40 million to the Kansas economy since its release. This past year, several foreign milling and baking firms specially contracted Karl wheat for export purposes.

Wheat Quality: Uniform quality wheat is advantageous because automation reduces the allowable flexibility in raw ingredients. In Kansas, the potential savings and revenue associated with producing higher quality wheat approximates \$25 million based on the cost of added gluten. Extension faculty address these concerns by organizing grain-grading schools, emphasizing milling and baking quality at production meetings, and demonstrating hardness testers.

VALUE-ADDED PRODUCTS

Value-Added Products: Over the past 4 years, the value-added Extension team has helped Kansas companies develop 40 new products. Numerous other products were improved, thus increasing sales and keeping companies in business. A patent in fat-free, candied popcorn has directly affected sales at one company and helped make it more competitive. Increased sales, in the start-up phase, is estimated at \$10,000.

Value-Added Center: The Kansas Agricultural Value-Added Center (KVAC) helps Kansas companies produce safe and high-quality food products that comply with local, state, and federal regulations. To assist new firms, KVAC has instituted a nutrition labeling program for inspecting labels for compliance and assisting with analysis and label preparation. A cooperative KVAC and Extension food-safety training program highlights quality assurance, manufacturing records, and facility design.

Frozen Dough: The use of frozen dough is an important segment of the baking industry. This is especially true for

the 25,000 in-store bakeries that account for \$8 billion in annual sales. Frozen dough requires strong flour that is often equated with flour milled from spring wheats. KSU scientists have shown that high-protein, hard red winter wheats like Karl and Vantage also produce frozen doughs of notable quality. This information should aid in marketing Kansas wheats for the frozen dough industry.

Dietary Fiber: KSU researchers have discovered that animals fed extruded grains had much lower serum and liver cholesterol and higher high-density cholesterol (good cholesterol) than those fed the raw grains. Extrusion processing did not damage the nutritional quality of the wheat, oats, or barley grains. Their increased soluble fiber content and cholesterol-lowering potential could make them useful in the prevention or treatment of heart disease. Additionally, those value-added products, including extruded wheat bran, could have economic benefit for Kansas processors.

Flat Breads: Middle East countries traditionally use white wheats, largely imported from Australia, to make flat breads. Studies show that Kansas white wheats also produce flat breads of excellent quality. The quality in terms of color, texture, pocket formation, and taste was comparable or superior to pita breads made elsewhere. Similarly, Kansas white winter wheats were shown to produce flour tortillas superior in quality to those made from soft wheats. These facts should prove valuable in marketing efforts.

Vitamin C: Vitamin C is essential to human health and is used in the body to detoxify pollutants, fight infection, and promote iron adsorption, and it is, perhaps, an anti-cancer factor. If added to bread, vitamin C would be broadly available in the food supply. Fortifying bread with vitamin C has not been successful because baking and storage destroys most of the added vitamin C. KSU scientists are investigating a more stable form of vitamin C that could be added to bread.

Vitamin C Patent: K-State researchers have patented a form of vitamin C that can be added to animal feed materials. The sale of this patent to industry represents the largest sale of intellectual property rights by KSU. Stable vitamin C has value-added potential in milk replacers, starter feeds, and drinking water. It has also proven stable for use in extrusion cooking and other feed processing methods. The value of stable vitamin C in aquaculture feeds is estimated to be \$3.5 million to \$4 million annually.

IRRIGATION AND GROUNDWATER PROTECTION

Irrigators are the largest users of water in Kansas. KSU research is focused on increasing irrigation and water-use efficiency. For example, furrow, sprinkler, and drip-system efficiencies are estimated at 60 percent, 85 percent, and 99 percent, respectively. Because we want to raise irrigation efficiency from 70 percent to 90 percent, KSU research is

centered on highly efficient irrigation systems such as drip and Low Energy Precision Application (LEPA).

Efficient Water Use — Southwest Kansas: Achieving the above efficiencies on 1.7 million acres in southwest Kansas would save Kansas producers \$7 million annually in

pumping costs and extend the life of the aquifer by 25 percent. Conversely, if the aquifer is depleted and all irrigated acres are converted to dryland crops, the annual loss in gross revenue would be \$265 million.

Efficient Water Use — Northwest Kansas: Drip irrigation research at the Northwest Research-Extension Center at Colby has shown that the practice can save 25 percent or 5 inches of water during the season. This represents a potential savings of \$2 million annually in pumping costs. Although water and pumping cost savings are significant, the high installation costs for drip irrigation systems are a deterrent.

Reasonable Cost Irrigation: Flood irrigation demonstrations indicate that about 40 percent of flooded fields had poor yield uniformity. Increasing field uniformity (water utilization) so lower-yielding areas yield within 90 percent of higher-yielding areas would increase income by over \$20 million annually. Field studies show that pumping-plant efficiencies are about 60 percent of accepted criteria. Increasing pumping-plant efficiencies by just 10 percent would result in annual fuel savings of \$3 million.

Plugging Abandoned Wells: In 1992, Extension organized 47 well-plugging demonstrations with over 2,000 in attendance. The program demonstrated proper plugging procedures as required by state law. When coupled with previous efforts, 40,000 well-plugging bulletins were distributed, exhibits were displayed at county fairs, and several

service groups planned to plug wells as community service projects. If 10 percent of the 500,000 abandoned wells in the state were plugged by the landowner, a cash savings of \$2.5 million would occur compared to commercial rates.

Pesticide Management Area: Because pesticides may impact water quality and affect drinking water treatment cost, a Pesticide Management Area (PMA) was established to control atrazine in the Delaware River Watershed. The State Board of Agriculture is the lead enforcement agency. The interdisciplinary effort includes Cooperative Extension—education, demonstrations, and grower meetings; USGS and Kansas Department of Health and Environment—monitoring and analysis; and the Agricultural Experiment Station—atrazine/herbicide best management practices, including terraces, ridge tillage, and vegetative buffer strips.

Atrazine Use Survey: A survey showed that 92 percent of the corn in the PMA was treated with atrazine at an average rate of 1.35 pounds per acre. Specialists estimate that farmers are now using 20 percent less atrazine because of voluntary and regulatory provisions. The voluntary provisions include rate reduction; best management practices; safer application and timing methods; conservation and riparian practices; and integrated weed management. Regulatory provisions include setbacks from wells and waterbodies and curtailing non-cropland use of atrazine.

RANGE MANAGEMENT

Kansas, with 17.4 million acres in tall, mid-grass and short-grass prairie, is an important livestock producing state, and range is a prominent forage source. Research at K-state has shown the significant impact of prescribed burning, intensive-early stocking, and sound management on cattle production. Progress has also been made in helping ranchers cope with endophyte-infected tall fescue in southeast Kansas.

Burning Flint Hills Range: While burning has been a common practice in the Kansas Flint Hills for over 100 years, research at KSU maximized the impact of that practice by defining the proper time to burn for maximum livestock response and effective weed and brush control. Approximately 50 percent of stocker operators in the Flint Hills burn regularly. An additional 30 percent burn at least once every 3 years. For steers grazed the entire season, an increased steer gain of approximately 32 lbs will be seen in the year of burning. Brush control is improved even with intermittent burning. Brush control without burning would be expected to cost approximately \$20 per acre every 10 years or \$2 per acre each year.

Prescribed Burning: Conservation Reserve Program tracts (CRP) are of great interest in Kansas with over 3 million

acres under contract. Nearly 90 percent of these acres are in permanent grass cover requiring special management for renewal and maintenance. Extension specialists conducted thirteen prescribed burning workshops in 1993, with 365 in attendance. As a direct result, it is estimated that prescribed burning techniques were applied on an additional 125,000 acres. There is great interest in the issue of land use after CRP contracts expire.

For the 375,000 cattle and 2.5 million acres currently affected, the total income enhancement of prescribed burning approximates \$16.2 million annually. If the practice were expanded throughout the Flint Hills, the potential income enhancement would approach \$26 million annually.

Intensive-early Stocking: Approximately 40 percent of stocker operators in the Flint Hills region are believed to use intensive-early stocking. Research at KSU on intensive-early stocking indicated increased per acre gains of 30, 55, and 80 lb with 2X, 2.5X, and 3X stocking rates, respectively. These increased gains were accomplished without reductions in individual animal performance. The impact of intensive-early stocking has been a 40 percent to 50 percent increase in the total number of livestock grazing the Flint

Hills. In addition, there has been a 12 percent to 15 percent increase in feedlot efficiency for stockers placed in the feedlot following intensive-early stocking. For the 1.2 million acres involved, total income enhancement approximates \$38.4 million annually. To this should be added \$15 million in increased income due to improved feedlot performance by nearly 670,000 feeders. If these practices were expanded to 2.5 million acres, 3X stocking, and 1.9 million feeders, the potential economic impact could exceed \$200 million annually.

Nutritional Management: K-State research has demonstrated the importance of nutritional supplements for cattle that consume poor-quality range or other forages. Conception rate differences of 5 percent and 6 percent are commonly observed between low- and high-protein supplements. If such improvements were applied to half the beef cows in Kansas (675,000 cows), the potential value of the additional calf crop would be about \$16 million to \$19 million annually.

Nutritional supplements are also beneficial for stockers managed in intensive-early stocking systems. Research results indicate that steers supplemented with 4 pounds of sorghum grain plus a growth promotant (ionophore) would increase gain by 0.5 to 0.6 lb/head/day. This translates to a potential increase in net profit of \$12 to \$14 per head. If this approach to supplementation was applied to half the land area in the tallgrass prairie region, the economic impact (above that of intensive-early stocking) would approximate \$16 million annually.

Conservation Reserve Program: Over 2.8 million acres of Kansas cropland (9.9 percent of tillable acres) were idled in the Conservation Reserve Program (CRP) between 1986 and 1990. Approximately 1 million acres are eligible for tillage in 1996, another 880,000 in 1997. Surveys show that if demand for U.S. wheat and feed grains is strong, farmers could return most of the CRP land to crop production. The majority of landowners would prefer to extend their CRP contract for 5 to 10 years.

Tall Fescue and Endophytic Infection: Tall fescue in Kansas and the United States is infected with a toxin-producing endophytic fungus that costs U.S. cattlemen \$793 million annually. K-State researchers have shown that 65 percent of the loss can be offset by interseeding white clover into infected fescue (the potential savings to U.S. cattlemen is \$515 million). Another 18 percent improvement was achieved by implanting stocker steers with progesterone-estradiol. Providing supplemental feed and adjusting stocking rates also increased gains and reduced costs.

Rye-Bermuda Grass Pastures: Bermuda grass is a warm-season forage, but its growing season, quality, and rate of animal gain in southeastern Kansas are suboptimal. Drilling annual rye into Bermuda grass pastures in southeast Kansas increases the grazing season by over 60 days and increases calf gains by 300 pounds per acre. Experiments also demonstrated that \$10 to \$15 per animal can be gained by allowing stocker cattle to graze for 2 to 3 hours just prior to shipment.

FORESTRY

State and Extension Forestry provides technical and educational assistance to the forest industry; assists landowners in their development of management plans; and cooperates with the federal government and others in forest resource surveys, conservation tree planting, and rural fire protection.

Forest Resource Survey: The Kansas Forest Resource Inventory was completed in 1994 through cooperative efforts by Kansas and the U.S. Forest Service. Since the last survey, the annual timber harvest in Kansas has averaged 30 million board feet. This provides an annual income of \$7.5 million to \$10 million to landowners. The subsequent processing of logs, sale of products, and manufacturing processes provides an additional \$75 million to \$100 million in annual economic benefits.

Conservation Tree Planting Program: This year marks the completion of the 38th year of State and Extension Forestry's Conservation Tree Planting Program. This multi-

agency effort (Cooperative Extension, Soil Conservation Service, and Wildlife and Parks) fosters the planting of over 843,000 tree and shrub seedlings. Landowners are helped with site preparation, species selection, and planting design and care. The estimated annual value for windbreaks (\$1,109,991), Christmas Trees (\$712,500), wildlife habitat (\$242,550), woodlot products (\$3,252), and crop protection (\$36,923) totals \$2.1 million.

Rural Fire Program: Through a cooperative agreement with the USDA Forest Service, Extension foresters acquires excess equipment from military bases in the state for the sole purpose of rural fire fighting. Primarily, the vehicles are acquired and loaned to rural fire departments. Each rural fire department is required to equip, paint, maintain, and insure the vehicles. Currently, 688 vehicles are in service in 95 Kansas counties. The value of these excess military vehicles to rural fire departments exceeds \$5 million.

FOODS AND NUTRITION

Programs in foods and nutrition focus on the physical, chemical, nutritional, and sensory properties of food as well as on nutrient metabolism, nutrient requirements, and diet and health.

NUTRITION

Food Product Quality: Foods and Nutrition researchers are investigating ingredients that promote health and increase product value. For example, brans from hard and soft white and red wheats can improve oral health, enhance flavor, and increase acceptability. Sensory methods are used to determine sweetness, bitterness, and astringency so flavor can be enhanced. Studies also show that natural antioxidants, added to soy and other vegetable oil, improve quality and stability and decrease oil loss, especially at high temperature.

Dietary Recommendations: Dietary guidelines encourage Americans to consume foods lower in fats, saturated fatty acids, and cholesterol and that are higher in polyunsaturated fatty acids, complex carbohydrate, and fiber. Studies show that soluble fibers (pectin, psyllium and oat bran) reduce hepatic cholesterol levels compared with rats fed diets containing insoluble cellulose. The study shows that newly synthesized cholesterol is released from the liver at the same rate regardless of the type of dietary fiber fed.

Zinc Deficiency and Vitamin A Transport: Research provides a biochemical and physiological link between zinc deficiency and symptoms of vitamin A deficiency, such as night blindness or impaired dark adaptation. Lymphatic absorption of vitamin A is also impaired in zinc deficient rats. This may explain why the vitamin is low in zinc deficient individuals. It may also help in devising new approaches in correcting vitamin A deficiency in premature infants, the elderly, and malnourished growing children.

Nutrition and Physical Activity of Rural Women Living Alone: Food consumption and nutrient intake studies show that age and education have a more profound influence on the dietary patterns of older women living alone than the place of residence. Living alone in a rural area does not place older women at nutritional risk as long as a balanced diet is maintained and energy intake is adequate. Interventions to improve diet should be targeted toward individuals with less formal schooling regardless of residence.

Health and Nutrition: The "economic value" of staying healthy, remaining in the work force, reducing chronic disease, and reducing health care cost is significant to both individual and business. Nutrition research impacts on health and therefore the economic consequences of illness and disease.

BIODEGRADABLE PACKAGING MATERIALS

A value-added packaging material manufactured from wheat gluten protein has been formulated and tested for mechanical and barrier properties. In tensile properties the biode-

gradable packaging material is similar to Saran Wrap® and can be used for food and nonfood use. The product should reduce landfill waste and be environmentally benign.

FOOD SAFETY

Food safety is an issue of concern for the livestock and meat industry and the consuming public.

FOOD SAFETY PROGRAMS

Food safety programs at K-State are designed to address questions that are critical to the Kansas economy. Concerns include food safety in foodservice; rapid detection of microbiological and chemical contaminants; quality assurance on the farm and in the home; and the development of new products. KSU is the home of the Kansas Value-Added Center, a Food Safety Consortium, and a cadre of value-added specialists.

Food Safety in Foodservice: Illness caused by microorganisms in food cause an estimated 6.5 million to 81 million illnesses and 9,000 deaths annually. Medical care and lost productivity costs range from \$5 billion to \$17 billion.

Over 77 percent of these cases are attributed to improper handling in foodservice establishments. With support from appropriate agencies, Extension agents are conducting food safety/sanitation programs targeted to school and university foodservice managers and employees; day care operations; community civic groups; and commercial foodservice, health care, and other interested groups.

Food Safety Waste Management: Industrial, retail, and institutional foodservice establishments dispose of a significant quantity of food and packaging waste annually. The majority is transported to landfills or through garbage disposal into the sewage system. Research shows that the quantity disposed ranges from 0.5 pounds per meal served to 1.6 pounds per meal. Approximately 70 percent of the waste disposed of is food and thus should be treated as a by-product rather than waste.

Safety of Canned Quickbreads: Recently, a new line of quickbreads has been introduced. The product is stored, distributed, and displayed without refrigeration and could be on store shelves for more than a year. Samples tested at K-State for water activity and pH raise the possibility of the risk of botulism in these products. Trials were initiated to establish the safety of canned quickbreads by inoculating, processing, and challenging the microbial quality of the products under normal storage conditions.

Safe Food for Children: This program is a food safety series for family child care providers and parents of preschool children. Each lesson includes a leaders's guide, brochure for parents, and stickers, shopping lists, magnets etc., and an animated video starring "Mike the Microbe." A satellite training program was aired for those who educate, license, or administer child care providers. Respondents included 179 satellite receiving sites in the United States and Guam, 3,000 participants, and many who ordered educational materials.

Food Safety for KANWORK Participant: This Extension program combines job skill training and foodservice career ladder opportunities and includes training in food sanitation and institutional foodservice. The program is being piloted in seven counties cooperatively with Extension and Social and Rehabilitative Services offices.

DETECTING CONTAMINANTS

Detections Systems: The negative impact of real and perceived food safety issues is about \$2 billion to \$5 billion per year. The Kansas share is \$300 million. KSU researchers have developed electronic livestock identification systems and detection systems for viral and microbial pathogens that will save Kansans \$6 million to \$7 million each year.

Controlling Microbial Contaminants on Meat Contact Surfaces: Food contact surfaces, such as cutting boards and table tops, are major sources of contamination if not properly cleaned. Research shows that an enzyme produced by microorganisms reacts with hydrogen peroxide to produce bubbles and can be related to working surface and product cleanliness. These simplified procedures can be videotaped, shared with processors, and used on a routine basis to check sanitation procedures.

FOODSERVICE

Foodservice Forecasting: Since 43 percent of the food dollar is consumed away from home, improved forecasting techniques are needed to reduce cost in foodservice operations. Forecasting is a means of reducing waste and improving efficiency when food is purchased, prepared, and served. A naive expert system model was developed to replicate the knowledge, experience, creativity, judgment, and intuition of the forecast knowledge expert. Quantitative models are being further tested and refined.

Foodservice Sanitation: In 1993, 35 Extension agents were certified in foodservice sanitation through a 16-hour Servsafe course developed by the Education Foundation of the National Restaurant Association. Subsequently, 30 food state sanitarians were trained at the request of the Kansas Department of Health and Environment, Food and Drug Section. Seventy school foodservice directors also participated in the Servsafe training via interactive TV. After certification, Extension agents presented food sanitation educational programs to a variety of audiences.

Nutrition Labeling: The new nutrition labels required by the Food and Drug Administration are making healthy eating easier for the consumer and may be a factor in marketing the product. An extension program has been developed to assist small- and medium-sized food companies with nutrition labeling. As a result, over 200 labels have been developed to assist Kansas companies in marketing "value-added" food products.

QUALITY ASSURANCE

Beef Quality Assurance: Extension specialists have organized three programs to assure food wholesomeness and maintain consumer confidence. These include 1. A survey and summary of systems used by large and small feedlots to monitor drug usage; 2. The use of electronic identification implants to permanently identify cattle from birth to consumer; and 3. Developing a cow-calf safety (quality) assurance manual for national use as a reference guide.

Swine Quality Assurance: Pork quality assurance is an initiative of the National Pork Producers and Kansas Pork Producers. Certification is achieved if producers review 10 critical control points for residue avoidance. Because of efforts by Extension specialists and the Kansas Pork Producers Council, Kansas has certified more than 200 producers. Kansas ranks number one in the nation in numbers of certified producers, even though Kansas ranks 10th among the states in total swine numbers.

Dairy Quality Assurance: A 10-point residue avoidance program was organized by a committee of veterinarians, regulatory personnel, and dairy Extension specialists and presented at 34 Kansas Dairy Herd Improvement Association annual meetings. The meetings were attended by 1,349 people who represented 556 herds (43 percent of all Kansas herds), 80 veterinarians, 16 milk marketing field representatives, and 8 regulatory personnel.

Quality Assurance—On-Farm Feed Manufacturing: In Kansas approximately 11 percent of the meat animal residue problems result from on-farm feed manufacturing operators. K-State county agents and specialists, Kansas State Board of Agriculture, Kansas Pork Producers collaborated to produce a quality assurance program to address this problem. The program will be used, not only in Kansas, but also by state and county Extension faculty in major swine producing states.

MEAT AND MEAT PRODUCTS

Because of abundant feed grain, forage, and range, Kansas is a leader in producing, marketing, and processing red meat. KSU scientists work to add value, develop new products, and improve packaging and processing systems that increase the marketability, profitability, and safety of meat and meat products.

ENHANCING PRODUCT VALUE

Wheat Germ and Comminuted Meat Products: KSU developed the commercial process of wheat germ protein utilization in comminuted meat products. Meat products formulated with wheat germ protein had lower cholesterol and cooking losses and higher water-holding capacity, better stability, and yields. No differences were found in atypical aroma and flavor of products containing 3.5 percent wheat germ protein. Wheat germ protein can be utilized as an extender and replacer of saturated fat and meat proteins in frankfurters and bologna.

Adding Value to Beef Products: K-State researchers want to maximize the value of beef by restructuring portions of the carcass that would normally go to ground beef into higher-value steak-like and roast-like items. Assuming that 4.0 billion pounds of carcass beef yields 1.0 billion pounds of ground beef and that 20 percent could be upgraded in price by \$0.50/lb by restructuring, this would add \$100 million in added value in Kansas.

Meat-Based Snack Food: Animal scientists have produced a meat-based crisp snack food by a cooking-extrusion process that is composed of 75 percent wheat flour and 25 percent mechanically deboned meat. Any kind of meat is suitable. The final product contains 2 percent to 3 percent moisture, 1 percent to 2 percent fat, and 12 percent to 15 percent protein and can be flavored to any taste. The cooker-extruder is used to make a variety of snack foods. The KSU product, however, is the first to utilize meat as a major ingredient. The product should have wide commercial appeal.

Marketing Lean Beef: Health concerns and declining consumption has led the industry to feature leaner table cuts and low-fat ground beef. K-State research shows that consumers are willing to pay almost 2 cents per lb for each unit increase in leanness in ground beef; for example, 10 cents per lb more for 90 percent lean ground beef than for 85 percent lean ground beef. If low fat ground beef garners 10 percent of the ground beef market, it could cause ground beef products to increase by 1 cent/lb and increase the price of nonfed cattle by 1.53 percent.

Pricing Hog Carcasses: A hog carcass pricing formula has been developed that explains 80 percent of the value differentials in fabricated carcasses. This allows for a hog carcass pricing system for buying grade and yield hogs that more accurately provides a reward for high-value quality traits.

RED MEAT PROCESSING SYSTEMS

Packaging Studies: K-State researchers are studying innovative ways to package and process red meat for the modern consumer. The studies involve gas packs (carbon dioxide) and gas atmospheres (100 percent and 10 percent oxygen). Commercial practice leaves too much oxygen in gas packs, reduces product life, and increases losses. These studies involved cooperation with Excel Corporation, Wichita, Kansas, and M-Tek, Elgin, Illinois. A 3–5 day increase in shelf life for pork products could amount to \$10 to \$20 per carcass.

Red Meat: K-State research on red meat processing (restructuring, low-fat, and value-added products) has increased the value of Kansas meat products by \$210 million annually. Pre-chill (hot processing techniques) developed at Kansas State University have been adopted in Australia, New Zealand, and other international markets. The potential annual savings in the U.S. approximates nearly \$100 million. The development of centralized processing techniques adds another \$86 million to the Kansas economy.

Heart Muscle (Beef and Pork): Heart is an undervalued meat product because of a failure to retrieve its functional properties. Current price is \$0.30/lb for beef heart compared to \$1.30/lb for 90 percent lean beef trimmings. If heart prices could be raised \$0.50/lb by improved use, this would total \$2 per animal for 6.7 million cattle slaughtered in Kansas. To study functional properties, researchers are comparing a rapid grinding-salting procedure with commercial chill conditions.

Shank Meat: Shank meat, a low-cost source of “manufacturing” beef, is high in connective tissue (sinew). Baader™ technology may provide an alternative of mechanical desinewing. KSU is investigating the desinewing parameters, yields, and ways to mechanically modify the sinew for reincorporation. If successful and commercialized, the process could increase the return from a 700 pound carcass by \$3 to \$5 (\$20 million to \$30 million per year for cattle slaughtered in Kansas).

Reducing Fat Levels in Red Meat: KSU meat scientists want to develop low-fat (7 percent to 10 percent) meat products with texture and taste characteristics comparative to those with traditionally higher (25 percent to 35 percent) fat levels. Hard salami is a high-value, fermented, relatively stable product with high value-added potential and could be marketed by both small- and large-scale processors. Six companies are cooperating in the study, and project findings have a high potential for commercialization.

Boxed Beef: Because Kansas is the largest beef processing state, enhancement of shelf life is critical to the economy.

Lactic acid and chlorine treatments of beef carcasses decrease microbial contamination but do not necessarily increase shelf life. Researchers are applying procedures approved for use with the carcass to subprimals just before packaging to determine if safety and shelf life can be enhanced. A 3 to 5 day increase in shelf life could increase the value of a beef carcass by \$100.

Processing Precooked, Restructured Beef: Concerns over diet/health issues necessitate the production of processed meat with less fat and salt. Meat scientists have produced restructured beef products with 0.2 percent salt and 5.0 percent fat compared to approximately 2 percent salt and 10 percent fat in traditional products. Connective tissue removal, alteration, and reincorporation also adds value to heart and chuck muscles.

MANAGING LIVESTOCK

Livestock management focuses on marketing and management systems, including feed and reproductive efficiency and disease control. Recommended production and protection systems must be cost effective and profitable for the producer and provide an affordable, wholesome, and desirable product for the consumer. There is also an emphasis on the use of Kansas products in building rations for beef, swine, and other livestock.

FEED AND NUTRIENT EFFICIENCY

Implants and Ionophores: Kansas is a leader in developing and testing livestock implants and ionophores. The benefits from implants approximates \$30/head and from ionophores approaches \$20/head. Cattlemen depend on Experiment Station research results to guide them in their use of these products. With 1.9 million cattle on feed, the economic impact for Kansas is \$95 million annually.

Feeding Wheat to Cattle: Kansas grows 300 million to 400 million bushels of wheat each year, so domestic, export, and alternative markets are essential to reduce price volatility. K-State researchers established the value of wheat in cattle rations. Now, when wheat prices drop and feed use is a competitive option, about 80 percent of Kansas feedlots include wheat in cattle rations. This adds approximately \$0.10 per bushel to the price of wheat and contributes up to \$40 million to Kansas farm receipts.

Milo Rations for Dairy Cows: The use of milo in diets for dairy cows is limited by low-soluble carbohydrates, and low digestibility and may elevate blood urea and adversely affect reproduction. Adding tallow to the diet improved milk yield 6 percent to 12 percent but also increased blood urea nitrogen. Substituting wheat for 30 percent of the milo in the diet increased milk production an additional 2.5 percent and significantly lowered blood urea nitrogen. Milk yield from this ration was better than from a corn-based diet.

Nutritional Value of Sorghum Grain: Sorghum, a 400-million-bushel crop in Kansas, is a livestock feed. K-State research has focused on nutritional value, crop yield, processing methods, and cattle rations. Prior to these investigations, the National Research Council (NRC) reported that the nutritional value of sorghum was 82 percent that of corn. NRC

now lists sorghum as ranging from 90 percent to 100 percent the value of corn, depending on the processing procedure. K-State research is thought to have added \$0.20 per bushel to the price and \$40 million to the state's economy.

Grain Sorghum in Nursery Pig Diets: K-State is cooperating in a regional effort (9 north central universities, 4 USDA laboratories, and several grain and seed companies) to improve the end value of raw agricultural products. K-State investigators found that by reducing the particle size of grain sorghum to about 400 μ , its nutritional value was equal to corn in nursery pig and broiler chick diets. This determination should help reduce the discount value of grain sorghum relative to corn.

Modified Wheat Gluten as a Protein Source for Baby Pigs: The use of modified wheat gluten could benefit baby pigs and Kansas farmers. Wheat gluten can be cost competitive compared to milk protein sources for baby pigs. Diets containing wheat gluten had 5 percent greater digestibility than diets with soybean meal. Compared to diets with dried skim milk, diets with the best wheat gluten supported equal rate and efficiency of gain for 14 days postweaning.

REPRODUCTIVE EFFICIENCY

Improving Reproduction: Administering prostaglandin F_{2a} during the early postpartum anestrous period will improve reproduction in beef cows. If administered between 25 and 40 days after calving, an 18 percent increase in pregnancy rate was achieved. The reduction in open cows pays for treatment and diminishes the need for replacement heifers. If a heifer fails to become pregnant, the net loss approximates \$250 per heifer.

Heifer Evaluation: Heifers that calve early in their first calving season tend to calve earlier and wean heavier calves throughout their lifetimes than do later-calving heifers. The HERD program promotes management techniques that enhance early heifer conception. Techniques include: 1. Group feeding of heifers according to the target-weight concept; 2. Scoring the reproductive tract; and 3. Heat synchronization for artificial insemination. Other features include pelvic area measurements and ultrasonic determination of pregnancy, fetal age, and fetal sex.

Facilitating Pregnancy in Dairy Cows: Cows that are not inseminated because of missed heats (about 10 percent of the herd) or found not pregnant (about 30 percent of the herd) should be given prostaglandin F_{2a} if a functional corpus luteum can be palpated or if milk progesterone is high. K-State research confirms that conception will occur 21 days or 14 days earlier than in untreated controls, respectively, for the two groups of cows. The savings are \$21 per cow for the former and \$42 per cow for the latter group of problem cows.

Increasing the Pregnancy Rates of Repeat Breeders: Repeat breeders represent about 25 percent of all dairy cows. The pregnancy rates at repeat services will be increased 10 percent if given gonadotropin-releasing hormone (GnRH) at the time of the third insemination. With treatment, about 10 percent more cows would be salvaged because those cows would calve and remain in the herd. For 43,000 cows enrolled in the Dairy Health Improvement Testing Program, this could increase gross income by \$806,000 annually.

Embryonic Signaling of Pregnancy Establishment in Pigs: Discoveries in KSU laboratories may alter the physiology of early pregnancy and improve litter size in swine. New routes of estrogen metabolism in pig embryos have been identified, and researchers have determined that prostaglandins are key regulators in early pregnancy. If 25 percent of lost embryos were saved, litter size would increase about 1.6 live pigs, and the U.S. swine herd could be reduced 15 percent without reducing the number of pigs produced. The savings could approximate \$150 million annually.

DISEASE CONTROL

Bovine Respiratory Disease: Bovine respiratory disease continues to be a major problem in cattle on pasture and in feedlots. Because *Pasteurella haemolytica* is an important cause of the disease, researchers have focused on isolating various antigens from the bacteria that may be used to develop experimental vaccines. In addition, monoclonal antibodies have been used to characterize important bacterial components.

Bloat in Cattle: Approximately 18 percent of cattle deaths in Kansas feedlots are from gastrointestinal upsets, and 71 percent are from grain or feedlot bloat. K-State research on bloat led to the development of poloaxalene (Bloatguard®). Numerous antifoaming agents have also been screened for preventing frothy bloat, but none was found effective. The research has shifted to bloat-causing microorganisms and the efficacy of antimicrobials.

Liver Abscesses: In Kansas, 850,000 grain-fed cattle are affected by liver abscesses. Losses approximate \$25 to \$66 per head. KSU microbiologists are in the final stages of developing a vaccine to prevent this loss.

Porcine Pleuropneumonia: This is an important disease in the pork industry, and many herds are infected. When it occurs in unexposed herds, morbidity can exceed 40 percent, and mortality can be as high as 24 percent. Investigators are evaluating assays currently used to identify infected animals and are defining how the bacteria cause disease. Those studies, which depend on molecular biology techniques, may lead to an effective vaccine.

Detection of TGE-IgM Antibodies and Virus Particles: A series of TGE-specific, monoclonal antibodies has been developed and used to develop an enzyme-linked immunosorbent assay (ELISA). This test will detect specific anti-IgM antibodies in swine serum within 5 to 7 days. Early detection significantly helps in managing an infected herd. Monoclonal antibodies can also be used to detect virus particles in tissue.

CATTLE MANAGEMENT SYSTEMS

Fly Control in Feedlots: KSU entomologists have developed methods for rearing a stable fly parasite. Mass release of the parasite in 18 cattle feedlots reduced the stable fly population by nearly 50 percent. In cleaner feedlots, this is below the economic threshold for chemical treatment. In Kansas, if only one-half of the fly irritation were prevented, the economic benefits would approximate \$7 million. Dependency on chemical dependency would also decrease significantly. Parasitic control of flies is also being tested on 12 dairy farms.

Acoustic Sorting of Feeder Cattle: Research at the KSU Agricultural Research Center-Hays has documented the utility of using ultrasound to measure backfat and marbling. The technique can be used to determine optimal length of the feeding period to insure that the carcass will grade choice. This technique can add \$20 per head to the total value of a group of cattle. Adoption by 50 percent of the industry would add \$40 million to Kansas farm receipts.

Feedlot Facilities: Extension engineers work with producers who are expanding their feedlots to evaluate facilities and ensure that present and future environmental regulations will be addressed. By investing in facilities that maximize feed efficiency and meet environmental regulations, a producer's investment can return dividends for 15 to 20 years. Properly constructed feedlots (500-head lots) can result in annual feed savings of \$750,000 annually.

Using Iodinated Resins to Disinfect Water: Large-scale systems have been developed containing penta-iodide resin capable of treating surface and groundwater and producing microbiologically pure, disinfected, potable water. A zirconium peroxide resin uses iodide ions to disinfect the water and then removes the iodide ions from treated water. A silver-chelex resin disinfects water but removes the iodide ion by precipitation in the resin bed. The first practical application of such a system was to poultry.

SWINE

Environmental Control in Swine Buildings: Electronic technology can control ventilation and furnaces in farrowing and nursery buildings, increase the number of pigs per litter, and reduce heating costs. KSU engineers worked with commercial companies in the design and use of the controls. With improved environmental conditions, litter size increased 0.5 pig, 25,000 additional pigs were weaned, and producer income was increased by \$500,000. The use of electronic controls should reduce heating costs 30 percent, conserve 100,000 gallons of propane, and save \$60,000 annually.

Using Porcine Somatotropin: Swine nutritionists have determined the nutritional requirements of growing and finishing pigs being administered porcine somatotropin (pST). The lysine requirements for pigs administered pST is more than double that normally recommended by the National Research Council. Dosage of pST for maximum performance of pigs fed higher levels of lysine is 5 mg/d for growing pigs and 4 mg/d for finishing pigs. These data will allow pork producers to maximize growth and carcass quality immediately if pST is cleared for marketing.

Feeding Strategies for Lactating Sows: An average producer weans 8 pigs per litter, whereas outstanding production units are weaning 9.5 to 10.5 pigs per litter. Swine nutritionists have found that increasing dietary lysine (0.65 to 0.85 percent) for high-producing sows increases weaning weight and allows pigs to reach market 5 to 7 days sooner. When the gestation/lactation diet was supplemented with 1.5 gram of folic acid/ton of feed, the number of pigs weaned was increased 1 pig per litter. This increased productivity would expand income for Kansas producers by \$5.2 million annually.

SHEEP

Sheep Research: Research in northwest Kansas has established that the lamb crop can be increased 110 percent to 150 percent through the use of Finn cross ewes. In Kansas, this has the potential of increasing annual lamb numbers from 132,000 to 180,000 for a net annual income gain of \$2.9 million. Since all producers want to improve their lamb crop, crossbreeding has a significant impact and is widely used. If 50 percent of the growers adopt the crossbreeding concept, the potential impact is \$1.44 million.

Sheep Nutrition: Nutrition research with grain and alternative protein sources has improved feed efficiency in lambs by

20 percent. As a result, a pound of gain can be achieved with 4 rather than 5 pounds of feed. Because of the monetary impact, growers have shown considerable interest. If 75 percent of farm-raised Kansas lambs were finished using this practice, the net annual savings would total \$323,000 each year.

Breeding Soundness for Rams: Ram Breeding Soundness Examination Clinics are held to examine the potential of a ram as a sire. Major areas involve conformation and condition scoring; physical examination of the reproductive tract and semen; and tests for epididymitis, the major cause of ram infertility. A high-scoring ram will increase the conception rate by 40 percent and lambing percentage from 70 percent to 150 percent, significantly enhancing profitability.

MARKET DEVELOPMENT

International Meat & Livestock Program (IMLP): This program develops training and trade exchanges for Kansans and the international community. The focus is on fabrication, evaluation, processing, and marketing meat and dairy products. In 1992, training programs involved representatives of 6 countries, and trade programs included delegates from 7 countries. Producers, feedlots, processors, feed companies, manufacturers, suppliers, and animal and food merchandisers cooperated to develop sales or trade opportunities.

CELL DIVISION

Regulating Cell Proliferation: Animal and plant cells contact their environment by surface components that respond to extracellular cues. KSU biologists have isolated a unique cell-surface molecule from bovine brain tissue that appears to be responsible for inhibiting cell division. They have learned how this cell-surface element inhibits cell division, where the cells are arrested in the cell cycle, and that the inhibition is nontoxic and totally reversible. Bovine, human, mouse, rat, and insect cells are sensitive to this regulatory component.

ANIMAL DAMAGE CONTROL

Wildlife Damage Control: Cooperative Extension provides assistance so farmers and ranchers can better control wildlife depredation problems. This includes educational and hand-on assistance for coyote and bird damage control and, where needed, assistance with wildlife control devices and methods. It is estimated that the program saves \$1 million annually by reducing animal damage, helps avoid at least 100 human health problems, and saves at least 2,000 nontarget animals (eagles, hawks, etc.).

FARM, RANCH, AND BUSINESS MANAGEMENT

Many farm and business decisions hinge on the management of renewable and natural resources; the marketing of farm and value-added products; and the cost-benefit ratio of proposed policies and enterprises. K-State has long been a leader in gathering, analyzing, and helping farmers use farm management data in managing risk and in assuring profitability on the farm and in the market place.

FARM MANAGEMENT

Farm Management Analysis: Each year detailed financial, production, and enterprise reports are collected from 2,298 Kansas Farm Management Association members. These data are used for farm-management-related research projects and Extension educational programs. By participating in this analytical program, association members can more effectively analyze farm programs, make informed decisions, and project future needs. We estimate that each association member saves \$500 annually (\$1,114,900 collectively) in accounting and reduced enterprise expenses.

Farmer Response to Risk: Results of the project indicate that production risk on large farms is relatively less than on smaller farms. This result helps us to understand additional reasons why farms have gotten larger over the years. The results are directly applicable to issues regarding crop insurance. This work provides information that allows more accurate calculation of premium discounts for large units.

Rural Community Response to Changes in Farming: Economic analysis showed that a county's economic composition determined the impact on the county of economic restructuring. Generally, trade center, mining, and farming dependent counties were most negatively impacted. Manufacturing dependent counties were least impacted. Most impacted were job and shopping opportunities, the least was public services.

BUSINESS MANAGEMENT

Short-Flow Flour Mill: A new wheat short-flow flour mill developed at K-State and licensed to Kice Milling in Wichita provides opportunity for small flour mills to be located in rural areas. Studies show that a 1,550,000 bushel per year mill could add 6 skilled jobs and return an estimated \$900,000 to the local community.

Cattle Feedlots: K-State, in cooperation with the Rural Electric Administration, investigated the economic impact of a small feedlot. A 3,500 head capacity feedlot would impact the local economy by \$5.5 million each year. For each person employed at the feedlot, 2 to 3 additional jobs are created in the community.

Turkey Production and Slaughter: Turkey production in Kansas is increasing. An economic study for a group of

Northwest Kansas farmers showed that a 10,000 bird unit, with turkeys raised to slaughter weight, would require an investment of \$364,595 but could return \$952,583 to the county or regional economy. Such a unit would handle about 65,000 turkeys per year.

Value-Added Education Efforts: The Cooperative Extension helps Kansas and U.S. grain producers, handlers, processors, and merchants add value to grain and grain products through instruction in utilization and processing principles and in flour mill, feed mill and grain elevator management. The programs feature hands-on training by faculty with industry experience and utilize pilot flour mill and feed mills at K-State. USDA grants permit the transfer of technology and methodology pertinent to manufacturing, profitability, and regulatory requirements. Food safety, product quality, and added value are emphasized.

MARKETING

Beef Marketing: About half of all beef sold in U.S. supermarkets is purchased in response to an advertised price discount. When beef is featured at significantly reduced prices, sale volumes increase at least 200 percent. Thus, supermarket advertising increases beef's market share. Research shows that supermarket advertising is important in affecting demand trends for beef, cattle prices, and producer profitability.

Sheep Slaughtering Market Concentration: Concentration of sheep slaughter by 4 major national firms increased from 55 percent of sheep slaughtering in 1980 to 70 percent in 1992. Studies show that the impact of this increased concentration had a positive effect on lamb marketing margins. Thus, market concentration likely increased the farm-to-wholesale margin by \$0.77/cwt.

Food Processing Technical Changes: Shipments from the Processed Food and Kindred Products Industry totaled \$380 billion in 1991, which was about 14 percent of all U.S. manufacturing activity. University studies on new technologies for processing, packaging, and marketing food products have helped increase labor productivity and consumer demand for processed convenience food. These technological changes assisted food processing firms to become more responsive to changes in farm product prices.

WATER AND CROP MANAGEMENT

Water Supply Reduction—Upper Arkansas River: The dwindling stream flow of the Arkansas River is supplemented by irrigation from groundwater in the semiarid climate of southwest Kansas. Recent studies show that irrigation significantly increases the value of the water and the value of the crops produced. For fully irrigated corn, the value of irrigation water can be as high as \$5.06 per acre inch.

Alternate Cropping Systems for Northeast Kansas:

Northeastern Kansas farmers produce many crops and use numerous cropping systems. In a recent study of 7 innovative cropping systems, the wheat/clover-sorghum-soybean system provided the highest net return (\$46.05 per acre). The impact of government programs were included in the study.

Aquifer Depletion in Northwest Kansas: Water level changes in the last 2 decades in northwest Kansas have averaged about 1 foot per year. A continued decline in the water table will seriously affect the economy of this region. If the price, cost, and yield trends of the past decade continue, studies show that irrigated acreage in the 12-county region could decline 24 percent, while net returns to farmers could decline 12 percent in the next 40 years.

BTU TAX

In 1993, a BTU tax was proposed to increase the cost on energy inputs used on farms. The estimated effect of the tax was an increase in production cost on the average farm in Kansas from \$1,085 to \$3,145 per farm, depending on the type of farm. The results of this study were used by legislators in their discussion of the proposal.

SPECIAL OLYMPICS PROGRAM

Special Olympic events were held in Winfield, Salina, Lawrence, Atchison, Hays, and Wichita. KSU studies show that the economic impact for all 6 communities totaled about \$5.9 million each year.

REVITALIZING RURAL KANSAS

Cooperative Extension helps Kansans revitalize communities through action and informational programs and through a 1. Strategic planning program (Creating Economic Opportunities); 2. An informational and referral program for businesses and economic and rural development (DIRECT); and 3. Data sets that impact economic development.

ACTION PROGRAMS

PRIDE: The Kansas PRIDE Program successfully completed its 23rd year of responding to the leadership needs of Kansas communities. One hundred and three communities participated in 1993, with 53 competing for Community Achievement Awards. Twenty-four communities were active in waste reduction-recycling efforts and 14 in water conservation, both special emphases for 1993. In 1993, 255,671 hours of volunteer labor were donated by 55,677 persons to accomplish 2,238 community betterment projects, an effort valued at \$1,278,355.

Creating Economic Opportunities (CEO): The four phases of the CEO program—organize, analyze, formalize goals, and implement action plans—require 12 to 18 months of intensive work. Implementation plans have been completed for 13 counties and 3 communities. During 1993, 7 communities were in some phase of the CEO program. Atchison County is implementing its action plans. A housing commission has been organized and a director hired. Two new grants have been obtained. One will help pay for housing rehabilitation, and one will help a senior citizens housing program.

DIRECT: Extension's DIRECT program is a single point of contact for information on business, economic, and rural development. During 1993, DIRECT assisted 1,250 client cases. Fully 20 percent of those cases involve the production of value-added foods. The key to success is individualized consultation, so essential production, processing, and feasibility

problems can be addressed. Fifty-five clients operated enterprises that were retained or expanded. Seventy-one clients created a new enterprise that resulted in revenues and employment. The net result was the creation of 478 new jobs and revenue increases in 175 enterprises.

Strategic Planning: Strategic planning in Atchison County was facilitated by efforts of the County Extension Board, county agents, Extension specialists, and the Atchison Area Chamber of Commerce. Outcomes of the planning effort include new housing initiatives, job creation, community appearance improvements, and the formation of a Housing Commission, a County Planning Commission, and a new PRIDE effort.

Manufacturing Technology: The Kansas Direct Program has entered into an agreement with the Mid-America Manufacturing Technology Corporation (MAMTC) to assist in manufacturing technology transfer to manufacturers across the state by providing special information and referral services to link manufacturers with needed assistance. MAMTC engineers helped clientele locate specialized training services and businesses with unique manufacturing capabilities and provide specialized consultation.

INFORMATIONAL ADVANCES

Research Data Sets: Cooperative Extension produces data sets that impact economic and rural development for use by interested individuals and main street coordinators, small business advisers, financial advisers, field officers, and economic development officers. The reports include:

- Kansas Population Study
- City Pull Factors
- County Strength Index
- County Active/Passive Income Ratios
- An Analysis of Retail Trade in Kansas
- Location Quotients of Economic Activity

Resource Directory Database: To assist rural communities in tapping limited resources, the Cooperative Extension Service, DIRECT Program, and the Kansas Rural Development Council (KRDC) developed a comprehensive data base

of federal, state, and regional agencies and organizations. The KRDC database includes 260 programs and services—each in a one-page format that includes purpose of the resource, requirements for participation, type of assistance, how the resource works, and contact person.

WASTE MANAGEMENT

Extension agents and specialists organize a variety of educational programs in waste management. Collectively, they reported making 16,073 program contacts. Additionally, 4,700 volunteers participated in the educational effort and made an additional 20,988 contacts. Educational efforts include publishing an agent newsletter, presenting educational programs directly or through volunteers, coordinating a national waste management satellite conference, university wide coordination, and information and referral for local officials.

COMMUNITY IMPROVEMENT

Community Improvement Programs—PRIDE: Waste recycling was continued for a third year as a special emphasis in the Kansas PRIDE Community Improvement Program. Extension agents and the Kansas Department of Health and Environment provided guidelines and technical and educational assistance. This year, 24 of the 103 enrolled communities submitted their recycling efforts for evaluation and PRIDE program recognition. Over 540 volunteers donated 5,967 hours to recycling and waste reduction projects.

Local Options for Waste Management: Cooperative Extension, with the Kansas Department of Health and Environment, coordinated six regional downlink sites for the satellite series “Local Options for Solid Waste Management.” Extension specialists provided coordination and printed materials. County agents handled local arrangements, publicity, and wrap-around programs. Over 145 local leaders participated and 26 counties purchased video tapes of the series for local use.

Yard Waste and Paper Disposal: Yard waste and paper products comprise over 50 percent of our nation’s landfills by volume. Research at Hays shows that these materials can be incorporated directly into soil at rates up to 45 tons per acre. Decay rates are enhanced by cultivation and mixing grass clippings with nitrogen-deficient paper products. When fully developed, this alternate disposal method could extend the life of landfills and save cities and counties millions of dollars.

Example Extension Programs: Extension educational programs in waste management include:

Are We in a Garbage Crisis: An educational program for Family Community Educators and youth groups that reached 424 persons directly. Another 1,997 persons

were taught by volunteers.

Enviroshopping: This program is used primarily by family and community educators, agents, and specialists, and it serves 1,827 persons. Volunteers instructed additional persons.

Ecology, Environment, and Solid Waste: This specialized program was used with 328 individuals.

Environmental Concerns/Pollution Prevention: This is a training workshop for county agents and health department officials on hazardous waste, recycling oil, chemical containers, and agricultural waste.

Household Hazardous Waste: This program, in cooperation with the Kansas Department of Health and Environment, reached 946 persons. Agents assisted government and other organizations in establishing hazardous waste collection programs.

Waste Generation: Waste generated in Kansas by food, grain, and livestock agricultural businesses was cataloged by type of industry, county, industrial code, and whether the waste was a benefit (resale or reuse) or a liability (cost to dispose).

Beef Tallow Fuel: Using 1993/94 diesel fuel prices, an analysis of the use of beef tallow as an alternate fuel showed that the cost of production was favorable.

Landfill Regulations: Because of the Resource Conservation and Recovery Act (RCRA), landfill regulations were scheduled to take effect, so county agents organized local and regional waste management committees and supporting educational programs.

COUNTY PROGRAMS

Sedgwick County: Over 15,000 Christmas trees were chipped and recycled for home and business use in Sedgwick County.

Marion County: Agents and volunteers in Marion County distributed a household product disposal guide to 7,000 individuals via the newspaper.

Riley County: In Riley County, a series of educational programs focused on composting yard waste, and the landfill waste stream was reduced by 10 tons per month.

Geary County: Agents and volunteers in Geary County emphasized post-flood clean-up and alleviating environmental risk.

Jewell County: In Jewell County, recycling contests were organized among school children and netted 9,240 lbs. of recyclable materials.

4-H AND YOUTH PROGRAMS

Educational programs for youth prepare them for leadership responsibilities and community service, and they enhance self esteem. The following reports highlight community-based programs that foster concern for the environment, care after school, and the educational and cultural needs of minorities.

Recycling—Jewell County Programs: Jewell County's annual Make It Happen Countywide Recycling Contest featured three categories: Collect All You Can, Adopt a Project, and Likeable-Litter. The program was adopted by elementary students in all 3 county school districts. County kindergartners and first graders collected #1 plastic items; grades 2 and 3 collected #2 plastic items; and grades 4 and 5 collected newspaper. A collection site opened on a bi-weekly basis as a direct result of this emphasis on recycling.

Kids After School Programs: The Reno County Kids After School Program (KAS) involves 6 sites in 2 school districts and was started to keep kids safe after school. Working closely with parents, principals, teachers, and

counselors, the program expanded to assist disabled youngsters and provide help with homework. The program was nominated for inclusion in the Partnerships Against Violence Resource Guide because of its successful approach to violence in families and communities. In 8 cases, the KAS program made it possible for parents to find work or return to school. Because of full-time employment, 4 parents left welfare rolls.

READ (Responsive Educational Approach to Diversity) Programs: Garden City is experiencing rapid change from a predominately white community to one that is 40 percent minority (Mexican, Southeast Asian, Laotian, Cuban, and African American). Many live at the poverty level. The dropout rate is 64 percent for Hispanics and 40 percent for Southeast Asian students. READ is a Cooperative Extension Service, School District, and Police Department after-school program. Program components include literacy, career education, and parenting. Three hundred children are enrolled at 8 schools. The program is cited as a model for use by other agencies and organizations.

FARM SAFETY

Farm accidents significantly disrupt the economic and social well being of individuals and families and impact the need for community support and service. Cooperative Extension organizes numerous programs to enhance agricultural safety and health.

Farm Safety Field Day: A pilot, day-long Farm Safety Field day was organized for a rural elementary school and held during normal school hours. It included a tractor rollover and 10 other demonstrations. Sponsors included an implement dealer, a national dealers association, the Red Cross, Farm Bureau, sheriff, and an elementary school in McPherson County. The program was then made available for statewide use.

Hazardous Occupation Training: A hazardous occupa-

tion training series is sponsored to reduce accidents, enhance safety, and reduce health-care costs. The training program was updated, supplemented with video tapes, and fortified with pre- and post-tests to measure knowledge change, teacher effectiveness, and to enhance the learning climate. A total of 1,480 student manuals were utilized.

Safety and Health for Older Kansans: Individuals in each county were trained to deliver safety lessons. "Hazard Alerts," complete with overhead transparencies, were also issued. The Grain Bin Safety Hazard Alert was used by 53 county agents. Project activities also included tabloids in "Livestock Safety" and "Health Concerns in Agriculture" (distributed to 71,000 individuals); two video tapes; and media packets (delivered to 42 Kansas newspapers and 22 radio stations); and equipment demonstrating respirator use and entrapment in grain bins.

AQUACULTURE

Studies have been conducted to evaluate the potential of crayfish aquaculture in Kansas. The experimental species, *Orconectes nats*, is commonly found in farm ponds in Kansas. It is hardy and prolific, but it readily overpopulates, and

growth is stunted. When subjected to a heavy harvest, the population was thinned, and rapid growth was achieved. Annual harvests of 150 to 900 pounds per acre of mixed sizes (bait and food sizes) were achieved. Crayfish could be cultured in Kansas for bait and human food if suitable markets were developed.