

Approved: Eugene H. Shore 2-4-93  
Date

## MINUTES OF THE HOUSE COMMITTEE ON AGRICULTURE.

The meeting was called to order by Chairperson Eugene Shore at 9:05 a.m. on January 28, 1993 in Room 423-S of the Capitol.

All members were present except:

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

Conferees appearing before the committee: Marc Johnson, Interim Dean, College of Agriculture, K-State University  
Dr. George Ham, K-State University  
Gerry Posler, K-State University  
Dr. Curtis Kastner, K-State University  
Dick Hahn, K-State University

Chairman Shore called the meeting to order and explained the purpose of the meeting is an update of the Kansas Agricultural Experiment Station (KAES). Marc Johnson, Interim Dean, College of Agriculture and Interim Director, KAES, addressed the committee stating that Experiment Station scientists are innovative and successful and that K-State has committed itself to position the Experiment Station on the cutting edge of technology. He introduced other faculty to provide reports on specific topics.

Dr. George Ham, Associate Dean and Associate Director, KAES, discussed the strategic planning process. The strategic plan has been worked on for two years and is currently in the hands of a task force. He emphasized that the research programs are mission oriented with the goal of keeping Kansas competitive in a global economy.

Jerry Posler, Head, Department of Agronomy, reported on crop production programs. Mr. Posler discussed wheat breeding and genetics, resistant grain sorghum germplasms, use of native bacteria for biological control and productivity in animal gain per acre.

Dr. Curtis Kastner, Department of Animal Sciences and Industry, discussed livestock and range and the importance of environment, sustainability, food quality and productivity.

Dick Hahn, Department of Grain Science and Industry, discussed short flow milling, wheat starch production and the bio-plastics market.

Committee discussion followed on deer and elk niche markets, soil erosion, swine production facilities at K-State (now and possible future plans) and biological controls. All of the above testimony is contained in attachment #1.

Chairman Shore announced the formation of a sub-committee on **HB 2106: Regulating the production of domesticated deer**. The sub-committee will be chaired by Representative Lloyd and Representatives Bryant and Reinhardt will serve on the sub-committee.

The meeting adjourned at 10:02am. The next meeting is scheduled for January 29, 1993.

Experiment Station

# RESEARCH

Developments

1993

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A Report to the

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Kansas Legislature

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By the  
Kansas Agricultural Experiment Station  
Kansas State University

HOUSE AGRICULTURE  
1-28-93  
ATTACHMENT #1



Office of  
**Dean of Agriculture**  
**Director of Agricultural Experiment Station**  
**Director of Cooperative Extension Service**

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February 4, 1993

**Extension  
Systems and  
Agriculture  
Research  
Programs**

*Cooperative  
Extension  
Service*

*Agricultural  
Experiment  
Station*

*International  
Programs*

**College of  
Agriculture**

*Academic  
Programs*

Dear Friends,

This report provides a cross section of Experiment Station accomplishments on topics ranging from crop and livestock production and protection, water and environmental quality, value-added marketing, financial management, and family needs to rural revitalization.

Also included are a brief overview and summary reports on strategic planning, crop production, livestock and range, and value-added marketing and processing.

I'm pleased to report that Experiment Station scientists are innovative and successful in competing for special and competitive grants to leverage the depth and quality of their research programs. Last year, the College of Agriculture received \$11.3 million in extramural funding. If one includes Experiment Station scientists in all departments and colleges, the total is \$14.2 million.

The Experiment Station research program is project driven. Each project is peer reviewed and has a finite life that rarely exceeds three years. We want to fund projects and obtain grants that favorably impact the economic, environmental, and social well-being of Kansans.

Kansas State University has committed itself to an in-depth review of the structure of agriculture. We think it essential that we position the College, Experiment Station, and faculty on the cutting edge of technology that will best serve students, communities, and all Kansans.

Your comments and suggestions are invited.

Sincerely,

Marc A. Johnson  
Interim Director

# TABLE OF CONTENTS

<b>EXECUTIVE SUMMARY</b>	<b>1</b>
<b>OVERVIEW</b>	<b>3</b>
Marc A. Johnson	
<b>STRATEGIC PLANNING</b>	<b>5</b>
George E. Ham	
<b>CROP PRODUCTION</b>	<b>7</b>
Gerry L. Posler	
<b>LIVESTOCK AND RANGE</b>	<b>9</b>
Jack G. Riley	
<b>VALUE-ADDED MARKETING AND PROCESSING</b>	<b>10</b>
Charles W. Deyoe	
<b>CROP PRODUCTION STRATEGIES</b>	<b>13</b>
Field Crops	13
Alternate Crops	15
Horticulture and Forestry	15
Photosynthesis and Nitrogen Fixation	17
<b>LIVESTOCK, FORAGE, AND RANGE</b>	
<b>MANAGEMENT</b>	<b>18</b>
Forage and Range	18
Livestock Management	19
Dairy	21
Swine	23
<b>PLANT AND ANIMAL PROTECTION</b>	<b>25</b>
Plant Protection	
Plant Disease Research	25
Wheat	25
Soybeans	27
Insect and Other Pests	27
Biological Control and Resistance to Herbicides	29
Plant Identification	29
Animal Protection	
Boxed Beef	29
Biological and Biochemical Approaches	30
Assessing Pathological Risk	32
Wildlife Protection and Enhancement	32
Ticks	33

<b>WATER AND ENVIRONMENTAL QUALITY</b>		<b>33</b>
Treatment and Technology	33	
Diffuse Pollution	35	
<b>VALUE-ADDED MARKETING, PROCESSING AND UTILIZATION</b>		<b>36</b>
Adding Value to Grains	36	
Adding Value to Meat	37	
Value-Added Products	39	
Specialty Products	40	
<b>BUSINESS AND FINANCIAL MANAGEMENT</b>		<b>40</b>
Marketing Livestock	40	
Business Management	41	
<b>NATURAL RESOURCE CONSERVATION</b>		<b>43</b>
Resource Conservation	43	
Water-Use Efficiency	44	
<b>HUMAN CAPITAL AND FAMILY NEEDS</b>		<b>45</b>
Perceptions of Social and Economic Issues	45	
Nutrition	46	
Nutrition and Exercise	46	
Food-Service Systems	47	
Protective Clothing	47	
<b>RURAL AND COMMUNITY REVITALIZATION</b>		<b>48</b>



## EXECUTIVE SUMMARY

Reports of a cross section of research projects by the Kansas Agricultural Experiment Station are provided on topics ranging from crop and livestock production and protection to water and environmental quality and value-added Kansas products. Progress in financial management, resource conservation, human capital and family needs, and rural revitalization are also included.

**Crop Production:** The emphasis is on profitable, sustainable, and efficient production of field, forest, and horticultural crops. Variety and germplasm releases include Karl wheat, a high yielding, high protein hard red winter wheat; Arlin, an improved and adapted hard white winter wheat; Weskan barley; and numerous sorghum germplasm releases. Research on alternate, horticultural, and forest crops is also underway. Improved crenshaw melons and bermuda grasses have been released, and advances have been made in managing fruit tree rootstocks, flowering herbaceous perennials, and hardwood species for fuel. Basic research is being directed at photosynthesis, nitrogen fixation, heat and drought tolerance, and morphogenesis from leaf callus.

**Livestock, Forage, and Range Management Systems:** Livestock management research focuses on environmentally and economically sound livestock, forage, and range systems. Animal scientists are working to increase the fertility of cows subsequent to calving, the value of cull cows, and the benefits of feed supplements. Rye-bermuda grass forage systems reduce erosion, add 60 to 100 days to the grazing season, and increase cattle gains up to 145 pounds. Research with dairy animals includes the use of hormones as profertility agents, milk replacers for calves, and extruding whole soybeans to destroy antinutritional factors. Fine grinding enhanced the nutritional value of cereal grains for swine and poultry and decreased fecal and nitrogen excretion significantly.

**Plant and Animal Protection:** Wherever possible, researchers utilize genetic resistance, biological control, and management strategies to develop control measures and reduce the need for chemical treatment. The Wheat Genetics Resource Center (WGRC) has assembled 3,500 wheat accessions, 1,200 cytogenetic stocks, released 14 improved germplasm lines, and begun to map the wheat genome. Other advances include a soybean cyst nematode resistant line, bacterial isolates which inhibit winter annual grasses, and rapid detection methods for *listeria* bacteria. K-State researchers have also isolated an inhibitor of cell proliferation and are studying the receptors of bacterial toxins, biochemical changes in macrophages and target cells, and immunity to pathogenic organisms.

**Water and Environmental Quality:** Kansas is faced with major adjustments in its water use and planning horizons. Technology is being evaluated to refine fertilizer recommendations and model plant uptake of hazardous chemicals. Engineers are constructing crop yield mapping devices to use to diagnose production problems, compare treatment effectiveness, and provide for spatially variable fertilizer applications. Machine vision technology is being developed to monitor weed infestations and control the application

rate. Scientists are also studying the effectiveness of best management practices in preventing non point source pollution in the Delaware and Blue River basins and the Herington Watershed.

**Value-Added Marketing, Processing, and Utilization:** Research expenditures for improving the quality and value of Kansas products are significant and are being enhanced. K-State research is directed to uses for wheat starch, wheat gluten, white wheat, and non food applications. KSU scientists also work to add value to meat and augment beef's market position by using controlled atmosphere packaging, antioxidants in precooked products, meat-based snack foods, extended shelf life, and products with less fat and salt. Experiment Station scientists also work with the Kansas Value-Added Center in developing and testing new products, formulations, and processes like soy yogurt, fermented, and other food products.

**Business and Financial Management:** Management is a key to production, marketing, and cost efficiency; and a factual knowledge base is essential in making informed management decisions. K-State research shows that consumers will pay higher prices for leanness in ground beef. Researchers are developing a hog carcass pricing formula (grade and yield basis) and quantifying the value of various fed cattle traits and economic impact of the cattle finishing and beef packing industry in the Kansas economy. They are also investigating the impact of federal farm policies in the Great Plains, reducing farm risk, alternative crop insurance policies, and the use of flex acres in farming systems.

**Natural Resource Conservation:** K-State research has focused on resource conservation and soil management and cropping strategies that control erosion, maintain production, and minimize cost. Engineers have demonstrated that the water-use efficiency of drip irrigation and low energy precision irrigation systems approach 95 to 100 percent. Economists are examining the impact of the conservation reserve program (CRP) and are studying the economic and environmental impact of farming practice and water quality policy on farm income.

**Human Capital and Family Needs:** A Computer Assisted Telephone Interview system helps researchers determine the opinions, perceptions, and feelings of Kansans about policies and procedures that affect individuals, families, and communities. Data sets about the impact of environment on rural children's development have been prepared. Research has also addressed the nutritional affects of dietary fiber and lipid metabolism, use of wheat germ in comminuted meat products, bakery products with reduced calories, and selection of a hospital food-service system.

**Rural and Community Revitalization:** Kansas is a rural state but farming and the rural economy is changing. K-State programs help families, communities, and the rural sector with coping strategies for economic development, rural retailing, and diversifying local economies. The greatest impact of abandoned railroad branch lines is on communities located more than 100 miles from major grain markets. Waste stream analyses have also been completed for the food and beverage operations of mid-scale hotel properties and a college dining center.

# OVERVIEW

*Kansas Agricultural Experiment Station*

*Marc A. Johnson*

Interim Dean, College of Agriculture

## Introduction

Previously, our reports to the Kansas Legislature emphasized integrated research thrusts like water and environmental quality; crop and livestock breeding and reproductivity; and crop and livestock protection. This report, however, represents brief reports on a cross section of research topics including:

- Crop Production—Field, Forest, and Horticultural Crops
- Livestock, Forage, and Range Systems
- Plant and Animal Protection
- Water and Environmental Quality
- Value-Added Marketing, Processing, and Utilization
- Business and Financial Management
- Human Capital and Family Needs
- Rural and Community Revitalization

Today's report to the Agricultural Committee includes an overview and brief reports on strategic planning, crop production, livestock and range, and value-added marketing and processing.

## New Directions

Just as the Legislature is organizing anew, the Agriculture Experiment Station and College of Agriculture is recommitting itself to address strategic plans and critical questions concerning the Kansas economy, environment, and the economic engines that produce, protect, and market Kansas products on a local, national, and global scale.

I'm convinced that agriculture's production of substantial quantities of grain, meat, and food products is essential in keeping agribusinesses in Kansas. I'm also sure that agribusiness is the rural and urban engine that drives growth and a substantial part of the Kansas economy. We need to continue to emphasize research and education on the farm, in the classroom, and in support of business and industry so Kansas farmers, processors, and businesses remain competitive.

Although the written report highlights many research projects, I can only emphasize a few:

**Genetics and Crop Breeding:** K-State plant breeders have made significant strides in releasing germplasm and varieties that enhance yield, profitability, and protect the environment. Scientists in the Wheat Genetics Resource Center have begun to map the entire wheat genome to insure that future crop improvements can be made quicker, more accurately, and with greater predictability.

**Mapping Grain Yields:** Engineers have developed navigational and mass-sensing instrumentation with which to map crop yields—maps that can be used to diagnose production problems, compare treatment effectiveness,



provide for precision yet spatially variable application of agricultural chemicals in the field.

**Biological Control of Annual Grasses:** Biologists and weed scientists have identified over 100 bacterial isolates (from Kansas soils and plants) which inhibit root growth in weedy bromes and goatgrass yet do not injure wheat. The challenge is now to devise effective field control systems.

**Irrigation Efficiency:** Irrigators withdraw well over 80 percent of the state's water withdrawals. KSU engineers are researching water-use efficiency using drip, sprinkler, and low energy precision application (LEPA) systems. Irrigation efficiency using drip and LEPA systems can approach 95 to 100 percent yet maintain 200 bu/a yields.

**Agricultural Policy:** K-State and Oklahoma State University are providing leadership in addressing the impact of trade, commodity subsidy, and environmental policy on farms, industries, and other sectors of the Great Plains.

### **Evaluating the Structure of Agriculture**

Kansas State University has committed itself to an in-depth review of the structure of agriculture, including the Cooperative Extension Service, Agricultural Experiment Station, and College of Agriculture. The Interim Dean of Agriculture has been charged with the responsibility of organizing and conducting the study which will be completed prior to starting a nationwide search for a new chief administrator of agricultural programs.

A blue ribbon task force will be asked to study the structure of agriculture and make appropriate recommendations. We think it essential to consult widely with agriculture, industry, and faculty leaders over a six-month period before producing the report.

We want the recommended structure to position the land-grant university system and College of Agriculture to be the leader in agricultural and rural issues; strengthen our teaching, research, and extension capabilities; and enhance working relationships with other state and university programs. We think it essential to be flexible, anticipate change, and position our faculty to stay on the leading edge of technology that will best serve students, communities, and strengthen our competitive position.

Should you have suggestions concerning potential procedures or issues please write or call. Alternatively, you may wish to communicate directly with task force members.



## **STRATEGIC PLANNING**

*George E. Ham*

*Associate Dean and Associate Director, Kansas Agricultural Experiment Station*

### **Strategic Planning**

The strategic plan for the Kansas Agricultural Experiment Station (KAES) is being revised. We are examining both programs and organizational structure so productivity and efficiency can be enhanced and service to clientele can be improved. Statewide, 310 Experiment Station scientists from

25 KSU departments in five colleges, two branch stations, two research-extension centers, and 11 experiment fields work to support a \$7 billion agricultural industry. Today, the rapid pace of economic, social, and technological change makes planning more difficult than ever. However, we continually evaluate programs and plan changes to enhance agricultural profitability and sustainability. Our challenge is to configure the Experiment Station so faculty can continue to respond rapidly and effectively.

### **Flexibility and Accountability**

In our strategic plan, we want to maintain flexibility so KAES's goals and resources can be readily adapted to new and challenging conditions. As a first step, we reexamined the KAES mission statement and the short- and long-term goals which support this important industry. There are many important, researchable problems. Our task is to set priorities and address critical needs because KAES cannot be all things to all people. Some important agricultural issues cannot be addressed because of resource limitations or priority ranking. To ensure accountability, research objectives must be specific, measurable, and realistic. Each project has a finite life and an expected reporting date.

### **Priorities**

Current and potential research programs are evaluated to determine which to maintain, expand, or terminate. Our goal is to support research that will keep Kansas farmers and ranchers competitive in a global economy. This includes programs essential to production efficiency, farm profitability, and environmental quality. Research programs, however, must be adaptable to emerging needs and changing conditions. We plan to continue programs to enhance the production, protection, processing, marketing, and distribution of agricultural products with emphasis on cattle, swine, wheat, and feed grains. The strategic plan places high priority on new and emerging issues; an adequate, wholesome, and affordable food supply; quality of life; water and environmental quality, and resource conservation.

In addition, the KAES strategic plan will outline an integrated set of programs by which priority goals and objectives can be achieved. We expect that the KAES program will be project driven and that each project will be peer reviewed. Related events that will shape and expand research accomplishments will include KAES projects, in-house competitive grants, extramural grants, contracts, and other funding sources.

### **Mission and Goals**

The mission of the KAES is to conduct basic and applied research to ensure a plentiful, nutritious, safe, and acceptable food supply; promote a desirable quality of life for the people of Kansas now and for the future; and preserve the natural resource base.

### **Primary Responsibilities**

1. Continue vigorous basic and applied research programs in agriculture and related areas that anticipate the needs of Kansas citizens.
2. Prepare future scientists for interdisciplinary problem solving.
3. Transfer research-derived information and technology to end-users and provide expertise to implement and apply them to world situations.

## Critical Goals

1. Develop resource-efficient plant and animal systems that conserve natural resources.
2. Protect soil and water quality and conserve soil and water resources.
3. Enhance productivity and quality of food and fiber sources to ensure safe, stable, and acceptable food supplies.
4. Promote improved dietary behavior and nutritional status for optimal human health.
5. Achieve successful marketing strategies and global competitiveness of agricultural products.
6. Improve the well-being of individuals, families, and communities to enhance their quality of life.
7. Enhance the production, processing, storage, marketing, and distribution of agricultural products.
8. Expand the knowledge base of agriculture and related areas.

These priorities will be accomplished through the following scientific program areas: 1) Agricultural Product Development and Utilization; 2) Animal Systems; 3) Economic and Social Issues; 4) Environment and Natural Resources; 5) Food, Nutrition, and Health; and 6) Plant Systems.

# CROP PRODUCTION

*Gerry Posler*

*Head, Department of Agronomy*

## OVERVIEW

In Kansas, profitable crop production is essential to the state's economic viability. Crop acreage totals 31 million acres on 69,000 farms with 20 million acres devoted to grain crops (wheat, sorghum, corn, and soybeans). For many producers, sunflowers, canola, dry beans, oats, barley, rye, and horticultural crops also provide cash income and livestock feed. Twenty million acres of range, hay, silage, and pasture provide essential feedstuff for livestock (beef and dairy cattle and sheep). In 1991, the total value of field crops was \$2.6 million, and Kansas ranked sixth in the nation in farm exports.

## Research

Crop production, protection, and marketing research is conducted by faculty in the departments of Agronomy; Entomology; Plant Pathology; Agricultural Engineering; Horticulture, Forestry and Recreation Resources; Agricultural Economics; and four branch experiment stations at Hays, Garden City, Colby, and Parsons. Many of those efforts involve interdisciplinary teams of scientists and extension specialists.

Current research is designed to enhance crop and soil management strategies, sustain profitability, conserve resources, and protect water and environmental quality. These efforts include:

1. Crop breeding and genetics to produce improved varieties and

germplasms of sorghum, soybeans, alfalfa, canola, sunflower, barley, melons, beans, and turfgrasses.

2. Soil nutrient management, including nitrogen, phosphorus, potassium, and several micronutrients.
3. Protecting crops from insects, diseases, and weed competition.
4. Tillage practices to conserve moisture, reduce weeds, optimize nutrient use, and minimize soil erosion.
5. Cropping systems that integrate an appropriate mix of crops and crop rotations, and which use optimum inputs of tillage; weed, insect, and disease control; nutrients; labor; and machinery.
6. Water use and management under both dryland and irrigated conditions to optimally utilize available water resources.
7. Soil and water conservation practices to sustain these vital resources.
8. Research in water and environmental quality and management systems that minimizes risk from nitrates and pesticides such as atrazine.

K-State scientists have significantly enhanced crop production systems in Kansas, particularly for crop breeding and genetics; soil fertility and nutrient management; soil and water conservation and management; water use efficiency; weed control; and insect and disease management. KSU research and extension efforts led to the early adoption of hybrid corn and sorghum, stubble mulch tillage, semi-dwarf wheats, soybeans for grain, prescribed burning, intensive early stocking of range, and use of soil tests.

Recent achievements include:

1. Release of Karl hard red winter wheat, a variety with superior quality and high yield.
2. Release of Arlin hard white winter wheat, a variety with improved disease resistance and superior milling and baking quality for the hard white winter wheat industry.
3. Sorghum germplasms resistant to chinch bugs, new greenbug biotypes, disease, and which are tolerant to stress have been released and which enhance environmental quality and profitability.
4. Developed the concept of intensive early stocking of tall grass range. Doubling the stocking rate during the first half of the normal grazing season increases cattle gains from 60 to 135 lbs/acre and economic returns by about \$35 million.
5. Native bacteria from Kansas soils and plant roots are being evaluated for biological control of grassy weeds in winter wheat at Ft. Hays. More than 100 bacterial isolates have been identified which inhibit the growth of brome or jointed goatgrass species without inhibiting winter wheat. In field studies, selected isolates reduced the production of downy or Japanese brome 50 percent without injury to wheat.
6. Use of grain sorghum hybrids containing greenbug and chinch bug resistant germplasm developed by KAES scientists provides benefits estimated at \$45 million annually.
7. At the Southeast Branch Experiment Station, soybeans grown in rotations with wheat or grain sorghum yield 10 percent more than do continuous soybeans. Crop rotations also reduce the incidence of cyst nematode, a pathogen that can reduce soybean yields by 50 percent.

8. The Wheat Genetics Resource Center has conserved plant materials; identified specific genes for resistance to major diseases, insects, and stresses; and begun a map of the entire wheat genome that will benefit producers everywhere.
9. Research with Low Energy Precision Application (LEPA) sprinkler irrigation systems at Garden City resulted in irrigation application efficiencies of 95-100 percent, yet maintained corn yields that exceed 200 bu/a.

## LIVESTOCK AND RANGE

**Jack Riley**

*Head, Department of Animal Sciences and Industry*

### OVERVIEW

The livestock industry is very large, complex, and economically important to Kansas. In 1990, livestock and livestock products represented 66 percent of the cash receipts on farms and ranches with 90 percent of the income attributed to beef cattle and their products. Kansas has 1.4 million beef cows, 4.2 million fed cattle, 1.7 million stocker cattle, and 6.3 million cattle slaughtered. These numbers are even more impressive when viewed in relationship to the total cattle industry in the U.S. (4 percent of beef cows, 6 percent of total cattle, 14 percent of cattle on feed, and 20 percent of cattle slaughtered). Even though the swine, dairy, sheep, and poultry numbers are less impressive, they still represent \$525 million of farm income annually. It has been estimated that over the past 20 years, beef production has increased 33 percent/cow; pork production 63 percent/sow; milk production 50 percent/cow; and poultry production 86 percent/hen. Continuing to improve the level and efficiency of livestock production remains a significant component of the Animal Sciences and Industry Department.

### Range

Range comprises 40 percent of Kansas agricultural land and includes nearly 17 million acres of native range and 2 ¼ million acres of perennial pasture. Kansas ranks first in per acre productivity of rangeland in the 17 western states and second only to Texas in overall production from rangeland. The use of beef cattle to convert this basic natural resource in saleable commodities is an important facet of Kansas agriculture. In order to ensure the long term viability of range livestock production, attention also must be given to the sustainability of range livestock management practices. Therefore the goals of range livestock nutrition research at K-State is to pursue nutritional and grazing management schemes that optimize the efficiency of range forage utilization while ensuring the maintenance of a vigorous range-plant community. The use of marginal lands for grazing livestock conserves and improves the soil; prevents water runoff and erosion; and increases water-holding capacity. On land suitable for crops, livestock utilize crop residues unsuitable as human food. The soil is improved through the rotation of food and forage crops and the incorporation of animal waste into the soil.

## **Food Animal Research**

Food animal research has far reaching benefits to producers, suppliers, processors, and consumers, and those benefits are not simply economic. A safe, nutritious supply of food is essential for a healthy, thriving population. Protection of the animals' health and welfare, conservation of natural resources, maintaining quality of the water and environment, and infusion of human capital into rural communities are vitally important to the future of animal agriculture. Not to be overlooked is the importance of academic instruction for the next generation of animal scientists.

## **Science**

To quote Henry A. Wallace, "Science, of course, is not like wheat or automobiles, it cannot be overproduced ... in fact, the latest knowledge is usually the best. Moreover, knowledge grows or dies. It cannot live in cold storage. It is perishable and must be constantly renewed."



# **VALUE-ADDED MARKETING AND PROCESSING**

*Charles W. Deyoe*

*Interim Head, Department of Grain Science and Industry*

## **Value-Added Marketing and Processing**

There are eight important areas of value-added marketing and processing research at Kansas State University. The objective is to add value to Kansas products and favorably impact the Kansas economy. In most instances, the examples cited involve interdepartmental and interdisciplinary efforts and have significant actual or potential benefits.

### **KSU Short Flow Milling System**

Kice Industries, Inc., Wichita, has used the short flow milling concept developed by a K-State milling scientist to convert two existing flour mills and has sold three 1,000 cwt units. The first units, located in California, will be on line by October, 1992. Two other U.S. units will also be operational in 1992. Kice Industries is also committed to converting a large Kansas flour mill to the short flow concept. For the 1,000 cwt units, Kice will also supply equipment, bins, and pre-milling flows for wheat cleaning systems. These developments have created new jobs and new business opportunities in Kansas.

### **Extrusion Center**

**Utilizing Wheat and Corn Starches in Thermoplastics:** KSU has recently been awarded two patents for "Starch Based Biodegradable Packing Filler and Method of Preparing Same." Three to four commercial companies have shown interest in this technology. The advantages of using wheat starch are readily apparent. For example, if 10 percent of the total plastics resin market were replaced by wheat starch, it would provide use for 100 million

channels of wheat. Research is underway to extend this work for use in foam sheets, thermo-formed containers, and foamed structural plastics.

**Food Applications Include:** 1) Honey graham breakfast cereal, produced by extrusion technology, combines two Kansas products, honey and hard white winter wheat, to produce a healthy and wholesome breakfast cereal. 2) A nutritious soy snack food uses soy fiber and soy protein and expands the use of soy products for food use. 3) Pre-cooked, instant pasta products designed for convenience and use in microwave ovens were developed using KSU extrusion equipment. 4) Several Kansas companies are conducting contract research in the extrusion center.

### **Modified Wheat Starch**

K-State research on the properties and use of wheat starch has resulted in changes that enhanced the economic value of wheat starch. 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.

### **Wet Processing Laboratory**

Three KSU departments, Agricultural Engineering, Chemical Engineering, and Grain Science and Industry, are collaborating in the development of a wet-processing laboratory (wet milling of grains). Scientists in those departments are collaborating to investigate processing systems for grain sorghum, wheat, and other Kansas grains. Starch and other products will be separated and evaluated for uses in non-food and other value-added applications.

### **Kansas Hard White Wheat for Making Noodles**

Research to identify the critical quality factors in white wheat for producing superior oriental-style noodles is underway. In Asian markets, Australian white wheat flours are often considered of premium quality for both salt-noodles and instant fried noodles. Asian markets utilize 40 percent or more of the wheat flour they produce for noodles. If the noodlemaking quality of Kansas white wheat flours can be upgraded to match that of Australian noodle flours, the value of Kansas white wheats will be enhanced in Southeast Asian countries. Milling companies in Korea and Japan have indicated interest in using U.S. hard white wheats.

### **Frozen Dough**

In-store bakeries represent an \$8 billion business and are heavily dependent on frozen doughs for many of their products. Many producers of frozen dough believe that high protein spring wheat flour is required to provide the quality of products desired. However, a number of high protein, high quality, hard red winter wheats (HRW) such as Karl are now available to provide flour for these applications. Research results indicate that some HRW wheat flours perform well in frozen dough for white bread. This could expand the use of Kansas hard red winter wheat flours into this growing sector of the baking industry.

### **Whiter Wheat Bran for Use as Dietary Fiber**

Research is being conducted to produce a whiter wheat bran. The development of whiter bran would add significant value because it is now largely marketed as a lower value feed ingredient.

## High Protein Wheats

Kansas companies milled 87,871,000 bushels of wheat in 1991. However, Kansas hard red winter wheats are often too low in protein to meet baking industry specifications. To increase the protein content of their mill mix, Kansas mills use 20 to 35 percent hard red spring wheat from North (ND) or South Dakota (SD). To obtain high protein ND or SD wheats, Kansas mills pay a protein premium (about \$0.18) and shipping costs (about \$0.51). Therefore, high protein wheats like Karl, developed by K-State, increase market share and add value to the Kansas crop. In 1992, about 43,940,000 bushels of Karl wheat were produced. Wherever the protein content of Karl wheat exceeds 14 percent, it can replace hard red spring wheats formerly imported to meet the flour specifications of the baking industry.

## EXPERIMENT STATION RESEARCH DEVELOPMENTS— 1992

### CROP PRODUCTION STRATEGIES

The uncertainties of the 1980s brought significant change to Kansas agriculture. Agriculture became more complex and the need for profitable, sustainable, and efficient crop production strategies more acute. To help farmers cope with change, the Experiment Station intensified research efforts on developing superior germplasm and field crops, alternate crops, horticulture and forestry crops, photosynthesis, and nitrogen fixation. This resulted in varieties with improved nutritional quality, yield, and insect and disease resistance.

#### Field Crops

**Variety and Germplasm Releases:** K-State plant breeders work to genetically improve the state's important crops. Important variety releases include:

**Karl:** This high yielding, high protein hard red winter wheat has commanded a market premium because of superior quality and its performance on the farm and in the milling industry. Because of its protein content and quality characteristics, Karl could add an additional \$4 to \$6 million to the state's economy for the next several years.

**Arlin:** Arlin is a hard white winter wheat variety with improved adaptation, disease resistance, and superior milling and baking quality. Its white color and baking quality should enhance the growth of the fledgling hard white wheat industry in Kansas.

**Weskan Barley:** Weskan barley was released in 1991 by the Agricultural Experiment Station after its development by the Northwest Research-Extension Center. This new barley is the recommended variety for western Kansas because of a 10 percent yield advantage, 2 lbs/bu test weight advantage, and superior winter hardiness.

**Experimental Variety KS89H48:** The experimental hard red winter wheat variety, KS89H48, will be released in 1993. KS89H48 is adapted to



western Kansas dryland conditions. It yields 11 percent better than TAM 107, currently the most popular wheat variety grown in western Kansas. In addition to its leaf rust and Hessian fly resistance, KS89H48 also has improved bread making quality compared to TAM 107.

**Sorghum Germplasms:** Sorghum germplasms with resistance to 1) chinch bugs, 2) new greenbug biotypes, 3) sorghum diseases, and 4) stress tolerance have been released. These improvements contribute significantly to environmental quality and farm profitability. Use of greenbug and chinchbug resistant sorghum hybrids is estimated to provide \$45 million in annual benefits to Kansas farmers.

**Screening for Resistant Varieties:** The most economical and environmentally friendly way to control wheat diseases is with disease resistant varieties. Techniques have been developed to enable rapid, accurate disease assessment of large numbers of breeding lines in the greenhouse or growth chamber to aid wheat breeders in selecting plants resistant to soilborne mosaic, tan spot, and speckled leaf blotch. These methods are now in use by both public and private breeders in the Great Plains region.

**Best Management Practices:** Best Management Practices as well as variety performance trials for major crops are conducted at the Combelt Experiment Field. Cultivar selection is of critical importance for profitable and efficient farming. Research shows that nitrogen fertilizer rates can be lowered when applied at the proper time in the plant's life cycle. Also, costs can be lowered and post-emergent herbicide rates can be reduced if applied when weeds are small (10 days after planting) rather than when weeds are large (28 days after planting). Additionally, the need for herbicides is reduced by using narrow row soybeans planted at high populations to increase competition.

**Crop Variety Development:** The Southeast Branch Experiment Station is involved in variety testing, new crop development, and strategies to decrease pest damage of soybeans. Area farmers are provided test results on over 200 new or existing varieties of winter wheat, winter barley, spring oats, full-season and double-crop soybeans, and full-season and short-season corn. Research also focuses on developing short-season corn production strategies and resistant varieties to combat charcoal rot and cyst nematodes in soybeans. Research with charcoal rot shows that crop rotation can boost soybean yields by 10 percent. On infested soils, varieties resistant to soybean cyst nematode yield nearly double that of susceptible varieties.

**Crop Rotations in Southeast Kansas:** Crop rotations generally improve crop response but cultural practices are also important. For example, the yield of sorghum in a 10-year rotation following soybeans was 16 bushels higher with conventional and reduced tillage than with no tillage. In addition, the nitrogen supplied by soybeans in alternate years was not sufficient for optimum yields of sorghum, and any nitrogen fertilization system increased sorghum yields. The use of broadcast urea-ammonium nitrate solution (UAN) often resulted in lower yields than those obtained with urea fertilizer or anhydrous ammonia because UAN can be intercepted on plant residue, especially with no tillage systems.

**Dryland Cropping Systems:** Grain sorghum has been traditionally grown by producers in a wheat-sorghum-fallow rotation. Using water-conserving technologies now available, scientists want to determine if corn, soybeans, and sunflowers can be used as a complementary crop in dryland

rotations. They have also expanded efforts in limited irrigation research. Farmers with limited water supplies who are beginning the transition back to dryland agriculture want to know which crops and when to irrigate.

### **Alternate Crops**

**Rapeseed or Canola:** Results to date indicate that none of the rape varieties currently available have sufficient hardiness to withstand northwest Kansas winters. Research at the Northwest Research-Extension Center has examined adaptability, agronomic requirements, yield, and seed quality requirements of rapeseed relative to its use as an alternate crop in western Kansas. Particular attention is being directed to overcoming the crop's susceptibility to winterkill. Representative spring varieties have also been evaluated for planting date requirements.

**Sunflowers:** Research on the use of sunflowers as an alternate crop in northwest Kansas has focused on the effects of planting date and plant population on yield and seed quality. The factors affecting profitability, including seed size and test weight for confection sunflowers and oil percentage for oil-type sunflowers, have also been studied. Current planting date recommendations are based on research from the Fort Hays Branch Experiment Station which indicate few yield differences for planting dates ranging from early May through early July, and with considerably fewer insect problems with later planting. Research data from other regional locations indicate significant advantages for early planting in terms of yield, test weight, and oil percentage.

**Milkweed:** Milkweed is normally considered a weed but scientists at the Southwest Research-Extension Center are studying its commercial potential to produce the floss found in milkweed pods. This is a cooperative project with the University of Nebraska.

### **Horticulture and Forestry**

**Earlibush Crenshaw:** A bush crenshaw melon has been released by the Experiment Station. The KSU Research Foundation is applying for Plant Variety Protection and negotiating for an exclusive release to insure its availability to growers. The inheritance and genetic interaction of genes determining the various flesh and rind colors of melons was also determined.

**Bermuda Grass:** Midlawn and Midfield bermuda grasses have been released by the Experiment Station to the commercial trade. The cultivars are hardy, drought tolerant, and disease resistant and have been patented. Sod for golf courses, parks, and home lawns will be available from licensed growers through a sod certification program by the Kansas Crop Improvement Association.

**Sustainable Vegetable Production:** A sustainable vegetable cropping system was investigated utilizing fall planted legumes as organic fertilizers in conjunction with plastic mulch and drip irrigation systems. The yields of organically fertilized muskmelons equaled those obtained using chemical fertilizers. Legume-based systems offer advantages such as 1) reducing erosion and sequestering soil nitrogen during winter months, 2) increased soil microbial activity, 3) weed suppression, and 4) disruption of disease and insect life cycles. The use of plastic mulches and drip irrigation appears to maximize early and total yield of muskmelons, fruit quality, and water savings.

**Grapevine Management:** The best adapted quality grape varieties for Kansas include Reliance, Mars, or Remail Seedless for dessert grapes; Vignoles, Vidal Blanc, Seyval Blanc, and Cythiana for wine. Additionally, intensive training during the first year of growth is not detrimental to the establishment and productivity of the vine and may hasten early production in the vineyard.

**Flowering Herbaceous Perennials:** Herbaceous ornamental perennials increase diversity in the floriculture market. KSU research has delineated several environmental stimuli to flowering herbaceous perennials including photoperiod, exposure to cold to break dormancy, and maintenance of growing environment to prevent short-day induced dormancy. Thus, florist crops can be produced which can be utilized in the landscape after the useful interior-life of the plant has ended.

**Fruit Tree Rootstocks:** In the last 15 years, 95 percent of the commercial apple plantings established in Kansas have been propagated on tree size controlling rootstocks. However, only a limited number of available apple rootstocks are adapted to the Kansas environment. The advantages of tree size control are more efficient orchard operation, pest control, and harvesting. Also, the use of smaller size trees at higher densities reduces the total amount of pesticide used. Fruit rootstock research provides for factual recommendations to commercial fruit producers in Kansas.

**Fuel Productivity of Hardwood Species:** Studies show that 1) Siberian elm grows well on most sites, and cottonwood and silver maple are well suited for eastern sites. In eastern and central Kansas, black locust, cottonwood, Siberian elm, and silver maple plantations yield as high as 6.0 dry DTE/acre/yr after four to six years. Cottonwood production on good sites is 40 percent greater in eastern than in central Kansas. 2) Longer rotations appear to lower production costs. Energy wood costs for the best sites run between \$1.56-\$1.77/GJ. 3) Energy analyses have shown on-the-stump output/input ratios of about 50:1, and give positive support to the short-rotation woody fuel concept. 4) Coppicing of most species produces abundant stump sprouts.

**Management Systems for Native Pecans:** Nuts, wood, and hay harvested from native pecan groves in southeastern Kansas add \$3 to \$5 million to the local economy. KSU research has focused on low-input pecan management techniques to reduce cost and enhance profitability. Pecan production is inherently cyclic—years of heavy production are followed by years of low production. Thinning a heavy nut crop early in one season promotes greater production in a subsequent season. Improved crop and pest monitoring techniques now allow growers to predict whether thinning by two nut-feeding insects will benefit or damage the crop. If damaging insect populations occur, KSU research has shown that a biological pesticide, *Bacillus thuringiensis*, can be used to manage these pests without disrupting naturally occurring biological control organisms.

**Cold Tolerance:** Using cell cultures, KSU horticulturists selected cell lines in grapes, blackberry, and strawberry that are significantly (6-8 degrees C) more cold tolerant than cultivated varieties. Strawberry plants have been regenerated, and attempts to regenerate whole plants from other cold tolerant lines are in progress. The cold-tolerant lines have unique genetics, and studies have been initiated to elucidate the role of genetics and gene control in cold tolerance. Research shows that cold acclimation thickens cell walls, and rigid cell walls can prevent winter desiccation.

**Heat and Drought Tolerance:** In grapes, heat tolerance appears to be associated with the accumulation of hormone ABA, and external applications significantly increase heat tolerance in grapes. Heat tolerance in beans has been studied using electrical conductivity and is highly heritable. Thus, this technique will assist in breeding for varieties better adapted to the high summer temperatures. Drought tolerance has been studied by evaluating seedling root growth in growth chambers using computer-assisted counting equipment.

**Morphogenesis from Leaf Callus:** Horticultural scientists are working to enhance the regenerative potential of *Rosa hybrida*. Callus of *Rosa hybrida* "Tiffany" was induced in darkness from 5 mm leaf disks after two weeks on the culture medium. Adventitious roots and cotyledons were developed under dark conditions from callus subcultured on a separate medium. The cotyledons turned green when transferred under light on a third growth medium. In contrast to leaf callus, calli from rose stem sections failed to differentiate. Despite various morphological abnormalities and genetic variations which can result, these techniques hold great promise for increasing the regenerative potential of *Rosa hybrida*.

### **Photosynthesis and Nitrogen Fixation**

**Photosynthesis:** Photosynthesis is the primary determinant of plant productivity. K-State researchers are genetically modifying the basic photosynthetic apparatus in order to better understand the light reactions of photosynthesis. To enhance genetic analysis, *Synechocystis* has been chosen as a versatile alternative because photosynthesis in crop plants and this bacterial species are similar.

Photosystem I is one of two pigment protein complexes which convert light energy into chemical energy. Genes encoding various polypeptides of photosystem I have been cloned and characterized. These genes were then deleted from the bacterial genome to generate mutants lacking specific polypeptides of photosystem I. Study of these mutants is helping to unravel the assembly and function of this component of photosynthesis.

**Photosynthesis and Moisture/Heat Stress:** The interplay between photosynthesis and moisture/heat stresses limits crop production in Kansas, the Midwest, and other regions. Scientists at KSU are cooperating with 15 other states in a North Central Regional (NC-142) study of the molecular basis of this relationship. Long-term goals are to 1) understand the structure/function relationships of photosystem I as a crucial enzyme in the photosynthetic membrane and 2) the role of the root growth in moisture acquisition. At KSU the structure of the photosystem I enzyme has been examined by topological probes and by domain-specific antibodies. The use of antibodies has been most valuable in understanding molecular influences on heat stress.

**Glutamine Synthetase from Root Nodules of Legumes:** In legumes, glutamine synthetase (GS) plays an important role in the assimilation of ammonia excreted by nitrogen-fixing bacteria. There are nine different GS enzymes in the common bean. K-State research has demonstrated that root nodules that fix more nitrogen have smaller amounts of several GS isozymes. This discovery indicates that GS not only plays a role in ammonia assimilation, but individual GS isozymes may be important in controlling the nitrogen fixation activity of the root nodule.

# LIVESTOCK, FORAGE, AND RANGE MANAGEMENT SYSTEMS

Nearly one-third of the state's crop production and essentially all range and pasture in the state are marketed through livestock. To help farmers and ranchers cope with changing weather, market, and production factors, the Experiment Station has instituted research that emphasizes producing, protecting, and marketing livestock that feed efficiently, gain weight rapidly, and increase profitability and sustainability on the farm and in the feedlot. Practices must be environmentally safe and economically viable.

## Forage and Range

**Reproduction of Tallgrass Prairie Perennials:** Prairie ecosystems are the primary feed for livestock in Kansas and the Great Plains. Regeneration and sustainability of prairie forages are influenced primarily by vegetative reproduction rather than from seed. KSU biologists have demonstrated that vegetative reproduction of the dominant perennials in tallgrass range is plant-size dependent and strongly influenced by prescribed burning and grazing regimes. The studies show that grazing, burning, plant population density, and size distributions interact to determine long-term patterns in forage populations and rangeland productivity.

**Managing Infected Tall Fescue Pastures:** Tall fescue, the predominant cool-season forage in southeastern Kansas and southeastern U.S, is estimated to be 90 percent infected with a toxin-producing endophyte fungus. This costs U.S. cattlemen \$793 million annually in reduced conception rates and cattle gains. Research at the Southeast Kansas Branch Experiment Station (SEBES) has shown that approximately 65 percent of the reduced performance is offset by interseeding white clover into the infected fescue—a potential savings of \$515 million to U.S. cattlemen. White clover also fixes atmospheric nitrogen and, potentially, can reduce annual fertilizer needs by 1.3 million tons of nitrogen—saving cattlemen an additional \$128 million.

**Bermuda Grass-Rye Grass Forage Systems:** Bermuda grass is a warm-season forage, but its growing season, quality, and rate of animal gain in southeastern Kansas are suboptimal. Research at the SEBES combined cool-season (rye) and warm-season (bermuda grass) into a single forage system. Cattle grazing rye in bermuda grass sod gained as much as 28 lb more per head and 20 lb more per acre than cattle grazing rye in tilled ground, without reducing bermuda grass performance and carrying capacity. The rye-bermuda grass system reduces erosion and the need for tillage and, potentially, adds 60 to 100 days to the bermuda grass grazing season and increases cattle gains up to 145 pounds.

**Grazing Management—Native Range:** The use of late-season rest rotations in managing tallgrass prairie is being studied under three continuous grazing or late-season rest rotations and three stocking rates. A principle objective is to evaluate systems that have the potential to sustain or improve animal performance while maintaining or improving the botanical composition and productivity of native range. A concerted effort is also being made to monitor ecological responses to grazing activities. Maintaining range resources in excellent condition will ensure their use by future generations of farmers and ranchers.

## Livestock Management

**Increasing the Value of Cull Cows:** If a beef cow fails to conceive, economics usually dictate culling her from the herd. An estimated 300,000 cull beef cows are sold annually in Kansas. Most are culled after weaning and are sold in thin condition after coming off late-season pasture. The potential exists for exploiting compensatory gain in these thin cows. Research trials have been instituted to examine the benefits of implant strategies for use while feeding thin, mature, nonpregnant, beef cows. Further, by feeding cull cows, some muscle systems could potentially have alternate uses rather than ground beef. Treatments included: 1) nonimplanted (controls), 2) Synovex-H (200 mg testosterone + 20 mg estradiol benzoate), 3) Finaplix-H® (200 mg trenbolone acetate), or 4) both implants.

**Improvement of Fertility in Cows Postpartum:** Prolonged anestrus where beef cattle fail to begin their estrous cycles prior to the breeding season is a national problem. KSU physiologists are using mastectomized and udder-intact cows to study the problem. Even though calves are fed by bottle, they still attempt to nurse their mastectomized dams where the udder was once attached (inguinal area). When the calf and cow are properly penned, the calf and cow can nuzzle and groom one another, but the calf cannot suck the inguinal area. By restricting the tactile stimuli of the calf to the head and neck of its dam, the estrous cycle begins, and the presence of the calf fails to delay first estrous in its mastectomized dam. This suggests that estrous cycles are inhibited as long as the calf can nurse the inguinal area but does not require the stimulation of the teat or actual milk removal.

**Supplements and Wintering Beef Cows:** Mature beef cows grazing winter range were fed supplements containing 10, 20, 30, or 40 percent protein either daily or three times weekly. Although frequency of supplementation did not alter cattle performance greatly, reducing frequency of supplementation would save approximately \$4/cow in transportation and labor if one spent three hours and travelled 7.5 miles each day while loading supplement and locating and supplementing cattle on range. Using the high protein (40 percent) compared with low protein (10 percent) supplement increased weaning weight by 30-35 lbs and would likely result in a 5-6 percent increase in pregnancy rate (potential benefit of \$30 to \$40/cow). Because approximately 1.35 million beef cows are maintained on Kansas farms, the potential economic impact is significant.

**Ventilating Livestock Buildings:** Pollutant and moisture removal from livestock buildings often depends on variable-speed fans operating at speeds where they are vulnerable to wind. A patented control method can be used to overcome the wind pressure on the fan. In typical Kansas winds, the novel technique would allow complete airflow cutoff only 0.5 percent of the time compared to 7 percent without it. A computer program for engineering ventilation fans and a simple estimation procedure for predicting variable-speed fan performance have been completed. These computerized tools are a significant aid in designing fans for livestock buildings.

**Feeding of Dried Bakery Product (DBP):** Beef Cattle metabolism and feedlot studies are being conducted to evaluate the net energy content and optimal replacement values of DBP for grain. DBP, a by-product of the baking industry, is composed primarily of baking products that do not meet batch specifications, ranging from spaghetti and pretzels to snack cakes. It includes raw dough to finished products. DBP contains approximately 10-11

percent of crude protein and crude fat. This by-product of the baking industry may have significant added value as a livestock feed. Replacement of significant amounts of grain with DBP and other by-products will enhance progress towards low-cost, sustainable systems for cattle production in Kansas.

**Roughage Value of Sun-Cured Alfalfa Pellets:** The roughage value of sun-cured alfalfa processed as pellets or chopped hay is being compared at two levels (5 percent vs. 10 percent of diet dry matter) of inclusion in beef finishing diets. Dry matter losses from chopping, hauling and feeding alfalfa hay may exceed 30 percent. Further, large amounts of dust, low-bulk density, and ration palatability are problems associated with chopped hay. If equal in roughage value to chopped hay, pelleting sun-cured alfalfa may add significant value. Expanded use of sun-cured dehydrated pellets in cattle diets would aid the financially strapped dehydrating industry in Kansas and other midwestern states. Maximum increased tonnage for dehydration in Kansas could mean approximately \$60 million in sales. A more likely figure would be 150,000 tons (\$15 million) annually.

**Near Infrared Reflectance Spectroscopy (NIRS):** This research is designed to test the accuracy of NIRS on Kansas feed and foodstuffs. When calibrated using good chemical data, the NIRS instrument gives rapid (about 1 minute) nutrient analyses. Currently, equations are being developed for gelatinized grain and cheddar cheese. Equations have already been established for alfalfa, grass hay, corn, milo, corn silage, ground pork, beef, and cheese. Although the initial cost of the instrument is high, 200 samples could be run daily without difficulty. Speed and convenience will enhance the use of effective quality control methods for both the feed and food industries.

**Time of Lambing:** The time of lambing was determined with six lamb crops over a three-year period when feeding occurred in mid-morning. With this feeding regime, the majority of lambs were born during the daylight hours. The slowest birth period was between 10:00 p.m. and 5:00 a.m. From a labor and convenience standpoint, this management system provides a notable economic advantage.

## Dairy

**Dairy Cattle Conception Rates:** New analogs of gonadotropin-releasing hormone (GnRH) are being tested as profertility agents in cattle. In earlier studies, K-State researchers found that a GnRH analog (fertirelin acetate or Avalyse) improved pregnancy and calving rates of beef heifers and suckled beef cows when the animals were given a single injection of the GnRH analog 11 to 14 days after artificial insemination (AI). This study was extended to determine the effects of a second GnRH analog (buserelin acetate or Receptal) on ovarian function and fertility of dairy cows. Administering the second analog altered number and distribution of ovarian follicles, increased cycle duration, and increased concentrations of progesterone, without a consistent increase in pregnancy rates.

**In Vivo and In Vitro Studies with Cystorelin:** Monitoring the development of follicles using ultrasonographic imaging allows one to follow the development of individual follicles. A transient increase in follicle-stimulating hormones (FSH) precedes the growth of several follicles, one of which grows faster and soon dominates the remaining follicles on both ovaries. This large, dominant follicle secretes estrogen. During the estrous cycle, two,

three, or four of these waves of follicular growth occur, with the last dominant follicle (second in two-wave cows, third in three-wave cows, etc.) becoming the follicle that ovulates about 24 to 30 hours after the beginning of estrus. Administration of GnRH at estrus increases the frequency of FSH pulse secretions on days 8 and 15 of the cycle and delays the appearance of the dominant follicle in the subsequent estrous cycle.

**Dietary Supplementation for Dairy Cows:** Milo usage by dairymen is generally limited to mid or late lactation cows, dry cows, and heifers because of its low energy value and total tract digestibility relative to corn grain. KSU research clearly demonstrates that a mixture of milo and wheat (70:30 ratio) is equal to corn in diets of early lactation cows and the addition of tallow is an effective way of increasing the energy value of milo in these diets. Further, the benefits of wheat and tallow in milo-based diets are additive with respect to milk production and complementary with respect to fat and protein content of milk. The results of our work will place milo in a competitive position with corn for the dairy feed market and enhance the value of wheat and tallow as dairy feed components.

**Evaluation of a Milk Replacer Protein Source:** Research is being conducted to determine the efficacy of solubilized wheat protein as a replacement for milk protein in calf milk replacers. Milk replacers are used extensively in the dairy industry in the diets of young calves. Good performance can be obtained by using replacers in which all of the protein is derived from milk; however, economical replacements for part or all of the milk protein used in milk replacers are needed. This research focuses on the use of wheat protein. There are approximately 10 million dairy calves born in the U.S. each year. If fed milk replacer, they require about 25 pounds of dry milk replaced, of which 22 percent is protein, or 5.5 pounds of protein per calf. This could be derived from Kansas wheat.

**Growth of Dairy Heifers:** In one experiment, heifers fed National Research Council (NRC) requirements for all nutrients were compared with heifers 1.15 times NRC requirements. In a second experiment, heifers were fed either NRC requirements or 1.15 times NRC requirements until 12 months of age, then the treatments were switched until the heifers freshened. The heifers fed 1.15 times NRC requirements from 3 months of age until freshening grew faster, without becoming too fat, and were larger at the various ages up to freshening. They started showing heat earlier, were bred earlier, and freshened about 7 weeks earlier than those fed 100 percent NRC requirements. In the second experiment, there was no advantage of feeding either 100 or 115 percent of NRC requirements until 12 months of age, then switching treatments.

**Processing Soybeans Fed to Young Calves:** The protein supplement used in the first dry feed fed to young dairy cows in much of the U.S. is soybean meal. Whole soybeans have the advantage of having a much higher energy concentration, but raw soybeans contain anti-nutritional factors that are detrimental to young calves. Also, the protein is more soluble in the rumen than is desirable. K-State researchers have established optimum processing conditions for whole soybeans used in calf starters. When properly processed, the anti-nutritional factors in whole soybeans are destroyed, the solubility of the protein is reduced, and performance is increased compared to diets containing soybean meal. The starter diets used at KSU contain about 18 percent soybeans.



**Feeding Dairy Calves Vitamins and Carotene.** Young dairy calves were fed various combinations of vitamins A, E, and C, and carotene to determine their effects alone or in combination on the health and performance of dairy calves. Observations included growth, health of the calf, and measurements of the immune system function and other defense mechanisms. It was observed that several responses to vitamin A depend on the amount of vitamin E present. The response to large amounts of vitamin C may be positive during stressful conditions but negative at other times. The requirements for a vitamin should be considered in relation to amounts of other vitamins (and possibly other nutrients) present.

**High-Protein, Low-Lactose Frozen Dairy Desserts:** Dairy scientists are developing high-protein, low-fat, and low-lactose frozen dairy desserts using ultrafiltration to selectively concentrate proteins and insoluble salts in milk. They are investigating the most acceptable levels of proteins and the use of stabilizers and emulsifiers in ultrafiltrated milk for formulating and processing frozen dairy desserts. The frozen desserts are 1) high-protein ice milk and 2) high-protein, low-fat, frozen desserts. Frozen yogurt products are also being developed. The product may be advantageous for individuals who require a high-protein, high-calcium diet and for those who have a lactose intolerance from milk sugar. The product will also have a low caloric content. Commercial companies have expressed interest in the product.

## Swine

**Starter Swine Diets:** (Evaluating Porcine Blood Meal and Plasma, Bovine Plasma, and Meat Extract as Replacement Protein Sources for Dried Skim Milk in Starter Swine Diets). One-hundred fifty pigs were utilized in tests to determine the efficacy of replacing the dried skim milk portion of a high-nutrient-dense diet with four commercially available animal blood or meat co-products. There were no differences in growth observed between pigs fed diets containing dried skim milk, porcine blood meal, or bovine plasma. Maximum performance was achieved during the Phase I period by feeding porcine plasma protein. Pigs fed the meat extract diet demonstrated significantly poorer performance than pigs fed the other diets, indicating that it is not an effective replacement for skim milk based on our substitution rates.

**Processing Cereal Grains to Optimize Nutritional Value:** Studies were conducted to determine the effects of fine grinding and pelleting on the nutritional value of cereal grains for swine and poultry. The experiments compared corn, hard endosperm sorghum, and soft endosperm sorghum at four particle sizes (900, 700, 500, and 300  $\mu\text{m}$ ). Rate of gain was generally unaffected by reducing particle size, but efficiency of gain was optimized for corn and the two sorghums at 500  $\mu\text{m}$  or less. Relative to corn, at 900  $\mu\text{m}$  the feeding value of the sorghums was 92 percent, but at the optimum particle size for each grain (500  $\mu\text{m}$  for corn and soft sorghum, and 300  $\mu\text{m}$  for hard sorghum) the feeding value of the sorghums was 99 percent in broiler chicks. Thus, it is important to mill appropriately to optimize the nutritional value of cereal grains. Also, the optimum particle size is different for corn (600 to 500  $\mu\text{m}$ ) and sorghum (500 to 400  $\mu\text{m}$ ) when processing costs and growth are considered.

**Minimizing Fecal Excretion in Swine and Poultry:** In this experiment, feed intake was similar among sow diets (particle sizes were 1,200, 800, 600, and 400  $\mu\text{m}$ ), but digestibility was increased such that daily consumption of

digestible energy and nitrogen were increased by 14 percent as particle size was reduced from 1,200 to 400  $\mu\text{m}$ . Also, daily excretion of dry matter and nitrogen in the feces were decreased by 22 and 31 percent, respectively, as particle size was reduced from 1,200 to 400  $\mu\text{m}$ . Similar trends were observed with feeder pig diets. Thus, with similar intakes of digestible energy, there was 22 percent less daily fecal excretion of dry matter, 25 percent less daily excretion of nitrogen, and 7 percent greater efficiency of gain when particle size was reduced from 1,000 to 400  $\mu\text{m}$ . Furthermore, pelleting enhanced the beneficial effects of particle size reduction, with a 10 percent increase in efficiency of gain and a 39 percent reduction in fecal excretion of dry matter when the pelleted diet with 400  $\mu\text{m}$  corn was compared to the meal diet with 1,000  $\mu\text{m}$  corn.

**Extrusion Technology and Swine Diets:** Three finishing experiments were conducted using extruded cereal grains and whole soybeans in swine diets.

**Extruded Sorghum and Soybean Diets:** A ground sorghum-soybean, meal-soybean, oil-based control was compared to diets with the sorghum extruded, extruded soybeans used in place of the soybean meal and soybean oil, and extruded sorghum and extruded soybeans used in place of the ground sorghum, soybean meal, and soybean oil. Diets with extruded sorghum or extruded soybeans improved nutrient digestibility and growth performance compared to the control diet. The effects were somewhat additive, with the greatest response in nutrient digestibility and growth performance when extruded sorghum and extruded soybeans were used.

**Extruding Sorghum and Soybeans Together:** It was demonstrated that the beneficial effects of extrusion were greatest when the sorghum and soybeans were extruded together versus extruding separately and then blending. This resulted in a 10 to 20 percent improvement in nutrient digestibility and growth performance from the extrusion of ingredients in sorghum-based diets.

**Extrusion Potential for Sorghum, Wheat, and Barley:** Digestibility of dry matter and nitrogen were increased by extrusion with barley responding the most (9 and 12 percent increases for digestibilities of dry matter and nitrogen, respectively) and wheat responding the least (no change). Relative feeding values were increased from 95 to 104 percent for sorghum, from 92 to 98 percent for wheat, and from 89 to 92 percent for barley when extruded. Thus extrusion of sorghum yielded a product with a greater feeding value than ground corn. Even with the additional 10 to 11 percent increase in processing costs, the 10 percent price advantage for sorghum versus corn, plus the 4 percent advantage in feeding value for extruded sorghum versus ground corn, reduced cost of gain by 3 to 9 percent.

**Diets for Nursery Pigs:** Considering the advantages of extruded ingredients in diets for finishing pigs, experiments were conducted to determine if the growth performance of nursery pigs could be improved by extrusion of dietary ingredients. Extrusion of corn and sorghum by themselves did not improve growth performance. Additional experiments are planned to determine why extrusion of cereal grains benefits finishing pigs but not nursery pigs. Extrusion conditions may be critical in gaining a consistent benefit, especially for the very young pig.

# PLANT AND ANIMAL PROTECTION

## PLANT PROTECTION

Crop losses to insects and disease exceeds hundreds of millions annually. Crop protection research takes many forms, but the emphasis includes the development of genetic resistance and biological control. Researchers utilize these and other approaches to control insect and disease pests and reduce the need for pesticides.

### Plant Disease Research

**Plant Pathology:** Departmental research contributes to varietal and germplasm development by researching the nature, cause, and control of plant diseases. Research is directed at 1) reducing input costs by developing disease resistant varieties; 2) reducing adverse environmental effects (heat, cold, drought, soil toxicity); 3) reducing effects of toxic materials by reclaiming toxic waste areas, reducing soil erosion, and improving groundwater quality; 4) minimizing environmental impacts and disease losses using environmentally friendly cropping and tillage practices; 5) increase agricultural sustainability through better management practices. Extramural support from state, federal, and private sources for research targeted on Kansas problems in plant pathology exceeded \$1.1 million in 1992.

### Wheat

**The Wheat Genetics Resource Center (WGRC):** The WGRC is a multidepartmental project centered in Plant Pathology. The Center is devoted to conserving and enhancing plant genetic resources, particularly wheat genetic resources. The WGRC is recognized nationally and internationally as a premier research and academic center. Accomplishments include:

**Genetic Diversity:** The WGRC conserves precious plant material from around the world to enhance the genetic diversity of wheat. The WGRC maintains a gene bank, along with evaluation and passport data, on 3,500 wheat species accessions and 1,200 cytogenetic stocks. Without this genetic resource, the opportunity to increase genetic diversity and protect commercial wheats from insects and diseases would be significantly diminished.

**Specific Gene Resistance:** The Center has developed new plant materials with specific genes for resistance to major diseases, insects, and other stress factors. To date, 14 improved germplasm lines have been released to wheat breeders to enhance sustainable wheat production and protection.

**Gene Identification:** Specific genes have been identified that impart resistance to Hessian fly, a major insect pest of wheat; several races of wheat rust, a problem with all U.S. wheats; and wheat streak mosaic virus, the most important wheat disease in several states. In a recent year, wheat streak mosaic virus (WSMV) caused losses in Kansas conservatively estimated at \$140 million. This research helps to avoid such losses by providing genetic resistance to WSMV and other diseases, insects, and environmental stresses.

**Mapping the Wheat Genome:** The WGRC has begun to map the entire wheat genome in collaboration with U.S. and other researchers. This ambitious undertaking, similar in concept to the human genome mapping project, will ensure that future crop improvements can be made quicker, more accurately, and with greater predictability.

**New Research Techniques:** The Center has developed new research techniques for use in Kansas and other locations. One research system, involving chromosome fingerprinting and chromosome painting, provides for positive identification of specific wheat strains.

**Training Students and Scientists:** The WGRC has become a national and international center for training students and established scientists through hands-on, practical, and basic research—research directed at solving important problems in Kansas and other nations.

**Global Application:** The plant materials, accessions, and stocks in the WGRC collection comes largely from other countries. Scientists from other nations come to the WGRC, learn advanced research techniques, share plant materials, and conduct mutually beneficial research.

**Seed Treatment:** Seed treatment is the most desirable way to use disease-control chemicals. Only small amounts of the chemical is applied to the seed, and there are no chemical residues at harvest. With the advent of systemic seed treatments, control of previously uncontrollable diseases became possible. K-State scientists have found treatments which control “take-all,” an important wheat disease. Two methods of seed treatment are now available.

**Managing Wheat Diseases:** Wheat producers must have accurate, up-to-date information in order to effectively manage the incidence of plant disease. Numerous management practices have been evaluated for their effect in managing wheat disease. For example: 1) delayed planting helps control cephalosporium stripe and take-all; 2) contrary to popular belief, nitrogen fertilizers do not affect the severity of tan spot; and 3) neutralizing soil acidity with lime (pH greater than 6.0) controls cephalosporium stripe.

**Wheat Scab:** Wheat scab contaminates wheat with mycotoxins, zearalenone, or vomitoxin when it is wet and humid during flowering. Unfortunately, no source of host resistance has been found in world wheat germplasm collections. We also lack basic knowledge about *Fusarium graminearum*, the causative pathogen. K-State scientists discovered that *F. graminearum* is more genetically diverse than previously thought. They developed methods for genetic analysis that may help in understanding mycotoxin biosynthesis, how the pathogen causes disease, and how resistance can be engineered in wheat.

**Disease Losses from Leaf Rust:** The leaf rust epidemic of 1992 was unusually severe. In early March, surveys in Texas, Oklahoma, and southern Kansas indicated the presence of more overwintering leaf rust inoculum than in the last 27 years. Measured losses in susceptible cultivars ranged from 15 to 119 percent. Models of overwintering and disease losses are being developed using weather data over the past 15 years.

**Fungicides and Seed Quality:** Research at the Northwest Research-Extension Center has established that the use of fungicides in winter wheat can increase yield or quality up to 15 percent. The data indicate that fungicides will have the greatest economic impact when wheat is grown for sale as seed.

## Soybeans

**Soybean Cyst Nematode:** In cooperation with the KAES soybean breeding program, there have been several hundred lines screened for resistance to the soybean cyst nematode (SCN). This led to the release of

KS5292, a group 5 line with superior yield potential and resistance to SCN race 3. In addition, 65 soybean cultivars and experimental lines were evaluated at nematode-infested sites in Kansas to identify cultivars with SCN-resistance. Susceptible cultivars typically yield 25-30 percent less than resistant cultivars in SCN-infested fields. Since the nematode is present in one-fourth of the leading soybean producing counties in the state, this effort is crucial in assuring future profitability.

### **Insects and Other Pests**

**Red Flour Beetle:** The red flour beetle, a stored products pest of global significance, is being studied as a genetic model system for coleopteran pests. To determine genomic instability, an extensive series of crosses was made between field strains collected from several continents. During this work, an important and novel phenomenon which has important implications in integrated pest-management strategies was recognized. In brief, when a female bears a chromosomal entity called a Medea factor, her offspring must inherit the factor or die during development. This work will contribute significantly to understanding the genetic structure of natural insect populations.

**Alfalfa Weevil Control:** In some years, nearly 85 percent of the alfalfa acreage (first cutting) in Kansas is sprayed with insecticides to minimize damage by alfalfa weevil. Research has demonstrated that dormant season treatments can help reduce survival of overwintering weevil eggs and reduce the need for insecticides. Treatments under study include propane flaming, burning, and flail mowing (to shatter stems and expose eggs to desiccation). Although not completely effective in replacing insecticides, these non-chemical treatments substantially reduced the need for pesticides.

**Blister Beetle in Alfalfa:** Blister beetles, commonly encountered in Kansas alfalfa, contain a toxin that can be fatal to horses when ingested. Control with pesticides is counterproductive because dead beetles are left in the hay. Sickbar mowing also leaves beetles in the hay because of tractor tire driveover. KSU entomologists have demonstrated that the risk varies with the species of blister beetle, phenology of alfalfa at cutting, cutting number during the year, type of equipment, and manner of use. Data on chemical conditioning and attractiveness of cultivars also have been recorded in research to find harvest systems that will enable Kansas to recapture profitable out-of-state markets.

**Resistant Greenbugs:** Researchers have verified the existence of greenbug strains that are resistant to insecticides and can also attack resistant hybrids. In response, K-State organized an emergency greenbug testing service. Greenbugs shipped to KSU were analyzed for changes in both insecticide susceptibility and host plant resistance. Insecticide resistant greenbugs were detected in 11 counties in Kansas and 14 counties in three neighboring states. A new strain, biotype I, which attacks sorghum hybrids resistant to biotype E greenbugs, was found in 12 Kansas counties and 12 counties in three neighboring states. Growers can now avoid using ineffective control measures by determining the greenbug strain present in their fields. Samples are also received from Texas, New Mexico, Colorado, Oklahoma, and Nebraska. Entomologists have also reported finding sorghum lines from Russia that are resistant to greenbug biotype I.

**Germplasm Tolerant to Greenbugs:** Entomologists, using greenbug salivary secretions, are searching for sorghum germplasm that is tolerant to

greenbug feeding. To...ce places no selection pressure on greenbugs and the development of additional biotypes.

**Russian Wheat Aphid:** KSU entomologists have identified durum and bread wheat lines with resistance to the Russian wheat aphid.

**Sunflower Pests:** KSU scientists have confirmed on a practical, large-field basis that farmers can use sunflower head moth sex pheromone traps, planting dates, location, and precipitation data to make accurate moth insecticide control decisions that significantly impact net crop returns.

### **Biological Control and Resistance to Herbicides**

**Biological Control of Annual Grass Weeds:** Native bacteria from Kansas soils and roots of plants are being evaluated for selective biological control of winter annual grass weeds in winter wheat. Laboratory tests have identified more than 100 isolates which inhibit root growth of one or more important winter annual brome species or jointed goatgrass without inhibiting winter wheat roots. In a field study in which solutions of selected bacterial isolates were injected in the furrow during seeding, several isolates reduced the biomass of downy brome and/or Japanese brome by more than 50 percent without reducing winter wheat biomass.

**Plant Resistance to Herbicides:** Beacon is a sulfonylurea herbicide for shattercane and Johnson grass control. Sulfonylurea herbicides are successful because they have a metabolic mechanism that differs from one species to another. Currently, we do not understand why subtle changes in the structure of sulfonylureas allow them to be used for selective weed control in nearly every crop. However, scientists at the Southwest Research-Extension Center have found a mutant gene in some hybrids and inbred lines which cannot metabolize and is susceptible to Beacon. By studying corn with that gene they hope to better understand sulfonylureas's mode of action and help develop improved herbicides.

### **Plant Identification**

**KSU Herbarium:** The KSU herbarium is a research laboratory and reference collection for plants growing in the central Great Plains. It also serves as a depository for voucher plant materials for KSU scientists. In cooperation with the Extension Service, the herbarium helps agents, specialists, and plant scientists identify problem plants, weeds, shrubs, and trees to assure proper treatment and research protocols. Plant identification services are also routinely offered to poison-control centers and law enforcement agencies.

## **ANIMAL PROTECTION**

The safety of crop and livestock products is closely tied to production, management, and processing procedures. For livestock, food product safety is dependent on animal health and livestock protection. The research often involves interdisciplinary cooperation between animal scientists and veterinarians.

### **Boxed Beef**

**Minimizing Contamination of Beef Subprimals:** Because Kansas is the largest beef processing state, enhancement of the safety and shelf life of boxed beef subprimals is critical to the economy. Research has shown that lactic acid and chlorine treatments of beef carcasses decrease microbial

contamination of the carcass. However, this decrease does not necessarily increase shelf life at the retail level. Research is underway to evaluate procedures that are approved for use with the carcass and apply them to subprimals just before packaging to determine if safety and shelf life at the retail level can be enhanced. A 3-5 day increase in shelf life for beef could conservatively increase the value of a beef carcass by \$100.

### **Biological and Biochemical Approaches**

**Regulation of Mammalian Ribosomal Protein Expression:** Ribosomal proteins are genetic components whose accurate transcription is critical in synthesizing protein. Researchers are investigating molecular mechanisms which regulate the transcription of a mammalian ribosomal protein gene and control the amount of ribosomal protein messenger RNAs. A reaction has been optimized which transcribes DNA templates into a biologically accurate ribosomal protein. Deletion DNA templates are also being used to map DNA sequences that ensure the proper transcription of the DNA. This research is an important component in genetically improving plant and animal species at the molecular level.

**Rapid Detection Methods for *Listeria* Bacteria:** *Listeria* bacteria, because of its association with animals and animal products, is significant to the Kansas meat industry. The frequent inability of direct plating to detect low numbers of *Listeria* in naturally contaminated food is well established. Food scientists at K-State have developed and are refining a U-Tube system using an enzyme for the rapid detection, isolation, and enumeration of this and other bacterium in meat. This system decreases the time required for detection from 5 days to 24 hours. This allows timely decisions by Kansas processors before meat and meat products are shipped, minimizes recalls, and improves consumer confidence. KSU has applied for a patent on the process.

**Inhibiting Cell Proliferation\_Bovine Cells:** K-State researchers have isolated and purified a unique bovine inhibitor (SGP) of cell proliferation. The inhibitor arrests exponentially dividing cells, and the inhibition is totally reversible. Experiments show that SGP arrests cells at a single phase of the cell cycle, and a broad range of cell types are sensitive to this naturally occurring inhibitor. The reversible nature of the SGP inhibition of cell proliferation is of particular significance. This discovery provides important and unique opportunities for studying factors governing cell cycling, including embryo genesis and transfer, fetal development, cellular and tissue development, tumor genesis, and immune functions.

**Avian Polyomavirus:** Avian polyomavirus (Budgerigar fledgling disease virus—BFDV) was originally isolated from fledgling budgerigars suffering from an acute disease that causes nearly 100 percent mortality. KSU biologists have developed a series of monoclonal antibodies that can be used to detect BFDV infected tissue. These antibodies will be used to develop new diagnostic tests and to determine if this avian polyomavirus is found in poultry flocks.

**Characterizing *Cryptosporidium parvum*:** *Cryptosporidium parvum* is an important pathogen of humans and domestic animals. It causes severe gastrointestinal illness, diarrhea, and weight loss, especially in calves under three weeks of age. No known therapy is currently available. KSU researchers have identified about 20 surface proteins on the parasite. Monoclonal antibodies to each surface molecules are being developed for use in protein

purification, screening genomic libraries, determining amino acid sequences, and function of each surface molecule. One surface molecule is involved in parasite motility. When taken orally, a monoclonal antibody against this molecule in infected mice significantly reduces parasitemia by 50 to 60 percent.

**Immunity to Pathogenic Organisms:** Protective immunity to most pathogens in vertebrate animals involves regulatory cells, called T-cells, because they are exported from the thymus. K-State biologists are studying the molecular mechanism that activates T-cells to provide protective immunity. This involves a group of genes called the major histocompatibility complex (MHC). Certain of these genes encode cell surface molecules that bind peptide fragments of a given pathogen to the T-cell. When the T-cell recognizes the peptide:MHC molecule complex, it may kill the cell harboring the pathogen or it may activate other cells of the immune system. Current research is focused on changing MHC molecules by mutagenesis and analyzing the effect on T-cell activation.

**Membrane Dynamics of Gangliosides:** Gangliosides, naturally-occurring membrane lipids, are receptors for bacterial toxins, facilitate the adhesion of pathogenic bacteria to surface covering membranes, and impact growth regulatory mechanisms involving peptide growth factors. Gangliosides are also thought to be linked to cell transformation and tumor development processes. The basic research being conducted at K-State will be applicable to a wide variety of human, livestock, and animal diseases.

**Immunity in Infectious Diseases:** KSU scientists are characterizing biochemical changes that occur in macrophages and target cells. A major goal is to elucidate how macrophages discriminate between normal cells and virus-infected or tumor cells. To assess biological effects, researchers are identifying and isolating the receptor for several toxins on the surface of T-lymphocytes, macrophages, and neutrophils. The effect of microgravity and simulated microgravity on inflammation and inflammatory responses is also being studied.

**Alpha Viruses:** Alpha viruses have been identified as causative agents of viral encephalomyelitis. This pathogen has the potential to cause devastating outbreaks of equine encephalitis. Biologists want to identify the molecular mechanisms by which an alpha virus prototype, Sindbis virus, induces pathological change in cultured cells. The objectives are to biochemically characterize the plasma membranes activities, which are disrupted in infected cells, and identify the viral products which induce the killing of cells.

#### **Assessing Pathological Risk:**

**Salmonellosis:** The procedures used to assess risks for domestic animals contracting salmonellosis from feed ingredients have been improved. Work has started to strengthen immunization procedures for pigs, cattle, and dogs by developing more efficient testing and challenge procedures for vaccine development.

**Fleas:** The ability to control flea infestation has been simplified by the development of a new device to capture and retain fleas under various conditions.

**Embryo Transfer:** The use of artificial insemination and embryo transfer makes the detection and control of deleterious genetic diseases increasingly



...important. The Department of Pathology and Microbiology has implemented new research in this area.

**Pleuropneumonia:** The testing procedure for detecting if pigs are infected with pleuropneumonia has been sufficiently developed to be used in commercial swine herds in Kansas and surrounding states.

### **Wildlife Protection and Enhancement**

Researchers in Biology are studying the effects of agricultural practices on wildlife numbers and habitat. Those studies include:

**Populations of Grassland Birds:** The effect of conservation acres on the population of grassland birds is being studied by KSU biologists. The objective is to determine if conservation reserve fields add to the crop degradation problem in surrounding fields. The KSU study is part of a multi-state North Central Regional project. In Kansas, over three million acres have been enrolled in the conservation reserve.

**Game and Non-Game Wildlife and Sustainable Agriculture:** Studies at the Melvern Wildlife Management Area and Konza Prairie Research Natural Area will determine the impact of current and modified sustainable agricultural practices on game and non-game wildlife.

**Prairie Dog Populations:** Prairie dog populations impact farmers and ranchers but human activity is significantly reducing the numbers of prairie dogs and prairie dog towns. Biologists are monitoring prairie dog numbers using county surveys. They are also assessing the feasibility of satellite imagery in enhancing survey effectiveness.

**Beavers:** Biologists are working to develop beaver monitoring techniques so the Kansas Department of Wildlife and Parks can adjust trapping pressure, maintain healthy populations, and control damage.

**Small Mammals and Prairie Ecology:** K-State research has demonstrated that rodents directly harvest flowers and seed heads from prairie forbs and grasses. The proportion of seed heads harvested for most species is low but may approach 20-90 percent for some forbs in some years. This high a proportion of harvested heads could negatively impact populations of these forbs. Based on a study of two forbs, rodents move seeds only a short distance. However, some seed heads were transported over 20 m by rodents. Thus, rodents may influence the abundance and spatial distribution of individual plant species because of long dispersal distances for some seeds and high levels of predation for other seeds.

### **Ticks**

**Lyme Disease in Kansas:** A three-year survey for the presence of Lyme disease antibodies in mammal hosts and for tick vectors of the disease has been conducted in Kansas. Their occurrence in deer and rodents suggests that there is some risk to livestock and humans in southeastern Kansas and as far west as Manhattan. Approximately 35 percent of the deer in that area tested positive for Lyme disease antibodies between 1990 and 1992. Conversely, in Chautauqua and surrounding counties nearly 60 percent of all animals tested positive for Lyme disease antibodies. Antibodies to Lyme disease could not be identified from animals in western Kansas. The black-legged tick, thought to be the primary vector of the disease in Kansas, is common in southeastern Kansas. The tick has been recovered from deer as far west as Riley and Marion counties.

# WATER AND ENVIRONMENTAL QUALITY

Kansas is faced with major adjustments in its water use and water-planning horizon. Because of their detection in groundwater, agricultural chemicals are a public concern, and a pesticide management district has been established in northeastern Kansas to control atrazine runoff. Research in water, and environmental quality is an important thrust.

## Treatment and Technology

**Water Treatment Technologies:** Biologists and animal scientists at KSU have adapted a resin-based water purification system for use by pullets. Production was monitored by measuring egg quality and pullet health. Water quality was monitored by measuring halogen residuals and bacteriological properties of the water. The project appears likely to generate two patents: 1) A Silver Cation Resin for use as a solid-phase demand disinfectant in water purification, and 2) A Zirconium Peroxide Resin for oxidation of the iodide anion and retention of iodine.

**Modeling the Uptake of Hazardous Chemicals:** Models that simulate the uptake of a hazardous chemical into a plant's transpiration stream, adsorption to roots, degradation in the root-soil environment, and adsorption to soil particles were incorporated into a previously developed deterministic model of the movement of water and solutes through the roots of a transpiring plant. Simulations were then performed to determine the qualitative effect of using a vegetative buffer zone on the removal of atrazine and benzene from a shallow aquifer. In soils where infiltration rates are expected to be highly variable, this modeling approach provided a superior method of simulating the vertical movement of solutes over an agricultural region.

**Crop-Fertilizer Technology:** Crop-fertilizer relationships are being studied using new technology. A portable chlorophyll meter (Minolta SPAD) is being evaluated to refine fertilizer recommendations, optimize profitability, and minimize environmental impact. A spoked-wheel fertilizer applicator is also being developed as a method to apply fertilizer, improve crop production, and minimize nutrient loss. The goal is to improve environmental quality by matching the amount and placement of fertilizer with optimum crop need.

**Mapping Grain Yields:** Mapping grain yields is a fundamental component of any site-specific system for managing cultural practices. Yield maps provide information that can be used to diagnose production problems, compare treatment effectiveness, and provide for spatially variable fertilizer and chemical application. KSU agricultural engineers have developed a mass-based sensor to determine flow rate of grain, and they interfaced it with a differential GPS navigation system to sense combine location. The combine, equipped with these sensing devices, is providing yield maps in cooperation with projects evaluating site-specific nitrogen management in two states.

**Chemical Application—Variable Application Rates:** Improper application of agricultural chemicals not only increase costs but also degrades the environment. KSU engineers are researching a machine vision technology to monitor weed infestation and to control the application rate. When no weeds exist, no herbicide is applied. When weeds are detected, optimum spray rates

are provided. Engineers are also researching technology to apply agricultural chemicals at optimum rates for small sectors of farmland to optimize profit and minimize pollution potential. Present technology utilizes one application rate for an entire field.

**Solid Waste Disposal—Used Tires:** If used tires are to be recycled successfully, on-farm uses must be considered. However, two potential health-related problems exist. First is the threat of establishing breeding sites for mosquitoes which transmit viral diseases to humans. Second is the hazard from tire pile fires. Because three detrimental species of mosquitoes, *Cx. pipiens*, *Ae. triseriatus*, and *Ae. albopictus* have not been documented in Kansas, there is little need to modify present practices for on-farm use of scrap tires. Major on-farm uses include using scrap tires for silage cover weights, soil erosion control, and windbreaks. Minor uses of scrap tires include tree planters, implement weights, and feed bunkers.

**Composting Municipal Solid Waste:** Composting municipal solid waste (MSW) may be a means of conserving landfill space. Composting significantly reduces the volume of trash but the residue still needs to be disposed. First year application of composted MSW suggests that rates up to 13.5 ton/a did not significantly affect field germination of grain sorghum. Early growth rates were not reduced by MSW compost at rates less than 13.5 ton/a, but they were reduced by more than 40 percent at 13.5 ton/a. Cow manure additions with the compost improved early growth of grain sorghum except at the highest MSW rate.

### **Diffuse Pollution**

**Managing Pesticides:** Agricultural engineers are monitoring and characterizing the presence of atrazine in the Delaware Basin; effectiveness of best management practices (conservation tillage, ridge tillage, and terracing) on pesticide losses in farmer-owned fields; and effect of tillage and pesticide incorporation practices on the loss of atrazine and alachlor in surface runoff in the Blue River Basin. The Blue River flows into Tuttle Creek Reservoir, where atrazine concentrations can exceed drinking water standards. Experiments with a rainfall simulator showed that incorporating herbicides into soil reduced loss. Controlling erosion, however, does not necessarily eliminate the concern about pesticide loss.

**Non-Point Pollution and Watershed Management:** Non-point source pollution comes from agricultural fields, watersheds, livestock feeding operations, and other sources. The Herington Reservoir is less than 10 years old, but non-point source pollution is a concern (the reservoir is also a city water supply). Agricultural engineers and cooperating agencies are demonstrating the effectiveness of innovative non-point source control practices in the watershed. Practices include filterstrips, tree stands, and created wetlands. Some livestock producers have built containment systems and others are changing the location and management of their facilities. The goal is to provide data to guide the design of waste management systems for small and intermittent livestock feeders.

**Protecting Groundwater in Northeast Kansas:** Because the movement of agricultural chemicals is a concern, the potential for nitrogen movement into groundwater is being tested in conjunction with 1) nitrogen fertilizer rate and timing experiments; 2) BMPs for reducing contamination of surface water by soil erosion, fertilizer, and pesticides; and 3) grass filter strips. Because of a heavy clay subsurface layer, the potential for nitrogen move-

ment into groundwater appears to be small. In addition, preliminary results indicate that grass filter strips reduce surface water contamination. Additional experiments are being implemented.

**Wellhead Protection:** Farmstead wells are susceptible to contamination, particularly from pollutants within 150 feet of the well. The proper storage, handling, and disposal of pesticides, fertilizers, petroleum products, and manure are very important. In this study of 187 farmstead wells, wells less than 150 feet from nitrate sources that included fertilized cropland did not have high nitrate levels. Some wells, where the depth to water is more than 120 feet or the aquifer is high in iron or manganese, were less susceptible to contamination. Wells less than 150 feet from nitrate sources and that were over 120 feet deep or had high iron or manganese had less than a 3 percent chance of yielding water with high nitrate. Testing, however, is the only sure way to find out if a well has high nitrate.

**Algal Blooms:** Research has demonstrated that excess nitrogen and phosphorous may be responsible for blue-green algal blooms in Milford Reservoir. Although bioassays show that nuisance blooms of algae in Flint Hills lakes and ponds are likely triggered by these nutrients, community structure also appears to be important. The objective of this research is to provide for better management of surface waters in Kansas for drinking, industrial, and recreational uses.

**Acid Deposition in the Konza Prairie:** K-State biologists are cooperating with the National Atmospheric Deposition Program. This provides scientists and policy makers with information about chemical deposition from the atmosphere in natural and managed ecosystems across the United States. Precipitation samples are collected weekly at the Konza Prairie Research Natural Area and analyzed at KSU and the Central Analytical Laboratory in Illinois.

During the past 10 years, no directional trends in acidity in the precipitation has been detected.

## VALUE-ADDED MARKETING, PROCESSING, AND UTILIZATION

Experiment Station expenditures for crops, livestock, and food science for the improvement of product quality and value-added advances are greater in many areas than corresponding expenditures for enhanced productivity of crops and livestock. Departmental research is supplemented by work in the Extrusion Center and Kansas Value-Added Center.

### **Adding Value to Grains**

K-State research is directed at wheat starch, non-food uses of wheat, wheat gluten, and white wheat. Examples of projects which add value to grains and grain products are given on pages 10 to 12 of this report.

### **Adding Value to Meat**

**Processing Schemes for Precooked, Restructured Beef:** Concerns over diet/health issues necessitate the production of processed meat with less fat and salt. KSU meat scientists have produced restructured beef products with 0.2 percent NaCl and 5.0 percent fat compared to approximately 2 percent

NaCl and 10 percent fat in traditional products. They adopted a muscle-washing protocol similar to that used in surimi processing to improve the utility of beef hearts and skeletal muscle. Connective tissue was also removed from chuck muscles and restructured in a pulverized form with 0.2 percent NaCl. Connective tissue removal, alteration, and reincorporation adds value to heart and chuck muscles and allows the use of these raw materials in products other than pet food and export items.

**Adding Value to Shank Meats:** KSU scientists work to add value to meat and augments beef's market position, competitiveness, and nutritional image in Kansas. Shank meat is a low-cost cut used for "manufacturing" beef products. The major disadvantage of shanks is their high proportion of connective tissue (sinew). Sinew is expensive to remove by hand, but Baader™ technology may provide an alternative of mechanical desinewing. Meat scientists are investigating desinewing parameters, yields, and ways to mechanically modify the sinew for re-incorporation. If successful, this value-added process could increase the return from a 700 pound carcass by \$3 to \$5 or a total of \$20 to \$30 million per year for cattle slaughtered in Kansas.

**Low-Fat, Hard Salami:** K-State scientists are exploring ways to overcome hardness and related textural disadvantages when fat levels of salami are reduced from the traditional 25-35 percent to 7-10 percent. One study uses encapsulated lactic acid, traditional lactic acid forming starter culture (LAFSC), and LAFSC plus a proteolytic culture in producing this fermented sausage product. Data collected include yield and processing information, appraisal of texture, and taste characteristics. Meat scientists are also using texturizing ingredients (oat fiber, polydextrose, or nutritoid) in low-fat beef hard salami. Hard salami is a high-value, fermented, relatively stable processed meat product with definite high value-added potential and could be produced and marketed by both small- and large-scale processors in Kansas.

**Enhancing Value of Heart Muscle:** Currently, heart is a very undervalued meat product considering its protein content. Current price is \$.30/lb. for beef heart compared to \$1.30/lb. for 90 percent lean beef trimmings. If heart prices could be raised \$.50/lb. by improved use, this would total \$2 per animal for about 6.7 million cattle slaughtered annually in Kansas. Meat scientists are comparing a rapid grinding/salting procedure with commercial chill conditions for the effect on functional properties (water binding, fat encapsulation) of heart protein. Provided adjustments could be made in meat product label requirements and in processed meat products, meat companies would be eager to use a lower cost raw material with the required functional and nutritional properties.

**Improving Ground Beef Product Life:** Improved shelf life and safety are critical to the Kansas beef processing industry that centrally processes coarse-ground beef for shipment. Forty to 50 percent of the beef tonnage is marketed in ground form. One KSU study explored the impact of removal time of beef muscle and proportion of this muscle on appearance and display life of ground beef that was first stored as coarse-ground in vacuum, then fine-ground and packaged in oxygen permeable film for display. A second study used fat and lean-trim beef sides treated with 200 ppm chlorine, 3 percent lactic acid, and/or water. Carcasses were fabricated, and lean and fat beef trim were used to formulate 20 percent fat coarse-ground beef, which was vacuum packaged in a keeper casing and stored for 7 days or 14 days. The product was then fine ground and packaged in oxygen permeable

polyvinylchloride film and subjected to display. The purpose is to explore a more flexible system for combining, storing, and displaying beef, one that improves display life and reduces case pulls.

**Antioxidants in Precooked Beef Products:** Enhanced shelf life and consumer acceptance of precooked beef is of great economic importance to the meat industry. However, development of oxidized flavors during storage is a serious problem. The problem can be controlled somewhat with artificial antioxidants such as BHA or BHT, but both are suspected as promoters of carcinogenesis, and the public tends to reject synthetic food additives. The use of natural antioxidants and economical protein sources, hydrolyzed to form short peptide chains and amino acids, are being investigated. Sugars are added to the protein hydrolysates and reacted to form brown pigments that may delay the development of off-flavors due to cooking. The brown pigments could also be used as antioxidants in other meat and non-meat products.

**Controlled Atmosphere Packaging for Pork Loins:** From 35 to 40 percent of pork loins are gas packed. This study involved commercially gas-packed (in carbon dioxide) pork loins kept in storage from 3 days up to 19 days before opening boxes and cutting sirloin and rib chops for display up to 5 days under retail conditions while packaged in oxygen permeable polyvinylchloride film. A second study examined the influence of different gas atmospheres (100 percent and 10 percent O<sub>2</sub>) on storage traits, weight loss, subsequent display life of chops, aroma of loins and chops, and microbial counts after storage for 14 or 21 days and display up to 5 days. Modified atmosphere packaging extends shelf life of pork loins and allows longer storage and greater flexibility of use of pork loins. A 3 to 5 day increase in shelf life could add \$10 to \$20 per carcass in value.

**Shelf-Stable, Crisp, Meat-Based Snack Food:** This value-added project concerns the manufacture of a meat-based, crisp snack food using a cooker-extruder. Any kind of meat is suitable. This snack item is made with 25 percent meat and 75 percent Kansas hard white winter wheat flour. The final product contains only 2 to 3 percent moisture, only 1 to 2 percent fat, and from 12 to 15 percent protein. The cooker-extruder can be used to make a variety of snack foods; however, this KSU product is the first to utilize meat as a major ingredient. Companies making extruded snack foods could find this to be a profitable item to make and market.

**Ground Beef Cooked Color:** Consumers use cooked meat color to indicate doneness of ground beef, and USDA has specific color guidelines for meat processors to follow when pre-cooking ground beef patties. Heating denatures the colored pigment in meat, but the denaturation pattern is not consistent, thus creating the potential for under or over cooking which can alter palatability and consumer satisfaction. Studies are underway to investigate the unknown factors affecting cooked color. Imported beef, mature cow meat, and market-age steer meat are being compared for unusual browning or persistent pink cooked color patterns. Lipid oxidation, myoglobin pigment chemistry, and frozen storage are being related to color development. This will help food establishments and USDA in revising processing guidelines and in preparing uniform meat products that are wholesome, safe, and palatable.

**Starch Utilization in Low-Fat Processed Meats:** Because of caloric intake and health, the meat industry and USDA recognize the need to

address the issue of fat levels in sausages and processed meats. Fat, protein, and water interact to play a major role in determining the textural and sensory characteristic of processed meats. Reducing fat content without modifying other constituents or processing techniques results in palatability problems. Starches have considerable potential for improving yields and sensory traits of low-fat meat products; however, there are so many modifications of starch that the optimization of their use is not known. KSU research is directed at determining which starch properties are important in a complex meat system and how various ingredients interact so processors will not have to rely on empirical work to optimize the use of starches.

### **Value-Added Products**

**Beef Curry:** A former restaurant owner sought assistance in formulating a beef curry product that could be marketed as a ready-to-heat and serve convenience product for hotel/restaurant use or as a frozen food entree for retail sale. With assistance from value-added extension specialists and support from the Kansas Value-Added Center, a formulation and schedule for thermal processing were developed. Further evaluations were conducted to monitor product quality and batch variation. Currently this product is being test marketed in Kansas prior to full scale production. Assistance is being provided to locate facilities for commercial production.

**Veal Patties:** An established Kansas company was asked to change the protein content of a veal patty product supplied to an institutional facility. Lacking research capacities at the plant, the company asked extension specialists and the Kansas Value-Added Center for assistance. Chemical analyses were conducted and the product was reformulated to meet the new specifications. This allowed the company to remain competitive in the portion control market and continue to contract with the institutional facility.

### **Specialty Products**

**Soy Yogurt Production:** This project is designed to add value to soy beans by determining the sensory and chemical characteristics of soy yogurt and frozen soy produced from rapid hydration hydrothermal cooked soy milk. The research was funded by the Kansas Value-Added Center in 1992 to add value to Kansas produced soybeans and to encourage further in-state processing. Although the study is completed, further work will be required to supply the necessary data for a patent application and commercialization.

**Fermented Food Products from Kansas Cereal Grains:** Solid state fermentation products made from cereal grains is a project designed to explore utilization of *Rhizopus oligosporus*, a food grade mold, to make tempeh-like foods. This research has great potential to add value to many Kansas cereal grains because the mold can transform cereal grain to delicious fermented foods. A patent application has been prepared and is being evaluated.

# BUSINESS AND FINANCIAL MANAGEMENT

K-State researchers utilize research and farm management data to help farmers, ranchers, and agribusinesses diversify, manage risk, and analyze farm and business opportunities. Management is a key to production and marketing efficiency and to minimizing cost on farms, businesses, and in processing plants. Farm management and business records play a key role in enterprise analysis and in capital and debt management.

## Marketing Livestock

**Marketability of Lean Beef:** Because of health concerns and a declining per capita consumption of beef, the industry has countered with advertising, leaner table cuts, and low-fat ground beef. If the market responds to concerns about fat content and adopts low-fat ground beef, the effect may be dramatic. K-State research shows that consumers are willing to pay almost 2 cents/lb for each unit increase in leanness in ground beef. That is, consumers seem willing to pay 10 cents/lb more for 90 percent lean ground beef than for 85 percent lean ground beef.

Market prices have been estimated for various assumptions about market share. For example, if low-fat ground beef garners 10 percent of the ground beef market, demand will increase, the retail price for all ground beef products could increase by one cent/lb, and consumers will demand an additional 34.6 million pounds of beef. This enhanced demand would increase the market price on nonfed cattle by 1.53 percent or about \$0.49/cwt.

**Value of Cattle Finishing and Beef Packing Industry:** Nearly two-thirds of Kansas gross farm income originates in the livestock sector. During 1991 Kansas feedyards produced (added to feeder cattle) approximately 1.9 billion pounds of beef with a gross live value of about \$1.425 billion. The value of feed and other purchased inputs totaled approximately \$975 million. This implies that the value added by the Kansas cattle feeding industry was \$450 million (not including the value added by grazing or backgrounding). Twenty percent of the work force of Finney, 15 percent of Ford, and 25 percent of Seward counties in Kansas are employed in beef packing. Thirty-four packing plants in the state employ almost 12,000 workers. The 1989 packing plant payroll in Kansas totaled over \$200 million.

**Value of Various Fed Cattle Traits:** Quality factors affecting fed cattle prices were examined during a 6-month period in southwest Kansas. Transaction prices were significantly affected by the percentage of cattle expected to grade choice; the choice to select carcass price spread; finish uniformity; average weight; dressing percentage breed; number of cattle purchased by a single packer on a given day; the packer-buyer; the feedyard; the day-of-the-week the cattle were sold; and the number of bids received. Asking and transaction prices reflect only approximately 25 percent of the packer value differentials for expected carcass quality grades of fed cattle, suggesting that live cattle price differentials do not fully reflect beef wholesale value differentials.



**Hog Carcass Pricing Formula:** The objective was to develop a hog carcass pricing formula for hogs purchased on a grade and yield basis. A component pricing model for hog carcasses explained 80 percent of the value differentials in the fabricated carcasses. This resulted in the development of a hog carcass pricing system for buying grade and yield hogs that more accurately provides a reward for the high-value quality traits of the animals.

**Determinants of Cattle Finishing Profitability:** Data from a western Kansas feedlot were analyzed to estimate the impact of price and performance variables on profit per head from finishing cattle. Sale prices, feeder prices, and corn prices had the most impact on profit variability over time. Differences in sale prices, feeder prices, and feed conversions were important in explaining the difference in steer and heifer profits over time. Results suggest that break-even prices should be calculated for a range of fed cattle, feeder cattle, and corn prices, and these variables should be included in representative farm modeling efforts.

### **Business Management**

**Measuring Financial Performance:** Whether to merge or not to merge is an important issue facing managers and directors of farm cooperatives. Methods are needed so firms with the most to gain from merging can be easily identified. This study examined the financial performance of 114 Kansas Cooperatives by firm size. Return on assets, gross margins, productivity, and variable costs per asset were all related to firm size. However, because of managerial expertise, certain firms are efficient and profitable and would not gain by merging. For others, consolidation could have significant benefits. This study shows how to identify firms with the most potential for gain from consolidation based on measures of financial performance.

**Flex Acreages:** The Flex Acreage Requirement and Integrated Farm Management Program Option of the Food Agricultural and Trade Act of 1990 were designed to increase planting flexibility and promote the use of resource-conserving crops. Economic analysis indicates that these provisions provide for cropping flexibility but do not provide strong incentives for adopting resource-conserving crop rotations. However, resource-conserving crop rotations could be more economically feasible with changes in current program provisions.

**Reducing Farm Risk:** Although fertilizers are perceived to be risk reducing, a study at the Kansas River Valley Experiment Field indicates otherwise. For strongly risk-averse producers, gains in irrigated corn yield and net return do not offset the increased variability associated with the higher yield. The preferred application rate of nitrogen fertilizer for continuous corn grown under supplemental irrigation is 150 lb/a and not 225 lb/a. The preferred application rate for corn grown in rotation with soybeans is 75 lb/a and not 150 lb/a. Strongly risk-averse producers should prefer smaller applications of nitrogen fertilizer.

**Crop Insurance Policy:** Alternative crop insurance policies have been studied by agricultural economists. Adverse selection and moral hazard are significant problems with the current crop insurance program which reduce its effectiveness and increase federal expenditures. Research has identified that area-based crop insurance or disaster-assistance programs may be an alternative under some conditions. A subsidized area insurance program may be less costly to administer than the present crop insurance program. Also, an

area disaster program would be less expensive to implement and administer than current disaster programs and, in some cases, would be preferred by producers.

**Federal Farm Policies and the Great Plains States:** Kansas State University and Oklahoma State University are providing leadership in addressing the impact of trade, commodity subsidy, and environmental policies on farms, industries, and other sectors of the Great Plains. Researchers at Oklahoma State are spearheading the construction of production budgets for large crop regions of the Great Plains. K-State will coordinate development of production budgets for the northern Great Plains states. Kansas information is largely available through Kansas Farm Management Association Records.

## NATURAL RESOURCE CONSERVATION

In Kansas, 12.8 million acres of cropland are highly erodible and conservation systems have been applied to 8.9 million acres, leaving 3.9 million acres requiring treatment. K-State research has focused on increasing water-use efficiency under dryland and irrigated conditions and on crop and soil management strategies to control erosion, maintain production, and reduce energy expenditures.

### Resource Conservation

**Cropping Systems that Conserve Soil and Water:** In western Kansas, particular attention has been directed at factors that minimize soil loss. The work includes the following cropping strategies.

- Adapting a wheat-sorghum-fallow rotation to a reduced tillage system.
- Establishing optimum fertilizer requirements for ridge-till, conventional tillage, and reduced tillage systems of furrow-irrigated corn.
- Adapting sunflower cropping systems to the dry, windy, and erodible conditions of northwestern Kansas.

**Economic Impact of Conservation Reserve Program (CRP) Lands in Kansas:** Kansas has enrolled over 2.9 million acres (31,162 contracts) in the CRP program. The state related goal of this regional research project is to determine what Kansas landowners intend to do with CRP lands when government contracts expire, and if farmers would leave the land in CRP under various economic incentives. The regional goals are to 1) examine potential alternative uses of land leaving the CRP program, 2) determine economic constraints of alternative uses of CRP land, 3) simulate national, regional, and local economic impacts of expected post-CRP land-use patterns, and 4) identify policy scenarios to simulate the economic and environmental impacts of post CRP land-use patterns.

**Windbreaks—Maintenance and Removal:** Data were collected from over 1,700 agricultural producers in Kansas to determine 1) the rate of windbreak planting and removal activities in Kansas, 2) why landowners are planting or removing windbreaks, and 3) the impact of educational and extension efforts. Foresters and specialists will use this information to plan strategies concerning the maintenance and development of the state's windbreaks. Conservation reserve program participants are also being

surveyed to determine what will happen to their land upon termination of the CRP contracts and if expected changes should be mitigated.

**Minimizing Erosion in Northeast Kansas:** The use of rye, winter wheat, and legume cover crops are effective in reducing soil erosion. Of the legumes tested, hairy vetch and sweet clover were the most winter hardy; the others were not sufficiently winter hardy to be effective. Using legumes as cover crops reduced the need for nitrogen fertilizer. Best management practices are also being developed for cover crop management relative to kill date, dry matter production, water usage, and nitrogen contribution. No-till research focuses on reducing soil erosion, lowering energy inputs, and maintaining productivity.

**Controlling Disease in Reduced Tillage Systems:** Reduced tillage farming conserves soil and water resources by maintaining plant residue on the soil surface. However, this practice greatly increases wheat diseases when wheat is grown continuously. A wheat-sorghum/reduced-tillage rotation system has been developed that allows a crop to be grown each year but prevents the buildup of important diseases such as tan spot and take-all.

### **Water-Use Efficiency**

**Drip Irrigation Technology:** Because of falling water tables in the Ogallala Aquifer, drip irrigation technology is being researched in western Kansas. The goal is to improve water-use efficiency and sustain the crop production potential of irrigated land. The data (crop-water use, non-beneficial uses, long-term drainage, and percolation) shows that subsurface drip irrigation systems can reduce net irrigation requirements by nearly 25 percent, yet maintain yields of 200 bu/a. The water savings are attributed to reduced percolation and long-term drainage.

**Irrigation—Conserving Water and Maintaining Income:** Crop yield, soil water drainage, and income vary greatly depending on the irrigation regime. For example, three inches of water can be lost from a six-inch pre-season irrigation of corn. The soil water slowly drains until the crop begins to aggressively utilize available soil moisture. To minimize soil moisture drainage, one should have sufficient well capacity to apply water only when needed by the crop. This strategy, however, may not provide the highest net income. That is, efforts to reduce drainage may limit crop acreage or the amount of water applied per acre and, thereby, reduce crop yield and net income. In an average rainfall year, two in-growing-season irrigations will produce about the same yield as will one pre-season irrigation and two in-growing-season irrigations.

**Irrigation Efficiency:** Water withdrawals from the Ogallala aquifer exceed recharge and water tables are declining. Engineers at Manhattan and at the Southwest and Northwest Research-Extension centers are researching water-use efficiency using drip, sprinkler, and low energy precision application (LEPA) systems. Irrigation application efficiencies using drip and LEPA systems can approach 95 to 100 percent while maintaining high (200 bu/a) yields. With drip irrigation systems, studies have shown no significant yield differences between irrigations applied at 1, 3, 5, and 7 day intervals. The longer irrigation interval provides for the most efficient use of rainfall.

**Economic Impact of Groundwater Protection Policies:** After a survey of northeast Kansas farmers and specialists, a representative Kansas farm was designed for the period 1986-1990. Then the economic and environmen-

tal impact of farming practice and water quality policy on farm income was examined using four conventional and four alternative crop rotations. The farm consisted of 640 acres of dryland crops: wheat, 110 acres; corn, 155 acres; sorghum, 125 acres; and soybeans, 250 acres. Whole farm budgets were created for 1) a conventional case, using the four conventional rotations on the entire 640 acres; 2) four alternative cases, where each alternative rotation was used individually on the 640 acres; and 3) four transitional cases, where each alternative rotation was used individually on 25 percent of the cropland, with the other 75 percent in conventional rotations. A comparison of the annual net returns showed that three alternative cases ranked higher, and two transitional cases ranked higher than the conventional case.

**Supplemental Irrigation in Southeast Kansas:** Poor seed quality is a major disadvantage of early maturing soybeans in southeast Kansas. Irrigation may not only improve early maturing seed yield, but also improve quality. Because irrigation sources are limited in southeastern Kansas, the optimum application time and rate of supplemental irrigation are critical. Preliminary data suggest that supplemental irrigation can increase soybean yields by 5 bu/a; that irrigation at early pod fill was better than at late pod fill; and that irrigation increased the oil content but not the protein content of the seed.

## HUMAN CAPITAL AND FAMILY NEEDS

K-State programs are designed to meet human capital and family needs for individuals, families, and communities. Researchers strive to be perceptive to both social and economic need.

### Perceptions of Social and Economic Issues

**Telephone Interviews:** A Computer Assisted Telephone Interviewing (CATI) Laboratory is now operational with eight independent stations and supporting software and supervisory staff. The CATI laboratory facilitates research on Kansans' perceptions of social and economic issues through the Future of Kansas Survey conducted in 1990, 1991, and 1992. In one survey done in March of 322 adult Kansas householders concerning opinions, perceptions, knowledge, and feelings, the results were released a month later.

**Rural Children:** K-State scientists are creating and analyzing composite data sets from studies of factors affecting rural children. The developmental data sets contain the children's age, quality of their home environments, parents' priorities, and their relationship with companion animals. The children's intellectual and social development are measures of the children's intellect, general development, empathy, and social development.

### Nutrition

**Dietary Fiber and Lipid Metabolism:** How insoluble and soluble dietary fibers influence insulin requirements of diabetics and alter cholesterol metabolism is being studied by KSU researchers. Insulin-dependent diabetics showed a modest increase in glycemic control and need for insulin when receiving bran supplemental diets. In this study, the use of dietary soluble fibers did not suppress sterol synthesis but did reduce the absorption of cholesterol by enhancing excretion of fecal neutral sterols.

**Processing Poultry Products:** Consumer acceptance of food products is highly dependent on flavor and aroma. Research results indicate that vacuum-packaging of cooked turkey results in more meaty and less warmed over flavor and aroma. Several phosphate salts and phosphate-ascorbate salts were effective in reducing stale flavor in meat in non-vacuum packed products but was of little benefit in vacuum-packed turkey.

**Wheat Germ Protein Flour Products:** Foods and nutrition researchers at KSU developed the process for using wheat germ protein in producing comminuted meat products. The use of soya and corn germ proteins is also compatible with wheat germ protein. The cholesterol content was decreased when plant proteins were incorporated into the meat product, but did not produce atypical aroma and flavor. Thus, wheat germ can be utilized as an extender and replacer of saturated fat and meat proteins in frankfurters and bologna.

**Value and Healthfulness in Bakery Products:** Reduced-calorie and sweetened bakery products appeal to those interested in fitness and weight control. To increase the healthfulness of bakery products, researchers are examining the sensory and physical effects of fat replacers and other ingredients. Six fat-replacing products are being compared to a full-fat control for chocolate chip cookies and muffins. Fat reductions range between 50 to 75 percent in the experimental products. The results are encouraging. The healthful muffin, low in fat, sodium, and high in dietary fiber, was liked equally as well as the leading muffin from a retail bake shop.

## **Nutrition and Exercise**

**Nutrient Intake by Healthy Older Women:** The effect of demographic characteristics, health habits, and social contacts on the nutrient intakes of healthy older women were determined using the 1989 Recommended Dietary Allowances (RDA) for selected nutrients. In general, nutrient intakes of healthy older women appeared to be adequate with the exception of energy and calcium. However, 43 percent of the study participants failed to get at least 75 percent of the RDA for energy. The results suggest that education, physical activity, and smoking play an important role in predicting nutrient requirements.

**Nutritional Implications of Exercise:** The effects of exercise intensity on tissue lipids of male rats fed a low (0 percent beef tallow) or a high (20 percent beef tallow) fat diet was studied. Exercised animals ran on a motor-driven treadmill at different rates over an eight-week period. High intensity exercise reduced weight gain, carcass fat, and serum triglycerides in high fat fed rats, but not in low-fat fed animals. High-fat feeding enhanced the lipid-lowering effects of exercise, suggesting an increased caloric expenditure in this group. This suggests that treadmill exercise has a greater effect on adiposity and tissue lipids than high-fat feeding. However, the high fat diet appeared to enhance the lipid-lowering effects of exercise.

**Exercise and Early Life Nutrition:** Childhood obesity is a growing health concern, and K-State researchers are studying exercise effects. In animal studies, treadmill exercise benefits lean rats as well as those overfed early in life. All animals exhibited positive effects such as loss of body fat and tissue fat. However, rats overfed early in life still remained heavier after 9 weeks of enforced treadmill exercise than their normally fed counterparts. Although exercise may be a valuable adjunct in treating childhood obesity, the study suggests that it will not replace a good diet early in life.

## Food-Service Systems

**Selecting Hospital Food-Service Systems:** Studies have been initiated to identify and model factors, including finance and human capital, which food-service directors should consider when selecting a hospital food-service system. Over 2,800 food-service directors in hospitals with 100 or more beds were surveyed to identify those directors who have actually selected food-service systems, the type of system selected, and the date of installation. Responses were entered into a data base for future use. Food-service directors will also rank the importance of food-service selection criteria. Those data will guide the development of a model to assist food-service managers in selecting cost-effective food-service systems.

## Protective Clothing

**Evaluating Textiles and Protective Clothing:** The use of coveralls is common in the workplace where protective clothing is required, including the mixing and application of pesticides. The fit of coveralls continues to be a major concern for both manufacturers and consumers. The work at KSU emphasizes ease and fit in critical areas of men's coveralls. Using accurate body measurements and specified amounts of ease, custom-fitted coveralls will be developed for study participants. A computer program has been written to generate coverall patterns to specified measurements and amounts of ease. The prototype garment is being evaluated and full-scale, human-subject testing will involve an exercise and evaluation protocol.

# RURAL AND COMMUNITY REVITALIZATION

Kansas is a rural state, but the role of farming and the rural economy is changing. Communities help meet the economic, social, service, and living needs of their people. K-State programs help families, communities, and the rural sector with leadership and analytical and economic development strategies so they can adapt to economic and cultural change.

**Coping Strategies in Rural Communities:** This interdisciplinary, state-level KAES competitive research grant focuses on factors contributing to the success of rural communities. Data were collected from 300 communities. Geographic Information System (GIS) technology are being utilized to overlay the geographic and social characteristics of these communities. GIS data, factor analysis, and a categorization scheme will be used to identify five successful communities with different economic profiles. Those communities will be the subject of intensive 1993 cases studies and will provide the research base for outreach programs on economic development.

**Rural Retailing—Impact of Change:** Revitalization includes attracting or developing new businesses and enhancing the management of existing businesses. The focus of this 12-state regional research project is on retailers, consumers, and factors that contribute to or detract from successful rural retail communities. Twelve states are participating in the project and providing data concerning a variety of economic conditions. Over 1,000 consumer households and 100 retailers have been surveyed using the Computer Assisted Telephone Interview (CATI) laboratory at KSU. The data, collected

in 1992, will provide substantial information concerning the needs and interrelationships of rural consumers and rural retailers for businesses, community development groups, educational specialists, and banks and loan companies.

**Scenic Byways:** Midwestern states are interested in developing scenic byways to diversify local economies, support economic development, and add to their tourism industry. KSU economists have published an economic analysis of economic byways in Iowa, Kansas, Missouri, and Nebraska. The study suggests methods for measuring benefits, costs, and local economic impact.

**Railroad Branchline Abandonment:** Economists are studying the impact of branchline abandonment on rural communities in south central Kansas. Abandonment has the greatest impact on Kansas communities located more than 100 miles from major grain markets. For distant markets, rail shippers pay higher transportation costs and earn reduced profits. Farmers receive lower grain prices, road damages increase, and economic development opportunities are foreclosed. Also being studied are 1) economic viability of shoreline railroads in a rural economy and 2) differential pricing in unregulated transportation markets in Kansas.

**Waste Stream Analyses:** To provide useful information for the development of community and industrial waste management plans, waste stream analyses were completed for the food and beverage operations of two mid-scale hotel properties and a college dining center. Information on weight and volume of organic and packing material wastes can be used by community and industrial managers to develop waste minimization and disposal plans and, where feasible, to reduce waste, initiate recycling, and collect food waste for composting or swine-feeding operations. A pilot composting project has been initiated using the food waste from an institutional food-service operation.

**Crayfish Culture:** Crayfish culture methods are being developed in the central states because crayfish can be marketed for fish bait and human food. This alternative form of agriculture, which is a major industry in the southern states, can provide pond owners with supplemental income. Researchers have examined the life history, growth pattern, and production potentials of crayfish and are now developing production management procedures and testing formulated diets (pellets).