Approved February 5, 1992
Date

MINUTES OF THE SENATE COMMITTEE ON AGRICULTURE.

The meeting was called to order by Sen. Don Montgomery, Chairperson, at 10:00 a.m./~~p.m.~~ on February 4, 1992 in room 423-S of the Capitol.

All members were present except:

Sen. Daniels - Excused

Committee staff present:

Raney Gilliland, Legislative Research
Jill Wolters, Revisor of Statutes
Shirley Higgins, Committee Secretary

Conferees appearing before the committee:

Camille Nohe, Attorney General's Office
Dr. R. Daniel Walker, Kansas Livestock Commissioner
Dr. Walter R. Woods, Director of the K-State Agricultural Experiment Station
Dr. George E. Ham, Asst. Director, K-State Agricultural Experiment Station
Dr. Curtis L. Kastner, Department of Animal Sciences and Industry, K-State
Dr. Michael D. Lorenz, Dean of Veterinary Medicine, K-State
Dr. Fred W. Schwenk, Head, Department of Plant Pathology, K-State

The chairman began the meeting with acknowledging and welcoming the Kansas Livestock Association's Young Stockmen who were visiting committee as part of their annual Capital Day.

Camille Nohe of the Attorney General's office requested the introduction of a bill to amend the Kansas Animal Dealers Act which deals with licensure. The request is a result of the outcome of a criminal case this past year where the Court of Appeals ruled that evidence from an inspection could not be admitted as evidence due to the present way the law is written. The proposed bill would allow for an inspection which would be the equivalent of a search warrant. The proposed lanaguage would require that notice be given of the inspection and possible impoundment of the animals.

Sen. Harder made a motion to introduce the bill, Sen. Frahm seconded, and the motion carried.

Dr. R. Daniel Walker, D.V.M., followed with a request for the introduction of a bill. (Attachment 1).

Sen. Webb made a motion to introduce Dr. Walker's proposed bill, Sen. Harder seconded, and the motion carried.

The chairman called on Dr. Walter R. Woods, Director of the K-State Agricultural Experiment Station, to begin a report on the station. (Attachment 2-2). Dr. Woods introduced four others to report: Dr. George E. Ham, Dr. Curtis L. Kastner, Dr. Michael D. Lorenz and Dr. Fred W. Schwenk.

Dr. Ham, Assistant Director of the Agricultural Experiment Station, was first to report. (Attachment 2-7).

Dr. Kastner, Department of Animal Sciences and Industry, followed with his report. (Attachment 2-8).

Dr. Lorenz, Dean of Veterinary Medicine, followed with a report on livestock protection. (Attachment 2-9).

Final report was given by Dr. Schwenk on plant pathology. (Attachment 2-11).

Dr. Woods made final comments noting that because of the funding both from the federal government and from the state general fund, the faculty can compete nationally and is committed not only to generate knowledge but also to seeing that the knowledge is applied.

Sen. Doyen had a brief question regarding safety in egg production, and it was noted that Kansas is not working on this at present but will be in the future. Dr. Kastner answered a brief question from Sen. Webb regarding preharvest safety.

The minutes of January 31 were approved.

There being no further questions, the meeting was adjourned at 10:46 a.m.

GUEST LIST

COMMITTEE: Senate Agriculture DATE: 2-4-92

NAME	ADDRESS	ORGANIZATION
Brent Paddock	RR#1 Blue Mound	KLA
Ron Shogren	Lindsborg	KLA
Mike Jones	Harper	KLA
Susan G. Stanley	712 S. Kansas 4B Topeka	KS. Dept of Health
Walt Woods	Manhattan KS	KSU
Clyde Jacobs	Manhattan KS	KSU
Mike Lorenz	Manhattan, KS	KSU
George Ham	Manhattan KS	KSU
Chris Fullmer	Dighton, Ks	KLA
FRED SCHWENK	Manhattan	KSU
Jim Bergner	Pratt	KLA
Gary Schellinger	Junction City	KLA
Curtis Kastner	Manhattan KS	KSU
Harry ? Dawson	Medicine Lodge KS	KLA
Kim Kline	Marion KS	KLA
Don Hook	LYNDON KS	KLA
Harish Manocha	Manhattan KS	KSU
SUE PETERSON	MANHATTAN	Kansas State University
Brandon Moore	Oberlin KS	K.L.A.
Alan Jones	Gem KS	KLA
Arlan Helms	Topeka	Budget
Mike Bohnhoff	Topeka	Budget
Gary Rolland	Hays	KLA

GUEST LIST

COMMITTEE: Senate Agriculture DATE: 2-4-92

NAME	ADDRESS	ORGANIZATION
Trudi McGlasson	Topeka	KLA
Gene [illegible]	Phillipsburg KS	KLA
Russell A. Frey	Topeka	Ks Vet Med Assoc.
Bill [illegible]	[illegible] Ks	KLA
Al LeDoux	Holton	CKFO
David [illegible]	Hutchinson	KLA
[illegible]	Satanta Ks	KLA
[illegible]	[illegible] KS	KLA
[illegible]	[illegible] Ks	KLA
Brian [illegible]	Allen KS.	KLA
Kerry [illegible]	Rozel KS	KLA

STATE OF KANSAS
Animal Health Department

Request For Legislation
Kansas Senate Agriculture Committee
Senator Don Montgomery - Chairman
February 4, 1992

Submitted by R. Daniel Walker, DVM, Kansas Livestock Commissioner

ANIMAL DEALERS ACT

1.) Expand authority to adapt U.S.D.A. regulations 9 C.F.R. 2.40, 2.50 and 2.75 for animal dealers.

2.) Amend to remove Hobby Kennel Operator registration category. Define Animal Dealer premises as "any premises where more than three intact female dogs, cats, or both are maintained and offspring are raised, leased, sold or offered or maintained for sale.

3.) Amend definition of "animal shelter" to include "unincorporated humane societies" and "no kill shelters."

4.) Change title of Livestock Commissioner to Animal Health Commissioner.

5.) Set time frame as to when a delinquent license or registration is deemed as expired and non-renewable.

6.) Accept research laboratory certification by AAALAC (American Association for the Accreditation of Laboratory Animal Care) in lieu of state inspection. State inspection of research facilities upon complaint only.

7.) Amend the number of animals maintained by a person that is presumptive evidence of being an animal dealer from 20 to 10.

PROTECTION OF DOMESTIC ANIMALS

1.) Amend definition of "livestock" as it appears in 47-1000, _et seq._ to read "... and other animals as deemed necessary by the animal health commissioner" and amend appropriate sections of 47-1000, _et seq._ to accomodate this change.

2.) Under Protection of Domestic Animals expand Animal Health Commissioner authority to allow administrative enforcement of quarantine violations and to issue citations and fines.

3.) Revoke registration of tranquilizer syringe guns.

Senate Agriculture
2/4/92

712 Kansas Ave., Suite 4B Topeka, Kansas 66603 Phone 913\296\2326 Fax 913\296\1765

Attachment 1

Food Safety and Livestock and Crop Protection

A Report to the

Kansas Legislature

By the
Kansas Agricultural Experiment Station
Kansas State University

Senate Agriculture
2/4/92
Attachment 2

KSU
KANSAS STATE UNIVERSITY

Director of Agricultural Experiment Station

Waters Hall
Manhattan, Kansas 66506-4008
913-532-6147
FAX: 913-532-6563

February 4, 1992

To Members of the Kansas Legislature

Dear Friends:

This report highlights research developments in Food Safety and Livestock and Crop Protection--topics that impact the health and economic well-being of Kansas citizens.

I'm pleased to report that Kansas is a leader in food safety and livestock and crop protection research. With USDA support, Kansas State University is part of a three-state consortium on food safety. K-State works with beef, Iowa State with pork, and the University of Arkansas with poultry. A prime focus is to rapidly detect infection or contamination, reduce health hazards, monitor risk, and determine intervention and control points.

Animal and veterinary scientists have made significant advances in rapid diagnostic techniques using monoclonal antibodies to detect viruses, improved methods (a patent is pending) for detecting bacteria, and treatment protocols that enhance conception in dairy cattle and may enhance litter size in swine.

I'm impressed with the depth and progress of Experiment Station research with biological control. Scientists at K-State are using molecular genetics and biotechnology to develop effective management and control strategies.

We invite comment about these or any Agricultural Experiment Station research project.

Sincerely,

Walt Woods

Walter R. Woods
Director

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EXECUTIVE SUMMARY

This report addresses food safety and livestock and crop protection—research that provides support for consumers, farmers, ranchers, and important segments of food service, processing, and marketing industries.

FOOD SAFETY

Rapid Detection Techniques: A research objective is to develop rapid and reliable microbiological and chemical detection techniques to increase food safety and shelf life and to decrease inventory and operating costs. The University has applied for a patent on one promising method. Another research team is directing its work toward hazard analysis to identify critical control points and their associated hazards to enhance safety in small processing plants. Controls can then be established and systematically monitored to minimize bacterial and other hazards.

Food Safety Consortium: Because food safety is a consumer and industry concern, Kansas State University, Iowa State University, and the University of Arkansas have formed a three-state food safety consortium. K-State's research focuses on beef and beef products, the University of Arkansas on poultry, and Iowa State on pork. The objective is to develop methods to rapidly identify infectious agents and toxins, evaluate potential health risks, identify intervention points, develop risk monitoring techniques, and reduce microbial or chemical hazards. Each research project addresses questions that are critical to the Kansas economy.

LIVESTOCK PROTECTION

Rapid Diagnosis: K-State scientists are addressing a broad spectrum of projects to protect livestock. Researchers have developed monoclonal antibodies to detect virus in swine and cattle, swine dysentery, and specific abortifacient pathogens in swine and pneumonic pathogens in cattle. Researchers are also working to isolate antigens that will assist in the development of experimental vaccines. Early diagnosis will greatly increase the ability to detect and treat infected animals.

Treatment Protocols: Discoveries in KSU laboratories promise to open new approaches to alter the physiology of early pregnancy and improve litter size in swine. Prostaglandins are key regulators in early pregnancy, and pregnancy rates of dairy cows can be increased by treatment protocols using prostaglandins. Research trials show that treatment with bovine somatotropin (BST), which increases milk production, enhances the immune response in cows.

Growth Inhibition: Early weaned pigs suffer digestive upset, diarrhea, and dehydration when fed simple corn-soybean, meal-based diets. Researchers have improved digestibility and growth by 30 to 40 percent by eliminating the gene expression of the trypsin inhibitor in soybeans. The fine grinding of cereal grains for growing pigs also improves digestibility.

CROP PROTECTION

Developing Resistant Germplasm: A continuing research objective in the Experiment Station is to develop germplasm with excellent growth and yield potential and natural resistance to insects, diseases, and environmental stress. Scientists in the Wheat Genetics Resource Center (WGRC) are performing pioneering research in molecular genetics, including chromosome banding, non-radioactive probes to mark chromosomes, and genetic mapping of individual chromosomes. Recent K-State releases have included germplasm and varieties with resistance to greenbug biotype I (grain sorghum), multiple pests (hard red winter and hard white wheats), leaf rust, greenbug, and Hessian fly (wheat germplasm), chinch bugs (grain sorghum germplasms), and cyst nematode (soybeans). Alfalfa breeders and entomologists have also produced superior alfalfa germplasm resistant to important diseases and insects.

Biological Control: A North Central Region research project is directed at developing biological control measures for wheat diseases. Researchers at Fort Hays have successfully isolated native strains of bacteria that inhibit root growth of weedy bromes and jointed goatgrass without inhibiting the roots of wheat. Additional research in biological control is directed toward microbial infection in insects, hormonal control of the insect cuticle, manipulating the insect digestive system, host-parasite interactions, and using microorganisms to transfer useful genes into plants. Other efforts include a search for natural enemies of the Russian wheat aphid.

Management Practices: Other research developments include demonstrating the efficacy of K-State corn borer prediction models which can predict egg laying events within three days of actual occurrence; testing management practices to reduce the toxic effects on endophyte infected pastures; developing Bermudagrass hybrids with resistance or tolerance to spring dead spot; controlling zoysia patch and spring dead spot in turfgrass with fungicides. Effective pest control, reduced chemical use, and environmental protection are underlying objectives in many food safety and livestock and crop protection management strategies.

OVERVIEW

Walter R. Woods
Director, Kansas Agricultural Experiment Station

Research programs in the Kansas Agricultural Experiment Station (KAES) address questions that are critical to the Kansas economy and the production, protection, and marketing of adequate supplies of safe, wholesome, and nutritious food.

Increasingly, we ask searching questions about each research project—is the research objective and the enterprise it enhances economically promising, environmentally safe, resource sustainable?

Our written report provides brief summaries of many research developments in food safety and livestock and crop protection. This overview focuses on only a few.

Food Safety: Kansas is a national leader in food safety research. With USDA support, Kansas State University is part of a three university Food Safety Consortium. K-State works with beef, Iowa State with pork, and the University of Arkansas with poultry. The charge is to conduct research that reduces or eliminates chemical hazards, monitors risk, determines intervention and control points, and rapidly and statistically identifies and evaluates infectious agents, toxins, and health risks.

KAES scientists have developed rapid and superior methods for detecting bacteria and viruses, enhancing microbial safety in selected products, monitoring cleanliness in the working environment, and in enhancing food safety and shelf life. For example, methods have been developed that reduce the detection time for a specific pathogen from two weeks to 24 hours. The method can also be used to detect other important pathogens. The University has applied for a patent on the process.

Livestock Protection: The safety of food products from livestock is tied to animal health and livestock protection. Often, the research involves interdisciplinary teams of animal scientists and veterinarians. Research teams are investigating liver abscesses caused by bacterial toxins in the rumen, why the immune response in stressed animals is reduced so significantly, development of rapid diagnostic tests for pathogens that induce abortion in swine, pneumonia in cattle, dysentery in swine, and viral particles in animal tissue. Aggressive programs to determine the effect of bovine somatotropin (rBST) on the immune response are also underway.

Crop Protection: In 1990, a new greenbug biotype, biotype I, began attacking previously resistant hybrids in Kansas. To minimize loss, growers were quickly alerted, and over 750,000 acres were treated with insecticides. KAES plant breeders at Manhattan and Hays responded immediately and resistance to biotype I greenbugs is now available in three K-State germplasm releases (KS96, KS30, and KS31).

Other impending or actual releases of insect and disease resistant materials, include a hard red winter wheat and a hard white winter wheat with multiple pest resistance; three wheat germplasms resistant to leaf rust, greenbug, and Hessian fly; two grain sorghum germplasms resistant to chinch bugs; and a soybean variety resistant to the soybean cyst nematode. Such releases materially reduce or eliminate the need for pesticides wherever the crop is grown.

Biological Control: I'm impressed with the depth of KAES research in biological pest control. Efforts include studies to introduce natural enemies of the Russian wheat aphid, isolate bacteria in Kansas soils which inhibit root growth in weedy grasses, circumvent insect immune systems, control the development of cuticle in insects, defend against enzymatic and digestive attacks by insects, and understand the genetics and biochemistry of disease-causing organisms. Researchers are working to transfer useful genes between plants via microorganisms which can infect both plant systems. Without doubt, K-State scientists are performing pioneering research in biological control.

Today's report will also touch briefly on:

- Experiment Station Priorities
- Food Safety
- Livestock Protection
- Crop Protection

EXPERIMENT STATION STRENGTHS

George E. Ham
Associate Director, Kansas Agricultural Experiment Station

The mission of the Kansas Agricultural Experiment Station (KAES) is to conduct basic and applied research in agriculture and related fields that will help ensure an adequate supply of wholesome food and fiber for a growing world population while providing reasonable incomes for producers and related agribusinesses in the state. The KAES supports numerous research projects that deal directly and indirectly with food safety and crop and livestock protection. These include Kansas-focused projects, regional research projects, and cooperative research with other states and other agencies where KSU is a major contributor.

Food Safety and Quality: Few issues have greater impact on agriculture than the safety and quality of the food supply. Today, a sophisticated food processing and delivery system supplies consumers with a great variety of food products with a high level of safety. However, the complexity of today's food system has led consumers to question practices and make assumptions. These questions deserve rational answers. With KAES support, Kansas has become a national leader in food safety research. We expect to continue and strengthen our leadership role in this important area. Developing rapid methods for detecting, monitoring, and controlling bacteria, virus, and chemical residues will continue as important research thrusts. Food safety risks need constant assessment because of new products, new technology, and new consumer demand. Interdepartmental programs in food science, genetics, and molecular genetics help focus research and educational efforts in these areas.

Livestock Protection: We are particularly pleased with research developments in biological control for both animal and crop pests. Approaches using biotechnology and molecular biology hold great promise. Experiment Station scientists have used these technologies in developing methods that enhance the rapidity with which disease can be diagnosed, treated, and controlled. These same techniques can be used in developing potential vaccines and treatment methods. Researchers have also been successful in altering the physiology of pregnancy in cattle and in using prostaglandins, which are key regulators in early pregnancy. Treatment protocols have been suggested that improve conception in cattle and may improve litter size in swine.

Crop Protection: Management of insect and disease pests is crucial in the production of crops and livestock. Pests and pest management activities impact production costs, product quality, and food safety. Safe and effective management of pests is dependent upon a knowledge of pest biology and ecology. Pest control mechanisms include genetic resistance, biocontrol measures, and safe and wise use of pesticides. Additional research is underway on such topics as pest biology and ecology, integrated pest management, host plant resistance screening, and biological control agents.

Scientists in the Experiment Station are recognized leaders, nationally and internationally, in developing germplasm with excellent growth and yield potential and superior resistance to insect and disease pests. Last year, germplasm or variety releases by the Experiment Station included genetic resistance to leaf rust, greenbug, Hessian fly, chinch bugs, and soybean cyst nematode. The great advantage of such releases is positive pest control without the use of chemical or treatment costs.

Our goal is to aggressively address the food safety, livestock and crop protection, and other research needs that are critical to the economy and well-being of Kansas citizens.

FOOD SAFETY

Curtis L. Kastner, Meat Scientist
Department of Animal Sciences and Industry

The scope of food safety is frequently summarized as physical, nutritional, chemical, and microbiological. The avoidance of physical contaminants in food is readily achieved by industry and does not pose the challenges of the other areas. Probably the best approach to nutritional safety for most individuals is to recommend moderation in consumption across all food groups. The issue of chemical residues is perceived by the consumer as the most important food safety concern; however, microbiological issues pose a more eminent health risk than chemical residues. Nonetheless, consumer perception is as important as reality and must be appropriately addressed.

The U.S. food industry has an excellent record with respect to food safety; however, market demands have resulted in alterations in processing and marketing that have created new safety challenges. For example, consumers want less salt in further processed products that are refrigerated (thus being regarded by the consumer as "fresh") but not frozen. Both of these practices pose microbial safety challenges important to Kansas because the state produces and processes large amounts of animal and grain-based products that are shipped to remote domestic and international markets.

Food Safety Consortium: Research programs at K-State are designed to address questions that are critical to the Kansas economy. For example, with Kansas being the number-one beef processing state, it is important to verify and monitor the chemical and microbial condition of beef before shipment. Therefore, an important part of the USDA Cooperative State Research Service funded Animal Science Food Safety Consortium project (also involves Iowa State University and the University of Arkansas) is to develop rapid and automated chemical and microbial detection techniques. An example of our success in this area includes reducing the time for the detection of the pathogenic bacteria *Listeria* from 9-14 days to less than 24 hours. This can allow for more timely ship-no-ship decisions, decrease inventory costs, and reduce incidence of expensive product recall. All of these impact industry profitability, enhance product safety, and improve consumer confidence in meat and meat products. Even though chemical residues do not pose a significant health risk, rapid and automated detection techniques can be used to verify this, thereby increasing consumer confidence in the meat supply. Current efforts include development of detection techniques for pesticides and toxins produced by molds.

Virus Survivability: Faculty in the College of Agriculture collaborate with others in the colleges of Human Ecology and Veterinary Medicine. An example of recently initiated cooperation between the Animal Science Food Safety project and the College of Veterinary Medicine includes determining those conditions that affect virus survivability in meat and meat products. This joint effort also encompasses expertise at Iowa State University. It is our opinion that the area of virology, as it impacts safety of meat and meat products, is an area of concern which will be emphasized more in the future. Many researchers believe that viruses have a significant impact on disease conditions that may take a long time (i.e., years) to express themselves after the original infection.

Critical Control Points: Another recently initiated part of the Food Safety project includes evaluating what can be done at critical control processing points to improve beef safety and extend shelf life. Safety is important; however, extended shelf life also improves our competitiveness in export markets where extended shipment times dictate the need for extended storage. Examples of critical control points and techniques in beef processing being tested include rinsing with lactic acid (a natural antimicrobial component of the muscle) before carcass chilling and before vacuum packaging of subprimal cuts in a boxed beef operation.

Technology Transfer: A major thrust of the Food Safety Consortium includes transfer of the technology to encourage industry application. Efforts to enhance the transferability of the technologies generated by K-State on the Food Safety project include USDA Food Safety and Inspection Service testing of rapid microbial detection techniques developed by Dr. D.Y.C. Fung; videotaping of rapid microbial testing techniques, which can be used to teach industry quality control personnel to perform those tests; and implementation of critical control point treatments (i.e., lactic acid washing) in test plants to demonstrate the effectiveness of the treatments, which will encourage industry adoption of the technology.

Summary: Our collective objectives in food safety at K-State are designed to meet current and future societal and industry needs, and every effort is being made to meet those objectives.

LIVESTOCK PROTECTION

Michael D. Lorenz, DVM
Dean of Veterinary Medicine

Scientists in the Kansas Agricultural Experiment Station (KAES) conduct basic and applied research in identifying and controlling diseases that cause economic loss to livestock in Kansas and the North Central Region. Scientists in several departments and colleges at KSU are collaborating effectively in seeking answers to both basic and applied problems in diagnosing, treating, and preventing livestock diseases. Although KAES research addresses a variety of disease problems, this report focuses on important areas of collaboration between departments and colleges.

Respiratory Diseases: Respiratory diseases seriously impact both cattle and swine and cause significant economic loss each year. KAES scientists have targeted these diseases as a major area of research.

Stress: Livestock production methods and environmental changes create stressors that decrease the ability of animals to mount effective resistance to viral and bacterial agents. K-State research shows that stress reduces the production of proteins that stimulate the immune response in animals. The immune response is augmented significantly when these proteins (interleukin-2 and interleukin-1b) are administered to stressed livestock. The commercial application of these findings is being investigated as a means of improving the response to vaccines. This research has involved 22 collaborators, nine departments, and four colleges at KSU. It has materially enhanced the training of several new scientists and has generated over 50 refereed publications.

Vaccine Development: Developing better vaccines to prevent respiratory diseases is another high-priority research thrust. The bacteria *Pasteurella haemolytica* is an important agent in the cause of bovine respiratory disease complex (shipping fever). KAES scientists have discovered antigens from this bacteria that stimulate resistance by the host animal's immune system. The development of growth strategies and culture media that enhance the production of these important antigens is under investigation. The production of more effective *Pasteurella* vaccines will be the ultimate outcome.

Diagnosis: Diagnostic tests for rapid and accurate diagnosis of bacterial and viral diseases are also important areas of research. We want to enhance rapid diagnosis and effective control of disease outbreaks. However, the detection of subclinical infection or carrier animals is most important because disease from these sources may be introduced into susceptible herds. Subclinical disease may decrease weight gain or increase susceptibility to other infections. Swine pleuropneumonia is one example of a chronic respiratory disease with high morbidity and high infection rate in swine. Detection of the disease is especially important in confinement operations and in breeding animals to be used in closed herds. KAES scientists are perfecting and evaluating better methods for detecting this important disease.

Monoclonal Antibodies: Recently, KAES scientists have developed highly specific monoclonal antibody reagents for the accurate diagnosis of infectious viral strains of bovine virus diarrhea, infectious bovine rhinotracheitis, and bone para-influenza. These reagents have received patents and are being sold to other universities and pharmaceutical companies. Tests are being evaluated for the early detection of swine transmissible gastroenteritis, swine dysentery, chlamydial induced swine abortion, and bovine respiratory syncytial virus.

Environmental Quality: KAES scientists are developing efficient and environmentally safe ways to control stable flies, hornflies, and houseflies: all important vectors of infectious diseases and a cause of economic loss to livestock producers. Lyme disease, of potential future importance to the livestock industry, is being assessed to determine the prevalence of infection in Kansas wildlife and the distribution of the ticks that transmit the disease. The environmental effects of confinement swine operations are the subject of research by KAES scientists. Investigators have identified high levels of bacterial toxins associated with dust in confinement swine operations.

Summary: The economic future of animal agriculture in Kansas will depend on our ability to rapidly detect and prevent both clinical and subclinical diseases. When using such techniques, we must consider the welfare and well-being of animals, environmental impact, and the production of safe and wholesome meat and animal products. Scientists at K-State are aggressively addressing those issues.

CROP PROTECTION

Fred W. Schwenk
Head, Department of Plant Pathology

Crops provide the building block for production agriculture. We use crops for our own food and as food for livestock. It is extremely important that we maintain a reliable supply of good, edible food. Kansas State University is committed to developing the crops and cropping systems needed to produce good food. Crop protection is an important part of that research, developing systems that take into account both near- and long-term production.

Crops, like people, are subject to a multitude of problems. Diseases, insects, and weather are all part of the environment and must be considered when scientists develop new varieties for growers.

Crop Protection: Crops can be protected from problems by various methods. Because problems change, and because it is not always possible to predict ahead of time which method of control will be best, KSU scientists work with multiple approaches to crop protection. Two of the most common are biological control and chemical control. Others, such as governmental regulatory measures, are used under more specialized conditions.

Chemical pest control gained popularity in the last century and continued to increase in this century. For a variety of reasons, pest control methods that limit chemicals are increasing in popularity. Chemicals are still the most effective and economical way to control some diseases, but increasing emphasis is being placed in finding practical alternatives.

The most common methods of non-chemical crop protection are biological, either by developing plant varieties that are resistant to the problem or by utilizing organisms in the environment to protect the plant.

Long-Term Effects: In all methods, a thorough understanding of the ecological aspects of crop production is important. It is most important that the systems that are developed take into account the long-term effects of their use. Much of the research at KSU is designed to increase understanding and to capitalize on those aspects of the ecosystem that can minimize crop damage.

Examples of the approaches being taken by KSU to develop crop protection systems are given elsewhere in this publication. Although they are listed individually, it is important to remember that many of them are being developed concurrently. In this way, we can continue to compare different systems so growers can make the most informed choices.

Research Approaches: Some research includes the most advanced forms of molecular genetics and genetic engineering, but it is important to remember that this is only one of many tools used in research. For some diseases, the best controls are the conventional ones such as crop rotation or modified planting date. For others, it is necessary to use resistant varieties, recognizing that resistance is usually short-lived because the pests continue to change.

For still others, it is most practical to use genetic engineering to produce a crop that has a special type of resistance or to modify a biocontrol agent to protect the crop.

In all of this, researchers at KSU are most concerned that the systems they develop and recommend are safe and practical now and in the future. It's extremely important that these systems be ones that maintain agricultural production indefinitely. After all, if it's not sustainable, it's not agriculture.

FOOD SAFETY RESEARCH

Livestock and plant-based food products are researched and monitored throughout the production and processing cycle to identify critical points and procedures that help ensure product safety and consumer confidence in the food supply.

Rapid, reliable microbiological and chemical residue detection techniques assist processors in minimizing the time-lag between processing and shipping and assist regulatory personnel in verifying the microbial and chemical residue status of food products. The availability of rapid detection techniques decreases inventory and operating costs and enhances consumer confidence. Research concerning critical production and processing control points also enhances safety, extends shelf-life, and increases competitiveness in domestic and international markets where safety and prolonged shelf life are imperative. This research technology is particularly important in Kansas efforts to add value to food products and ship them out of state.

FOOD SAFETY CONSORTIUM

Recently food safety has become an issue of concern for the livestock and meat industry and the consuming public. In response, the Congress, in 1988, authorized and funded a USDA grant program in Food Safety. Members of the participating consortium include Kansas State University, University of Arkansas, and Iowa State University. K-State's research has focused on the production, processing, packaging, and distribution of beef. The University of Arkansas is emphasizing poultry, and Iowa State, pork. Each university is charged with performing research and developing methods to:

- Rapidly identify infectious agents and toxins.
- Statistically evaluate potential health risks.
- Determine intervention points for controlling microbial or chemical hazards.
- Develop risk monitoring techniques
- Reduce or eliminate microbial or chemical hazards in production, processing, and distribution.

Research programs at K-State are designed to address questions that are critical to the Kansas economy. Because Kansas is the number-one beef processing state, it is important to monitor and verify the chemical and microbial condition of beef before shipment.

HAZARD CONTROL

Hazard Analysis and Critical Control Points (HACCP): Between 1973 and 1987, beef was implicated in nine percent of all outbreaks of food-borne disease. Although there has been a steady decline in the number of outbreaks in the last 15 years, beef remains a major vehicle for food-borne illnesses. HACCP analysis identifies critical control points and their associated hazards. Controls can then be established and systematically monitored to prevent adulteration. With Extension Service-USDA funding, a study has been initiated to establish HACCP procedures adaptable for use by small- and medium-sized processing plants.

Reducing Pesticide Exposure: Pesticides are used extensively by feedlot operators. Exposure to pesticides may result from insufficient use of protective clothing or equipment. The use of household starch is being investigated as a pesticide barrier. The thermal and permeability changes induced in four different starched fabrics were studied. Results indicate that laundered and starched Oskgosh fabric increased the permeability of the fabric, while the laundering and starching of a glove fabric decreased the permeability of the fabric. Permeability is a key factor in clothing design, since reduced permeability often contributes to heat stress. The use of coveralls is common in applications requiring the wearing of protective clothing. Work is in progress to determine the optimal amount of mobility and comfort required in woven, knitted, and non-woven coveralls.

Chemical Residues: Although microorganisms pose a greater food safety risk than chemical residues, development of techniques to detect organophosphate pesticide residues is a high priority for the USDA Food Safety and Inspection Service. Research is underway to refine recently developed methods for detecting organophosphate residues and metabolites in meat, determine the retention of those metabolites in animal tissues, and study the effects of cooking on organophosphate residues and metabolites.

Controlling Microbial Contaminants on Meat Contact Surfaces: Food contact surfaces, such as cutting boards and table tops, are major sources of contamination if not properly cleaned. Research to help monitor working surface cleanliness has shown that an enzyme produced by microorganisms reacts with hydrogen peroxide to produce bubbles and can be related to working surface and product cleanliness. These simplified procedures can be videotaped, shared with processors, and used on a routine basis to check sanitation procedures. This development will be important for smaller processors who do not have quality control personnel.

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.

Color as an Index of Degree of Doneness in Ground Beef: Many food service establishments (i.e., nursing homes) do not use standard cooking times or temperatures to determine the degree of doneness in ground beef. Instead, internal color is used as an index of doneness and the destruction of pathogenic bacteria. Standards are being evaluated to facilitate the accuracy of degree of doneness based on color. Before recommending reliance upon degree of doneness based on color standards, various sources of beef (i.e., domestic vs. imported) are being evaluated to assess their response. The incidence of food-borne illness could be minimized if proper standards were utilized at food service centers and at home.

The effect of newer types of processing, including low-salt and low-fat and restructuring, on the growth of pathogenic bacteria is also being studied. Testing is being done on organic acids, antioxidants, enzymes, and other approved food additives for their control of microbial growth on carcass and product surfaces. These products may be useful in reducing the incidence of spoilage and extending shelf life.

Permanently Identifying Cattle With Electronic Implants: Although no identification system is currently available, both producers and processors need reliable techniques to monitor and identify animals that are contaminated with chemical residues or microorganisms. Consumer confidence is elevated when safety is closely monitored and corrective action can be instituted promptly and with certainty. Rather than develop a trace-back protocol, KSU research is directed at assessing the merits of commercial implants as a permanent identification system for cattle from birth through processing.

ENHANCING MICROBIAL SAFETY

Rapid Detection Methods for *Listeria* Bacteria: *Listeria* bacteria, because of its association with animals and animal products, is significant to the 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 a U-Tube system using an enzyme for the rapid detection, isolation, and enumeration of this bacterium in meat. This system decreases the time required for detection from nine to 14 days to 24 hours. This technology is also being applied in the detection of other important bacteria pathogens. The University has applied for a patent on the process.

Rapid Detection Methods for *Clostridium* Bacteria: *Clostridium perfringens* has been the third leading cause of food-borne disease in the United States for the past several years. A more rapid and effective method is required for the detection, isolation, and enumeration of this bacteria, particularly in meat.

The Double-Tube method developed at K-State has been evaluated for its efficiency to recover this bacteria from meat and has been shown to be the best method to isolate and enumerate the bacteria. The Double-Tube method is faster and more sensitive than existing methods. Thus, it can be used to more rapidly verify the microbial safety of meat and other foods.

Rapid Methods and Automation Microbiology Center: This Center was established to develop automated methods for monitoring disease-causing microorganisms. The Center has demonstrated the effectiveness of commercially available, laser-counter instrumentation in rapid enumeration of microbes on meat samples. The microbial profile of a typical restructured, precooked, vacuum-packaged, refrigerated product has been evaluated after storage. This kind of baseline evaluation is imperative as we develop value-added processes to produce convenience foods. Refinement of these and other techniques will provide improved ability to monitor and ensure the wholesomeness of beef for the consumer.

Enhancing Microbial Safety for Meat Products: *Esherichia coli* 0157:H7, a bacterial pathogen, has recently emerged as a significant food-borne cause of hemorrhagic colitis in humans in the United States and Canada. The organism has been found in beef, pork, lamb, and poultry. Studies initiated by Experiment Station scientists have demonstrated that the fermentation process used in value-added meat processing will control the organism.

Safety of Canned Quickbreads: Recently, a new line of quickbreads has been introduced. Typically, the product line consists of quickbreads preserved in quart-sized, wide-mouthed jars. The products are baked in the jar and sealed immediately to create a vacuum with no further heat treatment. The product is stored, distributed and displayed without refrigeration and could be on store shelves for more than a year. Samples tested at K-State for water activity and pH raise the possibility of the risk of botulism in these products. Trials have been initiated to establish the safety of canned quickbreads by inoculating, processing, and challenging the microbial quality of the products under normal storage conditions. The effect of the time and temperature of various baking treatments on the safety of this food is of particular interest.

Food-Borne Viruses: Little research has been done on food-borne viruses, yet some are harmful to humans. This lack of research is partly because of the difficulty in recovering active viruses from foods. Pathogenic viruses such as Hepatitis A, Norwalk, and others have been reportedly transmitted through seafood, eggs, and ground beef. Techniques to recover active viruses have been developed through research efforts by faculty in Animal Sciences and Industry and Veterinary Medicine. Current research is designed to determine the temperature treatments that destroy viruses in meat and meat products.

Faculty at K-State in the colleges of Agriculture, Human Ecology, and Veterinary Medicine, and faculty at Iowa State University, are collaborating to determine conditions that affect virus survivability in meat and meat products. It is thought that virology, as it impacts safety of meat and meat products, is an emerging area of concern. Many researchers believe that viral infection can significantly impact disease conditions. Subsequent to infection, however, it may take years before the disease symptoms are manifest.

Controlling *Salmonella* and *Staphylococcus*: *Salmonella* and *Staphylococcus* are two of the most important pathogenic bacteria impacting food safety. Antioxidants have been approved by FDA as a preservative for some meat products. Lysozyme is an enzyme found in eggs, and nisin is a protein produced during the natural fermentation process for meat products. Experiment Station research has shown that these natural or food-approved ingredients are effective in destroying *Salmonella* and *Staphylococcus*. Further research will be devoted to refining the optimum combinations of ingredients to use for a wide variety of meat and meat products and critical points of application. To enhance food safety, the application of these materials in various combinations should be readily approved by FDA/USDA.

TECHNOLOGY TRANSFER

Efforts to enhance the transferability of technology generated by K-State include testing of promising methods by the USDA Food Safety and Inspection Service, videotaping of rapid microbial testing techniques for use in instructing quality control personnel, and implementing critical control point treatments (i.e., lactic acid washing) in test plants to demonstrate their effectiveness and encourage adoption of the technology.

LIVESTOCK PROTECTION RESEARCH

Safety of food products from livestock is intimately tied to livestock protection. Infectious agents and chemical residues can certainly be passed from a live animal to the finished product. Additionally, healthy, contented animals require less prophylactic treatment, and their immune systems are more effective against infection agents. K-State scientists are involved in a broad spectrum of projects that protect livestock. Many of those projects are interdisciplinary in nature and involve researchers in the colleges of Agriculture and Veterinary Medicine.

PATHOLOGY AND DISEASE

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

Porcine Pleuropneumonia: This important disease in the pork industry continues to increase at an alarming rate. Approximately 80 percent of the swine herds in the Midwest are infected. When it occurs in unexposed herds, the morbidity can exceed 40 percent and mortality can be as high as 24 percent. Investigators are evaluating assays currently used to identify infected animals and are defining how the bacteria cause disease. Those studies, which depend on molecular biology techniques, may lead to an effective vaccine.

Inherited Diseases: Extensive use of artificial insemination and embryo transfer has decreased the gene pool in cattle and increased the threat of inherited diseases. Pathologists at K-State serve as a sentinel for congenital diseases in Kansas and advise cattle breeders and breed associations who encounter difficulties.

Polioencephalomalacia (PEM) in Beef Cattle: PEM, a central nervous system dysfunction in ruminants (beef and lamb), is relieved by injections of thiamin. Approximately 18 percent of all full-fed beef animals contain thiaminase in their feces. Those animals are potentially susceptible to PEM because the enzyme degrades thiamin. Most feedlot operators have been trained to recognize and treat the condition to avoid animal losses. Ongoing research is devoted to discovering the prevention protocol rather than treating and evaluating the impact of PEM on animal performance.

DIAGNOSIS

Detection of TGE-IgM Antibodies and Virus Particles: A series of TGE specific monoclonal antibodies has been developed. These specific monoclonal antibodies have been used to develop an enzyme-linked immunosorbent assay (ELISA). This test will detect specific anti-IgM antibodies in swine serum that has been infected with TGE virus within five to seven days. This early detection can help with management of infection within a regional population of swine. The monoclonal antibodies can also be used to detect virus particles in tissue.

Detection of Bovine Respiratory Syncytial Virus (BRSV): Monoclonal antibodies to BRSV have been developed in mice. These monoclonal antibodies will be used to detect specific anti-BRSV-Ig antibodies and virus particles by an enzyme-linked immunosorbent assay (ELISA). The BRSV infection is difficult to detect by the current routine procedure. The BRSV-ELISA assay will detect IgM antibodies in bovine serum at three to seven days and the monoclonal antibodies can be used to detect viral particles in tissue during the first 24-48 hours of infection.

Production of *Serpulina hyodysenteriae* Monoclonal Antibodies: The organism that causes swine dysentery, *Serpulina hyodysenteriae*, represents a significant threat to the economics of swine production. Early and specific detection of this organism will improve the control and elimination of this swine enteric disease. KSU veterinarians have developed a specific monoclonal antibody to the pathogenic organism *S. hyodysenteriae* and the non-pathogenic *S. innocents*. This provides the diagnostic laboratory with the ability to identify and differentiate these organisms in feces and tissues of infected animals. Early diagnosis is very important in preventing and controlling swine dysentery.

Development of a DNA Probe to *Chlamydia Psittaci*: A DNA *chlamydia psittaci* monoclonal specific antibody diagnostic probe has been developed that will allow early detection of pathogenic abortifacient strains in swine and pneumonic pathogenic strain of chlamydia in cattle. The DNA chlamydia psittaci probe is highly specific and can decrease the time currently needed to culture the organism. Early diagnosis will greatly increase the ability to detect and treat infected animals.

LIVER ABSCESSES

Liver Abscesses in Feedlot Cattle: The incidence of liver abscesses in grain-fed cattle is about 25 to 30 percent. Economic loss includes liver condemnation at slaughter, reduced weight gain, and reduced feed efficiency. The infection is caused by a normal bacterium inhabitant of the rumen. The goal of K-State research is to understand the pathogenic mechanism of the infection. There is evidence that the organism produces a toxin that kills white blood cells and causes abscesses. The research is focused on studies of the toxin and the development of a protective vaccine. This would alleviate the use of antimicrobial feed additives to control liver abscesses. The economic loss for animals with severe liver abscesses ranges from $25 to $66 per animal.

REPRODUCTION

Embryonic Signaling of Pregnancy Establishment in Pigs: Conservatively, 20 percent of pig embryos perish during the second and third weeks of pregnancy. Estrogens and prostaglandins are known to participate in embryo-uterine signaling. Discoveries in KSU laboratories open new approaches to alter the physiology of early pregnancy and to improve litter size in swine. New routes of estrogen metabolism in pig embryos have been identified and researchers have determined that prostaglandins are key regulators in early pregnancy. If 25 percent of lost embryos were saved, litter size would increase about 1.6 live pigs, and the U.S. swine herd could be reduced 15 percent without reducing the number of pigs produced. The savings could approximate $150 million annually.

Facilitating Pregnancy in Dairy Cows: When cows are examined during a routine health visit by a veterinarian, those not inseminated because of missed heats (about 10 percent of the herd) or found not pregnant (about 30 percent of the herd) should be given prostaglandin $F_2\alpha$ if a functional corpus luteum can be palpated or if milk progesterone is high. K-State research confirms that conception will occur 21 days or 14 days earlier than in untreated controls, respectively, for the two groups of cows. This results in savings of $21 per cow for the former and $42 per cow for the latter group of problem cows.

To maximize the potential economic advance of this management tool, cows must be inseminated during estrus, or, in the absence of detected estrus, inseminated at 72 and 96 hours after injecting prostaglandin $F_2\alpha$. Kansas dairy producers in the Dairy Health Improvement testing program (43,000 cows) could realize $632,000 annually by utilizing this practice.

Increasing the Pregnancy Rates of Repeat Breeders: Repeat-breeders are found in all dairy herds and represent about 25 percent of all cows. Research has demonstrated that pregnancy rates of dairy cows at repeat services will be increased 10 percent if cows are given gonadotropin-releasing hormone (GnRH) at the time of the third insemination. With treatment, about 10 percent more cows would be salvaged annually because these cows would subsequently calve and remain in the herd. In total, for 43,000 cows enrolled in the Dairy Health Improvement testing program, this would potentially increase gross income for producers by $806,000 annually.

IMMUNE RESPONSE

Bovine Somatotropin (rBST) Effects on the Immune Response: Some have hypothesized that the dramatic increase in milk production from BST treatment will stress the immune system of the cow. However, BST treatment has been shown to improve the immune response of the cow. This research helps establish the information base that will be used to determine the fate of BST's approval for commercial use. Other health conditions (i.e. mastitis) are also being evaluated.

Health of Calves Supplemented with Vitamins A, C, and E and Beta-Carotene: Bovine respiratory diseases in North America are estimated to cost from $250 million to $1 billion annually. Recently, Vitamin E has been shown to be an immunoenhancer in a number of species, including calves. The effect of vitamin E on the immune response is affected by

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vitamin A in chickens and by beta-carotene in cattle. The interrelationships of vitamins E, A, C, and beta-carotene on the immune system in young calves is being addressed by KSU researchers. The effect of large amounts of vitamin A (such as are often used in milk replacers) and the interrelationship of large amounts of vitamin C on the function of vitamin E as it relates to the immune system are of particular interest.

RUMINAL FERMENTATION

Cause and Prevention of Bloat in Cattle: Approximately 18 percent of cattle deaths in Kansas feedlots are from gastrointestinal upsets, and 71 percent are from grain or feedlot bloat. Cattle in feedlots may also suffer from subacute bloat accompanied by reduced feed intake, decreased feed conversion, and poor performance. K-State research on bloat led to the development of poloaxalene (Bloatguard). Numerous antifoaming agents have also been screened for preventing frothy bloat, but none was found effective. Consequently, research has shifted to the microorganisms which cause grain bloat and the efficacy of antimicrobials in preventing bloat.

Ruminal Fermentation by Protozoa: Although the role of ciliated protozoa is subject to debate, many believe that protozoa play a beneficial role by regulating lactic acid metabolism in the rumen.

Tests demonstrate that ruminal protozoa in cattle fed high-grain diets appear to contribute to a stable rumen fermentation. This was evident in a higher ruminal pH and a lower fatty acid concentration in cattle with protozoa than in cattle without protozoa. The moderation of fermentation in the rumen was likely from reduced bacterial numbers associated with the presence of protozoa.

NUTRITIONAL FACTORS

Nutritional Well-Being of Weaned Pigs: Early weaned pigs fed a simple corn-soybean, meal-based diet experience extreme digestive upset, diarrhea, and dehydration that cause substantial economic losses. By eliminating the gene expression of Kunitz trypsin inhibitor, a 30 to 40 percent improvement in nutrient digestibility and growth performance of nursery pigs was demonstrated. Heat processing by extrusion rather than roasting resulted in physical disruption of antinutritional factors so that residual antigenic potential was reduced by 60 to 80 percent. Also, treatment with a hot ethanol-water mixture decreased antigenic potential to near zero. These discoveries will benefit farmer feeders who might purchase an on-farm extruder, and the soybean processing industry with the necessary capital to adopt hot ethanol processing procedures.

Modified Wheat Gluten: Alternative Protein Source for Baby Pigs: Kansas leads the nation in wheat production, and the use of modified wheat gluten could benefit baby pigs and Kansas farmers. Wheat gluten is relatively low in lysine but can be cost competitive compared to milk protein sources for baby pigs. Research results indicate that diets containing wheat gluten had five percent greater digestibility than diets with soybean meal. Furthermore, compared to diets with dried skim milk, diets with the best wheat gluten product supported equal rate and efficiency of gain for the first 14 days postweaning

Alternatives to Feeding Antibiotics to Weanling Pigs: Feeding antibiotics to pigs results in improved herd health and increased growth and reproductive performance. However, there is much concern about the routine use of antibiotics as feed additives. Research is in progress to evaluate the efficacy of adding naturally occurring microbes to the feed of weanling pigs to control pathogenic microbes without the use of antibiotics. To date, products with *Streptococcus faecium, Bacillus subtilis*, mixed Streptomyces, and mixed Aspergillus have given minimal and inconclusive results.

Experiments are also in progress to determine the potential of essential fatty acids in enhancing the immune response in weanling pigs. Supplementation of a *purified diet* with an essential fatty acid (linoleic acid) increased fatty acid concentrations in the small intestine and liver and improved immune system components in ways that should help pigs thwart opportunistic pathogens. Whether these same responses occur in pigs fed more conventional diets is yet to be determined.

Feed Processing and Digestion in Pigs and Poultry: Fine grinding of cereal grains for growing pigs improves digestibility. Results indicate that particle sizes substantially lower than the current recommendations of 700 to 900µm may be used without ill effects. Broiler chicks and nursery pigs responded favorably to 300 and 500µm corn and sorghum treatments. Sows had increased litter weights and less loss of body weight during lactation when fed diets with 400µm corn vs. diets with 900µm corn. These improvements resulted without increased incidence of gastrointestinal lesions or ulcerations. Microscopic evaluation of tissue will determine if impending lesions were in progress but undetected by evaluation procedures previously used. Experiments are also in progress to determine if the interaction of particle size and mill type (hammermill vs. roller mill) and diet form (meal vs. pellet) influences gastrointestinal ulceration in finishing pigs.

Nutritional Effects on Equine Health: Developmental orthopedic disease results in large losses to the horse industry. Optimum nutritional, management, and exercise regimens are being evaluated to maximize foal growth and minimize lameness and limb weakness. Additionally, the utilization of fat in mare diets is being evaluated for its effect on condition score.

Nitrate Variation in Sudan Hay Bales from the Same Field: Many farmers grow summer annuals like sudan for dry forage. Because of a variety of stresses, many types of forages can accumulate nitrate. If nitrates exceed 6,000 parts per million (ppm) on a dry-matter basis, the potential exists for nitrate toxicity and cattle losses. Individual large round bales of sudan hay harvested from the same cutting and field ranged from 1,525 to 6,250 ppm of nitrate, with an average of 2,764 ppm. These results illustrate the substantial variability that can occur in the nitrate content of baled forages because of field location and serve as a caution to producers who feed such forages.

ENDOPHYTE-INFECTED PASTURES

Supplementing Steers Grazing Endophyte-Infected Fescue: In 1990, Kansas imported approximately 3.3 million cattle. Between 20 to 25 percent of these animals may be subject to fescue toxicosis because they were grazed on endophyte-infected fescue. Feeding trials were instituted to determine if providing supplemental feed would diminish the effects of the endophyte toxins. The cattle were grazed on endophyte-infected pastures in southeast

Kansas and finished in a feedlot in southwestern Kansas. Supplementing steers grazing endophyte-infected fescue with ground sorghum at a rate of 0.25 percent of body weight improved feedlot feed conversion, decreased cost per hundred weight of gain, and improved yield grade.

Effect of Amaferm on Stockers Fed Endophyte-Infected Feed: Cattle grazing endophyte-infected fescue typically exhibit symptoms that include reduced feed intake, weight gain, and milk production; higher rectal temperature and respiration rate; and reduced serum prolactin levels. Tests at the Southeast Branch Experiment Station have shown that Amaferm will not offset the effect of feeding cattle endophyte-infected feed even though Amaferm is known to reduce rectal temperatures and improve dry matter digestibility.

Tall Fescue Forages for Horses: Kansas horsemen don't utilize tall fescue because of the harmful effects of endophyte-infected fescue on mares when consumed in the last trimester of pregnancy, the assumption that endophyte-infected fescue will have the same deleterious effects in horses as it does in cattle, and the assumption that the harmful agent is associated with the fescue plant rather than with the endophyte fungus. Research is directed to establish the feasibility of using endophyte-free and endophyte-infected fescue forage for growth and to determine the effect of the endophyte fungus on thermo-regulation and mineral utilization in exercised and non-exercised horses.

PROTECTING SILAGE

Characteristics of Indigenous Microflora in Silage: Indigenous lactic acid bacteria were isolated from five silage crops including wheat, alfalfa, corn, interseeded grain sorghum and soybeans, and forage sorghum. All crops had postharvest lactic acid bacteria counts that exceeded 500,000 colony-forming units per gram. There were no significant correlations between rate of fermentation during the first seven days post-ensiling and the indigenous lactic acid bacteria counts. However, corn and sorghum, which fermented rapidly, had higher populations of lactic acid bacteria, and the isolates showed higher rod to cocci ratios compared to the other three crops.

Indigenous Microflora on Alfalfa and Corn: The indigenous microflora on forages is responsible for silage fermentation, unless a commercial inoculant is added. Lactic acid bacteria, acetic acid bacteria, yeasts, molds, and lactate-using yeasts were examined on four cuttings of alfalfa, each at three maturity stages, and three corn hybrids. Acetic acid bacteria were predominant on alfalfa, but yeasts, molds, and acetic acid bacteria predominated on corn. Higher proportions of lactate-using yeast were found on corn than alfalfa. Lactic acid bacteria comprised a smaller proportion of the total populations with streptococci, the main indigenous lactic acid bacteria group. Once the crops were ensiled, lactic acid bacteria grew extremely fast and reached maximum numbers at three days post-ensiling. Yeast and mold counts showed a continuous decline as ensiling progressed, and this was much more pronounced in alfalfa than corn.

Silage Loss of Corn in Horizontal Silos: In the High Plains, horizontal silos are used extensively to store large amounts of silage. By design, a large percentage of the silage mass is exposed to environmental and climatic effects, and storage losses can be large. K-State scientists, using ash content as an internal marker, documented the loss in the top layer of horizontal silos under farm-scale conditions. Covering corn silage reduced spoilage losses of organic matter from 49 to 31 and 9 to 1 percent in the top and second 18 inches respectively. Although such losses are large, properly covering the silage in horizontal silos will greatly reduce storage losses.

Silage Loss of Alfalfa in Horizontal Silos: Horizontal silos store large amounts of feed, but over 20 percent of the original ensiled volume can be within the top three feet of the silo. Under pilot- and farm-scale conditions, covering silage increased silage dry matter and nutrient recovery regardless of time or depth from the original surface. In uncovered silages, significant deterioration occurred in the top foot within two weeks and through the second foot within four weeks after ensiling. Protecting the silage immediately after filling the silo should greatly increase storage efficiency.

Microbial Succession During the Ensiling Process: The microflora involved in ensiling comprises mainly lactic acid bacteria but other microorganisms are also present. This study investigated the effect of additives on microbial succession on alfalfa and corn during the ensiling process. Analysis showed that lactic acid bacteria comprised less than two percent of the total microbial population of both crops. Alfalfa treated with Biomate inoculate, and the combination of dextrose and Biomate, showed higher lactic acid bacteria counts than the control and dextrose treatments at one day post-ensiling. Adding dextrose accelerated multiplication of lactic acid bacteria in the ensiled alfalfa. Adding 1174 inoculant to corn silages did not affect the microbial succession during the ensiling process.

STABLE FLIES

Control of Stable Flies With Parasitic Wasps: Fly parasites are being sold in Kansas dairies without documentation of their effectiveness. Inquiry by several dairies prompted experimental releases of a Kansas strain of a parasitic wasp *(Spalangia nigroaenea)* that has shown promise in reducing stable flies in cattle feedlots. After release of fly parasites in Kansas dairies during 1991, parasitism increased from May to late June then dropped in July. Additional studies are needed before a reliable fly reduction program using parasites can be recommended for Kansas dairies. Release of adapted species and removal of fly breeding areas will be essential elements in achieving control.

Stable Fly Research in Cattle Feedlots: Stable flies reduce rate of gain and feed efficiency in cattle by attacking cattle to secure blood, which enables them to mature and lay eggs. Stable flies are abundant during the spring, then typically decline in July. Conversely, natural populations of fly parasites peak during July, then decline, which decreases their effectiveness in controlling fly populations. Presumably, spring releases of adapted parasites could improve control of the fly population.

Methods have been developed for rearing a promising parasite species at the Southwest Research-Extension Center. Preliminary releases have been made, but further work is needed to determine the required number of parasites per animal, what species should be used, how often to release, and the optimum environmental conditions for release.

ENVIRONMENTAL PROTECTION

Respiratory Disease and Environmental Stress: Losses from respiratory disease in cattle and swine are estimated at $17.5 million annually in Kansas. Scientists in Animal Sciences and Industry and Anatomy and Physiology have developed a model stressor system to investigate the endocrine and immunological consequences of stress on livestock. Using the restraint and isolation stress model in sheep, research shows that this stressor results in large releases of hormones from the brain and adrenalin gland. The stressor is associated with functional changes in cells involved with the immune response. Ongoing studies are designed to determine why these stressor-associated hormonal secretions result in a reduced immune response in stressed animals. The ultimate objective is to develop management strategies that minimize stress and enhance effective immune responses.

Livestock Environmental Protection: It is well known that air quality is critical to the respiratory health of confined livestock and poultry, and dust on building surfaces may be re-suspended, depending on air velocity. The deposition and turbulence of dust on surfaces at various orientations was studied in a climate-controlled section of a swine building. Similarly, the dust forming potential of grain and feed has also been tested. Data derived from these studies are being used to design confined livestock facilities to enhance livestock health and production.

Ventilation Fan Systems: The health of confined livestock and poultry is highly dependent on the design and performance of ventilation equipment. K-State researchers have designed a system (patent pending) that assures a safe minimum ventilation rate during the winter when livestock are vulnerable to sickness or death from underventilation. Fan motors have been designed and tested, motor sizes optimized, and fan impellers tested extensively to maximize performance. The effect of housing design, shutters, and guards has also been determined.

K-State engineers are also developing a computerized design to match impellers and motors to aid engineers in assembling properly functioning systems. A computerized process for selecting components (fans, inlets, controls, etc.) is also being developed. The results of this research will be applied in Extension programs that assist livestock producers in livestock management. The overall thrust includes pen design, waste handling, corrals, buildings, and heating and ventilating systems.

CROP PROTECTION RESEARCH

The state's major crops—wheat, grain sorghum, corn, soybeans, and alfalfa—contribute significantly to the Kansas economy; therefore, crop protection is essential. Losses to insects and diseases likely exceed hundreds of millions of dollars annually. Crop protection research takes many forms, but continuing work includes the development of genetic resistance and biological control strategies.

BIOTECHNOLOGICAL AND BIOLOGICAL CROP PROTECTION:

Biotechnology includes work with recombinant DNA, tissue culture, gene cloning, molecular genetics, and gene regulation; whereas biological control utilizes natural enemies or biological modifications for pest control. Researchers are utilizing each of these techniques in their work to control insect and disease pests and reduce the need for herbicides and pesticides.

Control in Wheat and Cereals

Soil-Borne Pathogens of Wheat: A North Central Region research project is directed at developing biological control measures for several common and economically important wheat diseases. Researchers are attempting to find and enhance the activity of naturally occurring organisms that are effective against specific plant pathogens. Work in Kansas is focused on beneficial organisms that will help control losses from tan spot disease.

In a related effort, work has begun to track biological control agents in the environment. If and when genetically engineered biological control agents are used, it will be necessary to know the mechanisms by which they spread in the environment. That knowledge will be essential in utilizing these organisms in a manner consistent with good environmental stewardship.

Russian Wheat Aphid: Developing biological control of the Russian wheat aphid is an important objective of a multi-state research effort. Natural enemies to the Russian wheat aphid from Europe and Asia are being tested for possible release. Research includes developing reliable field evaluation procedures for assessing the impact of biological control, and assessing climatic tolerance of newly introduced natural enemies. Climatic effects are of particular concern because Kansas has a relatively harsh climate and natural enemies introduced from other lands and climates may not be well adapted. Quarantine and testing rules must be rigorously maintained.

Microbial Weed Control: Scientists at the Fort Hays Experiment Station have successfully isolated native strains of bacteria that, under laboratory conditions, inhibit root growth of weedy, cool-season, annual grasses such as the bromes and jointed goatgrass, without inhibiting the growth of wheat roots. If this technology can be successfully transferred to field conditions, it can provide a competitive advantage by reducing yield losses from weeds in wheat. This would enhance weed control and would also reduce environmental risk and the use of agricultural chemicals.

Host Resistance to Fungal Diseases of Cereals: This research is directed at the role of chitinases and B-glucanases that digest fungal cell wall polysaccharides. Several chitinases have been purified and their biochemical and anti-fungal properties have been studied. Specific chitinase and B-glucanase isozemes are induced in the host cells upon infection by pathogens. Research goals include an overexpression of these genes in healthy tissues to increase their ability to resist infection by pathogens, and engineering genes into saprophytic bacteria to enhance their biocontrol potency against fungal pathogens.

Control of Insects

Research in biological control of insect pests may lead to strategies to circumvent the insect immune system or provide other means for more efficient biological control of insect pests.

Microbial Infections in Insects: Research has been initiated on two types of protein in insect hemolymph (blood) that may function in protecting insects from microbial infection. K-State biochemists have discovered and determined the primary structure of a serine protease inhibitor that is similar to human blood proteins that regulate blood clotting. Preliminary results indicate that this group of proteins regulates a series of reactions thought to be an important component in the protective response of the insect to microbial infection.

Studies are also in progress on a newly discovered insect hemolymph protein that has structural similarities with antibody molecules. This protein is produced in the insect in response to bacterial infections and may have a role in recognition and response to infections by insect blood cells (hemocytes).

Hormonal Control of the Development of Insect Cuticle: Cuticle degradation is controlled by the expression of endochitinases and N-acetylglucosaminidases. The cDNA clones of these enzymes have been isolated and partially characterized. Also, hormones have been shown to control the transcription of the genes in ligated abdomens of fifth instar larvae. Experiments are in progress to develop a baculovirus expression system that will express the chitinolytic genes. Infection of the larvae with these genetically engineered viruses is expected to improve biocontrol of insect larvae and minimize damage to host plants.

Insect Digestive Enzymes: Digestive enzymes are central to an attack by insects on a plant and for the plant's defense against enzymatic action through protein inhibitors. The objective is to increase plant resistance to insect attack through genetic engineering. The research is centered on inhibitors of insect amylases and of thiol-proteases. *In vitro* feeding studies suggest that such inhibitors can be an effective agent in plant resistance to insect attack. Genes that encode inhibitors will soon be introduced into rice plants. The project involves collaboration with Purdue University.

Studies Utilizing Basic Biology

Mechanisms by Which Plants Sense Environmental Change: The breakdown of membrane phospholipids catalyzed by the phospholipases is thought to play an important role in alterations of lipid metabolism from plant stresses such as pathogenesis, cold injury, and water stress. The genes for these enzymes are being cloned to help understand enzyme regulation and enzyme functions at molecular levels. Simultaneously, the changes in membrane phospholipid hydrolysis and enzymes involved in plants exposed to various stresses are being defined to determine the physiological significance of lipid breakdown in membranes in response to environment. A better understanding of those events will provide significant help in designing strategies to protect crops from stress-related loss.

Genetics and Physiology of Host-Parasite Interactions: Several research projects treat the genetics and biochemistry of disease-causing organisms, including the interactions of the host and parasite. Some projects are designed to help understand how pathogens recognize a potential host and initiate the disease process. In others, researchers are searching to understand what happens inside a plant or plant cell when it is attacked. The ultimate objective is to find successful control measures utilizing either host or parasite interaction.

Researchers are also studying the genetics of the pathogen. From this, they can determine the distribution and importance of specific forms of the pathogen and predict the appearance of new races that might overcome resistance currently found in plants. This information is provided to plant breeders, so they can develop varieties resistant to current and anticipated races of a pest.

Recombinant DNA Technology as Applied to Plant Pest Control: Under laboratory conditions, some pathogens are taken apart and reassembled on a molecular basis to help researchers understand how they work. Altering the contents and order of the pathogen helps determine the specific functions of each part. This work utilizes laboratory tools that were unknown just a few years ago.

In related work, researchers are trying to determine if it would be useful to incorporate part of the genetic information of a pathogen, such as a virus, into the genetic code of a plant. This might enable the plant to interfere with the internal spread of the pathogen and thereby reduce or effectively eliminate the disease.

Using Plant Pathogens as Tools of Change: Micro-organisms that cause disease are usually very small and move readily among plants. In so doing, they sometimes transfer small amounts of genetic information from one plant to another. Researchers are capitalizing on this natural process by using micro-organisms to carry useful genes into specific plants. By harnessing this ability in micro-organisms capable of infecting plants that are not closely related, researchers can transfer useful genes among plants. In one project, researchers use the common crown-gall bacterium to transfer traits among host plants. Although it might be considered a naturally occurring process, under laboratory conditions it is much more rapid and useful.

WHEAT

The objective of modern wheat management systems is to produce wheat as efficiently as possible by using high-yielding cultivars, nitrogen fertilizer, and foliar fungicides to control leaf diseases. Leaf rust, speckled leaf blotch, tan spot, and powdery mildew are the primary leaf diseases affecting winter wheat in Kansas. Estimates show that during the last 10 years, the combined effects of these diseases has resulted in annual yield losses of 1.9 to 11.3 percent, with an average yield loss of 7.3 percent.

The development of genetic resistance to insect and disease pests significantly reduces the need for chemical control, favorably impacts profitability, and provides enhanced environmental protection.

Wheat Genetics Resource Center (WGRC): A primary goal of the WGRC is to develop wheat germplasm with excellent growth and yield characteristics and natural resistance to diseases, insects, and environmental stress. The WGRC research group has identified genes responsible for resistance to leaf rust, powdery mildew, Hessian fly, greenbug, curl mite, wheat soil-borne mosaic virus, wheat spindle streak virus, wheat streak mosaic virus, and barley yellow dwarf virus.

Using advanced technology, WGRC scientists perform pioneering research in the emerging discipline of molecular genetics. This includes chromosome banding, non-radioactive probes to mark chromosomes for diagnostic assays, and genetic maps of individual wheat chromosomes. These genome-fingerprinting techniques enable researchers to identify and assign features to individual wheat chromosomes and to specific locations on those chromosomes. This permits scientists to identify, move, and track useful genes and modify plants much more quickly than ever before.

Germplasm Development: Winter wheat is plagued by many insects and diseases, and development of multiple pest resistance and genetic diversity is a prime research objective of the joint USDA-KAES wheat breeding program at Manhattan. In 1990 and 1991, three germplasms were released, all with different genes for leaf rust resistance.

Research approaches include evaluating genetic diversity in ancestral species for resistance to important wheat diseases, introgression of specific resistance genes from ancestral species and determining their chromosonal location and inheritance, determining the effect of resistance genes on yield and quality, investigating why some ancestral strains cross with wheat and some do not, and developing methods for obtaining durable resistance in wheat.

Variety Development: Seed from two new wheat varieties with multiple pest resistance is being increased for release in 1992. KS831374-142 is a hard red winter wheat, and KS-SB-369-7 is a hard white winter wheat. Both lines, if released, will provide improved resistance to stem rust, leaf rust, tan spot, septoria, and powdery mildew.

Russian Wheat Aphid: Compared to Colorado, Kansas has been extremely fortunate with respect to damage sustained from the Russian wheat aphid, which first appeared in 1986. Overall, the insect seems to struggle for survival during the summer months in Kansas unless an emerging source of volunteer wheat is present. Consequently, fewer acres were treated in 1990 than in 1989 when only 135,000 acres were treated.

Control with Fungicides

Treatments at Parsons: In southeast Kansas, wet conditions may prevail, and leaf rust can develop after the wheat has headed. The application of a fungicide (Tilt) increased yields significantly for several cultivars (Agripro Victory, AGSECO 7846, Chisholm, and TAM 107). The fungicide also improved grain yield of some disease-resistant cultivars, such as Pioneer 2551 and Karl. Other disease-resistant cultivars, Caldwell and 2163, showed little yield response when treated with Tilt. The application of the fungicide increased individual kernel weight for all cultivars.

Treatments at Hesston: In previous research at Hesston, small increases in yield of 1.4 to 3.2 bu/a were obtained with application of Tilt fungicide to Arkan wheat (1985-1987). Current trials compare Tilt with an experimental fungicide, Folicur, and with Dithane + Bayleton. The fungicides were applied at different stages of growth to Karl and Newton, varieties that offer important differences in disease resistance.

For Karl wheat, all treatments increased yields by 2.5-6.0 bu/a. Yields of Newton wheat improved by 6.0-6.9 bu/a with Folicur or Tilt applied at growth stage 8. All fungicide treatments significantly reduced leaf disease scores. The earliest fungicide treatments had the greatest impact on yield.

Seeding Rate Experiments at Colby: The effects of seeding rate and fungicide application (Bayleton, Tilt, and mancozeb) were compared for six winter varieties (Newton, Hawk, TAM 107, TAM 200, KS84HW196, and Norkan) at the Northwest Research-Extension Center.

Under dryland fallow conditions, significant differences were obtained for protein percentage, thousand kernel weight, percentage of small seeds, and seed yield. However, differences observed for yield, test weight, and percentage of large seed were statistically insignificant. Mancozeb fungicide produced the highest average values for grain yield and seed yield, but none of those values was significantly better than for Tilt fungicide. Values obtained with Bayleton fungicide were only slightly higher than those when no fungicide was applied.

Seed Quality Experiments at Colby: Studies to ascertain the effects of fungicide application on agronomic and seed quality characteristics of winter wheat have been conducted since 1985 at the Northwest Research-Extension Center. In most years, fungicide application has effectively controlled foliar diseases and produced improved yield and seed-quality characteristics, including test weight, thousand kernel weight, and percentage of large seed.

Tests have also been initiated to ascertain the effects of fungicide-induced improvements in seed quality on crop performance.

GRAIN SORGHUM

New Greenbug Biotype: A new greenbug biotype, biotype I, was identified in southwest Kansas in 1990. Costs attributed to this new biotype include treating over 750,000 acres with chemicals and the concurrent loss of millions of bushels of sorghum grain—costs likely exceed $10,000,000. Development of host plant resistance lessens, and in many cases eliminates, the need for using chemicals for greenbug control and protects both plants and the environment.

Screening Trials at Hays: In screening trials at the Fort Hays Experiment Station, sorghum germplasm with high resistance to biotype I and also to biotypes E and C was found only in a tetraploid (Johnsongrass-like) accession. A germplasm release (KS 96) was made to the sorghum industry and is currently being used in commercial grain sorghum breeding programs. It should provide a basis for maintaining a high level of host plant resistance in the future.

Screening Trials at Manhattan: At the Experiment Station at Manhattan, research in genetic resistance to grain sorghum pests centers on greenbugs of biotype E and I. Until 1990, the emphasis was on developing resistance to biotype E.

The K-State program released KS Bulk 30 and KS Bulk 31 with a new, diverse source of resistance to biotype E. In 1990, when the new biotype was discovered, KSU germplasm sources were re-evaluated. Only one source was found with resistance to biotype I. Fortunately, this resistance source resided in KS Bulks 30 and 31. Both of these released bulks were segregating for resistance to biotype I and could readily be used for developing new, resistant hybrids. KSU has also obtained greenbug resistant germplasm from Russia that is being screened for resistance to biotype I.

Chinch Bug Resistance: Research to enhance resistance to chinch bugs has focused on developing a reliable field screening technique for identifying useable resistance. This KAES research resulted in the identification and release of two lines, KS94 and KS95, for use in developing hybrids resistant to chinch bugs. Other sources of resistance have also been identified in advanced experimental lines and new introductions that will result in future germplasm releases. Development of the field screening technique has been a key factor in discovering new resistances and encouraging research activity by private breeding programs.

CORN

Prediction Models for European Corn Borer: Survey entomologists estimate that losses caused by the European corn borer approximate $11.5 million annually in Kansas. Analysis of multi-year, multi-site data has validated the usefulness of corn borer computer models developed at K-State. The models predict the timing of larvae development and the economic impact of insecticide application. Egg laying events are generally predicted within three days of actual occurrence. This accuracy greatly diminishes the need for field scouting, helps avoid unneeded chemical application, and enhances the effectiveness of required pesticide applications. Researchers in Nebraska, Iowa, and several seed corn companies have requested permission to adapt the model for their use.

Corn Borer Moth Flights: In 1990, there were ample first- generation European corn borer larvae to further test the use of the Kansas State University European Corn Borer Phenology and Management Model which predicts second-generation oviposition. Based on samples of first-generation larvae collected on June 12 and 27 and July 7, the model predicted that second-generation oviposition would occur from July 19 to July 29. Field scouting was begun on July 19 to verify oviposition predictions and recommended insecticide applications for both experimental plots and bulk fields.

Chemigation and Corn Borer Control: Tests are underway to evaluate the efficacy of standard ground applications and simulated chemigation applications of several insecticides for the control of second-generation European corn borer. Interpretation of test results is complicated by the combined effects of corn borers and spider mites on yield and the differential effect of insecticides on corn borers and spider mites. Numerically, more live corn borer larvae and corn borer-infested tunneling was observed in the reduced-mite check plots than in untreated check plots. However, all corn borer treatments resulted in a significant reduction in stalk tunneling when compared to the reduced-mite check.

Spider Mites: The efficacy of several miticides against the Banks grass mite were tested in trials at the Southwest Research-Extension Center at Garden City. The hot dry weather during the last half of the growing season contributed to a heavy infestation of spider mites. The application of miticides resulted in significant control at six days after treatment. However, none of the miticides resulted in acceptable control at 18 days after treatment.

SOYBEANS

Soybean Cultivar Development: The production of superior soybean germplasm is a long-term cooperative effort among scientists in the Agronomy, Plant Pathology, and Entomology departments. The objective is to produce plants with natural (genetic) resistance to many important soybean insect and disease pests in Kansas and surrounding states. Finding resistance to charcoal rot, currently the most important soybean disease in Kansas, is important. The control potential of crop rotations and other cultural practices is also being studied.

Developing varieties resistant to the soybean cyst nematode (SCN) is a new program. Promising advanced lines have been produced and are being tested in both the field and greenhouse. Researchers are also trying to link SCN control to specific cultural or crop and soil management practices.

A Soybean Cyst Nematode Resistant Variety: A maturity group V line, K81-27-278, which is resistant to race three of soybean cyst nematodes, is being increased for release to certified seed producers in 1992. K81-27-278 is the first maturity group V soybean developed by the Kansas Agricultural Experiment Station. It has exhibited a six percent yield advantage over Essex in Kansas and regional trials. Although the nematode is confined to relatively small areas of the state, field trials have shown that susceptible varieties may be subject to a 30 percent yield reduction. The release of this new line will offer producers considerable protection against the nematode.

Screening for Resistance to Soybean Cyst Nematode: Currently available public and private varieties in maturity groups III to V are being tested in soybean cyst nematode infested and non-infested locations. The objective is to develop cyst resistant populations and experimental varieties and provide for future releases of cyst resistant varieties. This testing is important because in non-infested fields some resistant varieties have lower yield potentials than comparable non-resistant varieties. However, without resistance, yield losses from susceptible varieties in nematode-infected fields are much more severe. The yield reduction is accentuated during periods of drought stress.

Charcoal Rot: In long-term rotational studies, fungus levels were highest when the soybeans were grown in the plot two years prior to the test year. However, it is significant that the amount of fungus in the plant did not increase each year when soybeans were grown continuously at the same location. This observation helps in understanding the beneficial effect of growing soybeans in rotation. The mechanism may be similar to that for diseases in other crops, where the amount of disease increases during the first few years of continuous cropping but then declines. This suggests that a micro-organism in the soil may be acting as a biological control agent. If so, discovery and use of that organism could decrease the incidence of disease.

Phytophthora Root Rot: Recent cooperative releases include soybean varieties Resnik and Flyer. The new releases have been quickly adopted by soybean producers to help protect the Kansas soybean crop from losses from phytophthora root rot.

ALFALFA

Alfalfa Germplasm Development: A long-term program in Agronomy and Entomology has produced superior alfalfa germplasm resistant to most of the important diseases and insects in Kansas and surrounding states. This research has produced resistance to bacterial wilt, anthracnose, spotted alfalfa aphid, pea aphid, potato leaf hopper, summer black stem, and downy mildew, all important plant pests in this area. This valuable germplasm is utilized by private companies to produce superior lines of alfalfa—lines which require minimal use of pesticides.

Developing Resistance to Multiple Pests: Historically, the emphasis in the cooperative USDA-KAES alfalfa breeding project was on the development of multiple pest resistant germplasms. Germplasms with resistance to as many as eight pests have been produced and are highly regarded nationally. Current research is directed at utilizing modern techniques of molecular biology in the alfalfa improvement process. Work also focuses on developing alfalfa lines with glandular hairs covering their surfaces. Glandular hairs provide a measure of resistance to insect pests, and may lead to the first alfalfa lines truly resistant to the destructive alfalfa weevil and potato leafhopper. This germplasm has been shared with both national and international plant breeders.

Plant Improvement Through Cell and Tissue Culture: Cell and tissue culture techniques are being used in yet another alfalfa-improvement program. Those techniques are used to hybridize plants that cannot be hybridized by normal plant breeding methods. Research is directed at producing somatic hybrids which can be used to transfer resistance genes from one plant into another, even plants that are only very distantly related. This is a difficult process, and to date hybrid survivability is still a problem. When the process is better defined, it should be possible to transfer genes for insect and disease resistance into alfalfa from other crops. This should reduce the dependency of alfalfa growers on control measures that are more costly and less environmentally friendly.

CANOLA

Continuing research on reduced-tillage and residue management at the Northwest Research-Extension Center is focusing on increasing soil moisture storage and reducing wind erosion hazards. Current studies involve stand establishment and winter hardiness of canola, an experimental alternative crop. To protect seedlings against abrasion and frost injury, trials also have been initiated to determine the crop protection effects of planting canola in no-till wheat.

TALL FESCUE PASTURES

In southeastern Kansas, tall fescue pasture is a major forage resource. However, cattle that graze endophyte-infected fescue pastures perform poorly, suffer conception declines, and endure other difficulties, particularly in the summer.

Research with Endophyte Infected Fescue Pastures

Management Practices: The Southeast Kansas Branch Station is testing a variety of management practices to reduce the toxic effects of infected pastures. Research trials include feeding grain sorghum during pasture trials, implants and use of copper supplements, and pastures interseeded with ladino clover.

Supplemental Feed: Steers fed ground grain sorghum during the pasture phase had higher backfat and yield grades than steers not receiving supplemental feed. This improved pasture gain without substantially affecting subsequent performance in the feedlot. Grazing steers on tall fescue for longer periods may reduce feed costs and provide for faster daily gain when placed in the feedlot. However, the ending pasture and feedlot weights are not likely to be significantly different because of low rates of summer gain.

Treatments with Copper and Implants: Scientists in Kansas and other states have observed that blood levels of copper decline in cattle grazing tall fescue. In addition, zeranol and certain implants have been shown to have significant benefits in increasing cattle performance. Research trials demonstrate the importance of choosing the proper implant and management regime. Orally dosing steers with boluses of copper oxide needles did not offset the reduction in rate of gain associated with grazing infected fescue.

TURFGRASS

Spring Dead Spot: Spring dead spot is the most damaging disease of Bermudagrass in Kansas. Disease control, using cultural management and fungicide applications, has proved erratic. Developing Bermudagrass hybrids with resistance or tolerance to the disease is likely the most reliable and durable means of control.

Developing Germplasm Resistant to Spring Dead Spot: Trials have been initiated to search for resistant germplasm with Bermudagrass clones inoculated with spring dead spot causing organisms. Although there is a significant difference among clones in susceptibility to the disease, none of the cultivars tested was immune. Many cultivars were also subject to winter kill. The screening trials are being conducted at the Horticulture Research Farm in Wichita.

Identifying Spring Dead Spot Organisms: Differentiating the spring dead spot organism *(Ophiosphaerella herpotricha)* from other fungi associated with diseased Bermudagrass is particularly difficult. Researchers in the Department of Plant Pathology have developed a cloned DNA probe that promises to be a useful identification tool. The DNA probe strongly hybridized with the DNA of 29 isolates of dead spot organisms from four states but not with the DNA of 29 other fungi species nor with the DNA of healthy root species.

Controlling Spring Dead Spot with Fungicides: Evaluation trials were initiated on Bermudagrass plots in Independence in 1991, using experimental fungicides. Results indicate that applications in late August are more effective than later applications.

In trials in Wichita where Bermudagrass plots were inoculated with spring dead spot organisms, treatment with fungicides (Banner and Rubigan) reduced the number of diseased spots and the total area of dead turf.

Zoysia Patch: Zoysia patch disease causes damage on golf course fairways and home lawns in many areas of the state. The disease results in the formation of roughly circular or irregular areas of blighted turfgrass in fall or spring. When the fungus is active, the affected area may have a yellow to orange ring at the margin of the patch. Zoysia patch develops in September as air temperatures cool and zoysiagrass begins the dormancy period.

Controlling Zoysia Patch with Fungicides: Previous research indicates that application of selected fungicides in the spring after zoysia patch was active helped suppress further disease development. Fungicide plots have been established on zoysiagrass fairways at four different golf courses. Results suggest that fall application of fungicides, before disease symptoms have appeared, helps to suppress zoysia patch.

In experimental trials at the Milburn Country Club, zoysia patch symptoms were severe throughout the testing period. All three fungicides (Banner, Rubigan, and Lynx) suppressed formation of new patches and increased recovery of turfgrass in established patches.

Zoysia Patch Causal Organisms: Research has been initiated to determine the causal organism of zoysia patch disease. Suspect organisms are collected, identified, and used to inoculate disease-free turf. Initial trials indicate that the *Rhizoctonia* fungi can cause zoysia patch symptoms in the spring. Research to determine the Rhizoctonia species associated with the disease, and whether this fungus is the primary causal organism, is continuing.

WEED CONTROL

Integrated Systems for Managing Honeyvine Milkweed: Researchers at Manhattan and Harvey County have developed an integrated system for controlling honeyvine milkweed, a serious perennial weed in eastern and central Kansas. The system includes a two-year rotation of wheat and sorghum to prevent a buildup of winter and summer annual weeds, conservation tillage practices to reduce soil erosion, and systemic herbicides that translocate into and destroy a significant portion of the underground rootstock. Economic analysis suggests that selected herbicide treatments return $50 per hectare over a four-year period.

Tolerance in Grain Sorghum to Acetanilide Herbicides: A system has been developed to characterize the tolerance of grain sorghum to acetanilide herbicides and to understand the inheritance of the tolerance trait(s).

Tolerance of the herbicide is dependent on a biochemical reaction in the plant involving glutathione. An enzyme catalyzes the reaction in the plant. Analysis and selection procedures were instituted with metolachlor-pretreated seedlings. Assays demonstrated higher levels of metolachlor in selected metolachlor-tolerant hybrids than in a metolachlor susceptible hybrid. It appears that screening inbreds, and incorporation of the inheritance trait(s) into adapted hybrids, would eliminate many problems now associated with commercial seed treatment to protect grain sorghum against this herbicide for the control of grassy weeds.

Controlling Rhizome Johnson Grass: Johnson grass is a serious perennial weed infesting corn fields in Kansas. Two new herbicides (micosulfuron and primisulfuron) have been evaluated under dryland and irrigated conditions. These herbicides are selective for Johnson grass when broadcast in corn and are critically needed in that crop. Research results indicate that split applications are more effective than single applications. Corn yields in weed-infested fields can be increased up to four times under dryland and two times under irrigated conditions.

Chemical Fallow-Reduced Tillage Studies: Research at the Northwest Research-Extension Center has demonstrated the potential advantages of utilizing a complete no-tillage system of weed control during the fallow portion of a wheat-fallow rotation.

Good weed control during the initial period following wheat harvest can often be easily and effectively achieved through tillage. However, atrazine applied after harvest has proven effective in preventing additional weed emergence during the fall and early spring months. Applications of Glean have also proven effective in controlling broadleaf weeds during the fallow period and presumably could extend the weed-free period beyond that provided by atrazine without damage to wheat stands the following fall.

OTHER CONTROL APPROACHES

Squash Bug: The squash bug is the most serious pest of squash and pumpkins in Kansas and nationwide. Research in Kansas is focused on evaluating the biological control potential of a naturally occurring squash bug parasite. The objectives are to increase basic biological knowledge of the parasite, evaluate the biological impact and cost-benefit potential of field releases, and enhance the use of biological and other control tactics in producing curcurbit vegetables.

Bioremediation of Contaminated Soil: Soils in the mine-spoil areas of southeast Kansas are heavily laden with heavy metals. Plants grow sparsely or not at all, and the non-vegetated soil tends to erode and spread heavy metals into lakes, streams, and groundwater. A project initiated jointly with scientists in Plant Pathology, Chemical Engineering, and Agronomy is directed at the symbiotic effects of mycorrhizal fungi. The research team will determine if mycorrhizal fungi can enable plants to grow in the presence of heavy metals. This would stabilize the soil, minimize groundwater pollution, decrease runoff, and enhance environmental quality.

Soybean Oil Soap Insecticide: Faculty in Biochemistry and Entomology have developed and tested soybean oil soap as an insecticide. Field applications were also made to soybeans and sorghum to determine whether the soap exhibits phytotoxicity in test plants. Four applications spaced three to four days apart showed no injury even in hot weather.

Lack of funding has prevented continuation of greenhouse studies to control greenbugs. Previous studies showed that a soap prepared from raw soybean oil was as effective as a commercially available control treatment.

ARMY CUTWORMS

Experiment Station scientists have evaluated numerous pesticides to determine their effectiveness against army cutworms. The relationship between the number of cutworms and subsequent crop yield was also studied. Those data were supplied to Extension specialists in the spring of 1991 during an army cutworm outbreak. As a result of Extension recommendations, growers treated over a million acres to control army cutworms and prevented a potential loss of $5 million for Kansas wheat farmers. However, based on those same K-State recommendations, another 800,000 acres were not treated. At a cost of $12 per acre, the savings from non-treated acres totaled $9.600.000.

ALTERNATE AND SPECIALTY CROPS

Management Systems for Native Pecans: During years of heavy production, nut-feeding insects are the target of annual insecticide treatments. However, in some years the insects beneficially thin the crop.

Improved crop and pest monitoring techniques being developed at the Pecan Experiment Field will allow growers to predict the damaging or beneficial effects of nut-feeding insects. If insect problems occur, research with the biological insecticide, *Bacillus thuringeiensis*, has shown that growers can manage these pests without disrupting naturally occurring biological control organisms. Adoption of this practice will result in fewer pesticide applications and wider use of environmentally safe pest-control measures.

Predicting Insect Problems for Sunflowers: Sunflowers are proving to be the biggest of Kansas' small crops (sunflower acreage increased by 69 percent in 1991). Sunflower head moth traps were established at 12 locations in eastern and south central Kansas to assist in predicting head moth worm populations and the need for insecticidal treatment. Data from the traps proved to be accurate in predicting where pest problems would occur and whether treatment would be necessary. Kansas is one of the first states to use these inexpensive traps to help growers make decisions on production and insect treatment.

Rapeseed Germination: Rape seed is a small-seeded, oilseed crop with promise as an alternative crop if germination and winter hardiness problems can be overcome. Cross-linked poluacrylamide is a material that can absorb many times its own weight of water. Research to determine if cross-linked polyacrylamide treatments provide an advantage for germinating seeds and seedlings has been initiated at the Northwest Research-Extension Center. Acceptable winter survival was obtained, but timely rains eliminated seed-zone moisture as a limiting factor in first-year results.

YARD WASTE AND PAPER DISPOSAL

A study at the Fort Hays Branch Experiment Station centers on the disposal of yard waste, paper, and cardboard—approximately 60 percent of the waste in landfills. These non-composted materials are incorporated directly into soil with tillage equipment at rates up to 45 tons per acre. Initial results are encouraging. Decay rates can be enhanced by frequent cultivation, thereby reducing the land requirement. Mixing paper with yard waste shows particular promise because the nitrogen in grass clippings enhances the decay rate of the nitrogren-deficient paper. When fully developed, this technology could significantly extend the life of current landfills and reduce the required size of new disposal sites.

CROP PERFORMANCE TESTS

Crop performance tests with wheat, corn, grain sorghum, soybeans, and alfalfa assist producers, seedsmen, and crop consultants in assessing insect and disease resistance and yield. For example, crops grown in performance tests are exposed to numerous insects and diseases during the annual production cycle. Those nurseries provide the opportunity for entomologists and plant pathologists to rate the disease and resistance response of numerous public and private varieties and to report them widely in appropriate publications and public meetings.