Approved February 5, 1991
Date

MINUTES OF THE Senate COMMITTEE ON Agriculture

The meeting was called to order by Senator Don Montgomery at
Chairperson

10:10 a.m./~~p.m.~~ on January 31, 1991 in room 423-S of the Capitol.

All members were present except: Senator Allen (excused)
Senator Harder (excused)

Committee staff present: Raney Gilliland, Legislative Research Department
Lynne Holt, Legislative Research Department
Jill Wolters, Revisor of Statutes Department

Conferees appearing before the committee: Dean Walter R. Woods, Director, Kansas Agricultural Stations, KSU
Dr. Hyde S. Jacobs, Assistant to the Dean of Agriculture, KSU
Dr. Rollin G. Sears, Department of Agronomy, KSU
Dr. Jack G. Riley, Head, Department of Animal Sciences and Industry, KSU
Dr. Fred W. Schwenk, Head, Department of Plant Pathology, KSU

Senator Montgomery, Vice-Chairman, called the Committee to order and called on Dean Woods for reports on the Agricultural Experiment Stations.

Dean Woods explained that information would be presented about research concerning crops and livestock. The Dean gave the Committee copies of the information to be presented and some further information about research at the experiment stations (attachment 1). The Dean introduced the following to explain an area of research.

Dr. Jacobs explained for Dr. George Ham, who could not be present, the way research subjects are chosen and reviewed and highlighted the success of research done with wheat. Dr. Jacobs stated the mission of the experiment stations remains the same, that is, to help farmers in Kansas to be competitive in the world economy.

When asked if any research had been done at Kansas State with the striper header, it was answered that it had been looked at but up till now no research has been done on the striper header.

Dr. Sears discussed wheat research explaining that future research will continue to improve quality and to produce wheat plants that can withstand the heat.

Dr. Riley explained about research on animals working to improve reproduction numbers. Dr. Riley provided samples of a new nutritious snack food that is made at Kansas State with 75% wheat and 25% meat.

Committee comments suggested that research should include working on the problems of shipping fever and pneumonia and on ways of drying meat which could be sold in areas where there is no refrigeration.

Dr. Schwenk explained that biotechnology research is directed toward problems within Kansas. Dr. Schwenk explained that biotechnology is the study of defining genes and then the transferring of genes of a particular kind to such other things as other plants or animals.

During Committee comments, Dr. Woods stated that the experiment stations in Kansas are in a positive position but that monies are needed yearly for new equipment as equipment needs are constantly changing that are needed to keep research on the cutting edge of research for today

and tomorrow. Dr. Woods stated that some private industries contribute well to research but that some do not. Dr. Woods answered that it recently was stated that the place where plant pathology research was going to be would be at Kansas State. Dr. Woods stated that the experiment stations of Kansas are as strong and as effective as any in the country.

Senator Montgomery thanked Dr. Woods and his staff for their presentation and then called on action for Committee minutes.

Senator McClure requested that the third sentence of the third paragraph of the January 30 minutes be changed to read, "Dr. Raub stated that an abandoned railroad right-of-way provides adequate land for a walking trail, a horse riding trail and a bicycle trail" and that on page two of the minutes that in line four the word 'is' be changed to 'are'.

Senator Frahm made a motion the January 30 minutes be approved as corrected; Senator Francisco seconded the motion; motion carried.

The Vice-Chairman adjourned the Committee at 11:02 a.m.

GUEST LIST

COMMITTEE: Senate Agriculture DATE: January 31, 1991

NAME	ADDRESS	ORGANIZATION
Sue Peterson	Manhattan	Kansas State
WALT WOODS	Manhattan,	Kansas State
Hyde Farabee	Manhattan	Kansas State
Rollie SEARS	Manhattan	Kansas State
FRED W. SCHWENK	Manhattan	Kansas State Univ
Jack Riley	Manhattan	KSU
Marshall A. Stelle	Hunter, Ks.	Farmer, Stockman & Banker
Chris Wilson	Topeka	KS Grain & Feed Ass'n

RESEARCH PROGRAMS IN

CROP AND LIVESTOCK

BREEDING & REPRODUCTION

A REPORT

TO THE

KANSAS LEGISLATURE

BY THE

KANSAS AGRICULTURAL EXPERIMENT STATION

KANSAS STATE UNIVERSITY

Senate Agriculture Committee
January 31, 1991
attachment 1

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KSU
KANSAS STATE UNIVERSITY

Director of Agricultural Experiment Station

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

January 31, 1991

To Members of the Kansas Legislature

Dear Friends:

This report focuses attention on scientific advances made through genetic improvement in crops and livestock -- the building blocks for Kansas agriculture.

Plant breeding teams are developing superior varieties for Kansas, and animal scientists are working to enhance reproductive efficiency, growth rate, and rate of gain.

Agricultural advances made through crop and livestock breeding programs are environmentally safe and economically advantageous. New varieties utilize water and soil nutrients more efficiently and often require the use of fewer pesticides. Improved animal seed stock and improved breeding strategies result in animals with higher birth and survival rates, feed conversion ratios, and leanness.

This report also chronicles the release of varieties resistant to insect and disease pests and the development of superior breeding techniques and advances in reproductive efficiency.

We invite comment about these or any Agricultural Experiment Station research program. We want to provide research support and factual information that will keep Kansas farmers and ranchers competitive in regional, national, and global markets.

Sincerely,

Walter R. Woods
Director

EXECUTIVE SUMMARY

1

Focus: This report features research programs that benefit farmers, ranchers and the state's economy through the development of superior germ plasm and varieties with improved nutritional quality, yield, and insect and disease resistance; and animal seed stock which enhances rate of gain, feed efficiency, and weaning weight. Ultimately, consumers are the most important beneficiary.

Crop Breeding and Related Research

Wheat: K-State's wheat breeding team is a national leader in the development of germ plasm and varieties with enhanced pest resistance, bread making and milling quality, and yield. Noteworthy developments include germ plasm and variety releases resistant to soil borne mosaic virus, Russian wheat aphid, Hessian fly, and other major pests. The variety Karl, a 1989 release, was tops in both yield and protein content in statewide tests in both Kansas and Oklahoma in 1990. K-State's leadership in hard white wheat development has led to commercialization of this new class of wheat. Pioneer Hi-Bred International gifted its entire wheat program to K-State.

Wheat Genetics Resource Center (WGRC): The largest collection of wheat's wild relatives in the United States is located at K-State. Using this collection, germ plasm resistant to leaf rust, soil-borne mosaic virus, Hessian fly, and greenbug has been developed. WGRC scientists have also constructed the first working map of the wheat genome. Scientists from six countries studied in the WGRC during 1990.

Grain Sorghum: K-State researchers cooperated in the release of 36 germ plasm bulks, two new sources of chinch bug resistance, and in developing a technique to screen sorghum for improved livestock feeding value. Chinch bug resistant hybrids from KSU germ plasm releases could reasonably be expected to outyield nonresistant hybrids by 5 bushels per acre.

Alfalfa: Pests for which resistance has been developed include bacterial wilt, anthracnose, spotted alfalfa aphid, pea aphid, potato leaf hopper, summer black stem, and downy mildew.

Corn: Breeders are developing drought resistant lines with hard endosperm to reduce handling and processing losses. Computer models have been developed to assess the economic impact of insecticides in controlling European and southwestern cornborer. Iowa and Nebraska are adapting the models for their use.

Soybeans: Foundation seed is available for a new release with a six percent yield advantage over Sparks and Spencer varieties. The soybean cyst nematode has been detected in Kansas and crop rotation has been demonstrated to be an effective management tool.

Pearl Millet and Sunflowers: In 1989, 11 advanced millet hybrids yielded from 4 to 76 percent more grain than the sorghum check on sandy soils. Yield advantages on silt loam and clay soils were not as promising. However, disease and insect problems on pearl millet have been minor, which enhances its value as an alternate crop.

Kansas has gained a significant share of the U.S. sunflower market because of research developments and the quality of its confectionery sunflowers. Kansas ranks third in sunflower production nationally.

Horticulture: A new, improved bush type crenshaw melon suitable for home gardens as well as high density commercial plantings has been developed in Kansas. Genetic variability in grapes to damage from 2,4-D herbicides has also been identified.

Forestry: A tree improvement program has been developed to complement State and Extension Forestry's Conservation Tree Planting Program.

Related Research: Production and management systems that enhance the effectiveness of genetic advances include biological control, crop rotations, and crop, soil, and weed management systems.

Livestock Breeding and Related Research

Beef

Reproductive Performance: Reproductive performance in Kansas' 1.5 million cow/calf enterprise is critical, because the failure rate is about 15 percent. To address this problem, an integrated reproductive management system has been developed to analyze production practice, identify reproductive inefficiencies, and perform cost accounting procedures.

Increasing the number of cows that conceive during the breeding season is an effective way to increase calving rate and profitability. Another is the induction and detection of puberty in heifers. K-State researchers have demonstrated that treatment with prostaglandin (PGF) can increase pregnancy rates. Similarly, treatment with melengestrol-acetate (MGA) is effective in inducing puberty in heifers.

Breeding Stock Selection: Standard bull tests provide a uniform post-weaning environment under which superior bulls can be identified. K-State also cooperates in one of the largest, most comprehensive cattle germ plasm evaluations. Data from those tests greatly facilitate the selection of superior breeding stock, incorporation of economically important traits, and development of leaner genotypes as dictated by consumer preference.

Diet and Reproduction: K-State research has shown that dietary energy is an important factor in reproductive efficiency. Low levels of dietary energy reduce birth weight, milk production, and delay return to cyclicity. Alternately, adding lipids to the diet enhances the return to cyclicity.

Ultrasound Technology: This technology can be used to (1) monitor marbling development and (2) predict carcass merit in live animals. Producers can use such information to facilitate the use of breeding and production strategies to predict an optimal market date and production strategy for each animal.

BEEFpro: This computer based management program is a tool for producers to track the economic consequences of management decisions and helps in developing a thorough cost/return analysis. Although operating and fixed costs are major determinants of profitability, reproductive rate (calves weaned per cow exposed) is the most important factor.

Swine

Litter Size: Research suggests that it may be possible to improve litter size by feeding riboflavin to gilts.

Starter Diets: Because soy protein may not be completely compatible, milk is often added to the diet of newly weaned pigs. Research trials show that dried porcine plasma has an equal, if not better, feeding value than dried milk. In other trials, utilization of soy products by weanling pigs improved as the processing techniques became more elaborate.

Sheep

Most ewe flocks are bred for fall lambs, and lambing percentages approximate 110-115 percent. Research shows that multiple births are consistently higher for crossbred ewes—66 percent for Finn cross ewes, 54 percent for Booroola cross ewes, and 23 percent for straight Rambouillet ewes. Management techniques have been developed that virtually eliminate seasonal variations in breeding, so lambs can be marketed when economically most advantageous.

Dairy

Reproduction Efficiency: Research trials demonstrate the effectiveness of treatment with prostaglandin in dairy herds where cows have not been inseminated because of missed heats (about 10 percent of the herd) or not pregnant (about 30 percent of the herd). It has also been shown that pregnancy rates at repeat services will be increased by treatment with gonadotropin (GnRH).

Stimulating Milk Production: Supplies of somatotropin (rBST), a hormone which stimulates milk production, are now available for large-scale use. K-State researchers are actively addressing the use of rBST, because its use demands an in-depth understanding of its metabolic and hormonal effects.

Veterinary Medicine: Veterinary services for small ruminants include pregnancy diagnosis, breeding soundness, insemination, health care, and the testing of promising pharmaceuticals.

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OVERVIEW

Walter R. Woods
Director, Kansas Agricultural Experiment Station

Agriculture is big business in Kansas—a $6.6 billion dollar business—with the value of production evenly split between crops and livestock. Feed grains and forages, however, are fed and marketed through cattle, so livestock sales account for over two-thirds of agriculture's cash receipts.

The Kansas Agricultural Experiment Station's mandate includes research support for the crop and livestock industry and for all farmers and ranchers.

Fulfilling the Need

K-State plant breeders are charged with genetic improvement of the state's important or potentially important crops (wheat, grain sorghum, corn, soybeans, alfalfa, melons, dry beans, sunflowers, and pearl millet). Animal scientists focus attention on reproductive performance, genetic improvement, and breeding stock selection.

Those efforts pay big dividends in (1) variety releases with enhanced insect and disease resistance, superior nutritional value, higher yields, and (2) farm animals with high birth rates, excellent survival, and improved rates of gain.

Research Highlights

Many research accomplishments are summarized in this report. Following are highlights of just a few:

1. **Release of Karl Wheat:** Karl, a 1989 release, is a high protein wheat that topped 1990 performance tests in both Kansas and Oklahoma. It is expected that Karl will occupy 8 percent of the Kansas acreage in 1991 and boost income $4 million to $6 million. Because of its high protein content, Karl can be used by Kansas mills, instead of spring wheats from other states, to improve flour protein and mixing strength.

2. **Wheat Genetics Resource Center (WGRC):** The WGRC is one of K-State's windows into biotechnology. WGRC scientists are transferring host plant resistance from wheat's wild relatives to domestic varieties, and they are making strides in providing a genome map for wheat. Using a genome map and molecular markers, improved varieties can be developed much more efficiently.

3. **Reproductive Efficiency:** The 1990 Agway Inc. Young Scientist Award presented to Dr. Jeffery S. Stevenson at the American Dairy Science Association is indicative of the quality of K-State's research in reproductive efficiency. That work focuses on improved breeding protocols effective use of hormones and their efficacy in dairy cows and young heifers.

A beef cow is an economic liability unless she produces a calf each year. Reproductive efficiency in cow/calf operations requires a high conception rate in both heifers and cows. Animal scientists have

demonstrated the effectiveness of hormone treatments in inducing puberty and conception in heifers and in improving the conception rate of mature cows.

Today's presentations will also highlight:

- Experiment Station Priorities
- Wheat Genetics
- Livestock Reproductivity
- Biotechnology

EXPERIMENT STATION PRIORITIES

George E. Ham
Associate Director, Kansas Agricultural Experiment Station

Economic development and quality of life in Kansas have been improved immensely by the research programs of the Kansas Agricultural Experiment Station (KAES). The KAES is a research program that includes 28 departments in five colleges, four branch stations/research extension centers, and 11 experiment fields. Farming and ranching have been enhanced with crop varieties and germ plasm released from KAES. Range and livestock production research continues today and adds greatly to the Kansas economy. The goals and mission of KAES have not changed appreciably in the long tradition of serving the state. The KAES research program has changed over time, but it remains dedicated to the proposition of solving practical problems facing Kansas agriculture. Research is a cumulative process. One finding suggests a certain path of inquiry which leads over time to additional conclusions. The knowledge base lays the groundwork for continued progress in crop and livestock production on a sustained basis. Research makes it possible to grow the crops and livestock that make Kansas an agricultural leader.

Determining Research Priorities

Research priorities are determined with input from several sources. Allocating limited resources will continue to be important in order to find ways to advance agriculture even more. KAES research programs are project oriented, and selection is based on the following inputs:

1. Individual Scientist
2. Citizen Input
3. Advisory Committees
4. Funding Source
5. Regional Research Committees
6. National Research Initiatives
   a) Protecting Water Quality
   b) Safe and Effective Management of Pests

c) Compatibility of Agriculture, Natural Resources, and Environment
d) Ensure the Safety and Stability of Consumer Foods
e) Plant Genome Mapping and Genetic Enhancement

7. Professional Societies
8. Planning/Priority Setting
   a) Department CSRS Reviews every 5-7 years.
   b) Board of Regent Reviews every 10 years.
   c) KAES Project Peer Review every 3 years.
9. Legislative Input.

Research Criteria

Criteria used to determine agricultural research priorities include:

1. Relevance to Kansas Agriculture
2. Urgency of Research
3. Department, KAES, and National Goals
4. Contribution to Knowledge
5. Social and Economic Impact
6. Benefit-Cost Relationship
7. Available Scientific Expertise
8. Non-Availability Elsewhere
9. Probability of Adoption of Results

Department and branch station heads are key in leading faculty in program priority setting and management in the KAES. Planning is a continual process in the various components of the KAES in order to improve program quality and appropriateness. Approximately $2,600,000 in KAES funds were reallocated to new research areas during the last five years. Program areas included: water quality, value added processing, water use efficiency, and weed ecology/biology.

Margin of Excellence

Four high priority agricultural research program areas that received new funding during the first two years of the Margin of Excellence program include the following:

1. Processing of Kansas Agricultural Products
2. Forage-Based Livestock Systems
3. Dryland Cropping Systems
4. Wheat Biogenetics

Maintaining Flexibility

Research programs must be flexible so that scientists and administrators can respond quickly and efficiently when unexpected problems or new needs arise. Recently, research programs were intensified, through a series of in-house grants, in the areas of water quality, sustainable agriculture, processing and alternate uses of agricultural products, and rural family and community well-being.

Because agriculture is so important in the state's economy, it is a great opportunity to serve Kansas agriculture as a partner in solving problems and providing research support and helping to keep Kansas farmers and ranchers competitive in a global economy.

WHEAT IMPROVEMENT

Rollin G. Sears
Wheat Breeder, Department of Agronomy

Plant breeding is one of the most environmentally sound practices conducted by the Kansas Agricultural Experiment Station (KAES). New varieties utilize water and fertilizer more efficiently, require fewer fungicides and insecticides and generally represent an improvement in end-use quality. Wheat yields have steadily improved in Kansas at an estimated rate of 3/4 bushel/acre per year since 1957. This is an average; in general, the heavier the disease pressure, the better the performance of new varieties relative to the old ones. Bread baking quality has improved for every significant measurable trait, starting with the variety 'Turkey Red' and ending with the newest KAES release, 'Karl'. Disease and insect resistance has also steadily improved. Karl has resistance or tolerance to 9 of the 11 important diseases affecting wheat in Kansas. By planting new improved varieties, farmers make a one-time investment; the requirement to apply a fungicide or insecticide is eliminated or reduced by the natural resistance provided by the new variety. Dependable and reliable yields are more important than record crops in an environment as diverse and unpredictable as Kansas. Providing as much natural protection against both abiotic and biotic stresses is one of the most important goals of the KAES wheat improvement program.

Genetic Resources

Future improvements in wheat depend on continued identification of new genes. Plant breeders must have genetic variability to select superior individuals. As new varieties are released that are resistant to an array of Kansas pests, it is only a matter of time before new forms of the disease or insect emerge to attack the new variety. Pests have co-evolved with wheat for over 10,000 years. Varieties resistant to leaf rust have had an "average resistance life" span of approximately 5 years before new races of rust have developed to render the variety susceptible. Diseases and insects, in combination, routinely reduce yields some 15-20 percent each year in Kansas. Eliminating that loss entirely would be extremely difficult; it is more practical to minimize the loss by developing new sources of resistance to keep ahead of pests and diversify protection. In the past year, the Wheat Genetics Resource Center (WGRC) has released 7 new germ plasm lines with new genes for Hessian Fly, leaf rust, powdery mildew, tan spot, soil-borne mosaic, spindle streak mosaic, stress tolerance, and increased protein content. Additionally, over 30 scientific articles have been published describing the techniques used to create this valuable germ plasm. The WGRC is both a world leader in the develop-

ment of wheat germ plasm and an advocate for the free exchange and sharing of that germ plasm.

Pioneer Wheat Program

This past year Pioneer Hi-Bred International Inc. elected to close its hard wheat breeding program located in Hutchinson, Kansas, for the past 25 years. Pioneer generously donated its unique and very valuable germ plasm to K-State. This gift strengthened the KAES programs. Additionally, researchers have worked hard to make sure this germ plasm was equally shared with all wheat breeding programs (public or private) in the Great Plains. Replacing a wheat breeding program is almost impossible, and loss of the Pioneer program could have been very costly. Each program develops wheats that have unique strengths for Kansas farmers. Pioneer wheats have excellent straw strength, Agripro's varieties have excellent test weight, and the KAES varieties all have increased protein content. One large breeding program, even if it had the total resources of all the programs, could not produce the diversity or uniqueness of varieties released by numerous breeding programs.

Future Developments

Future goals of the wheat improvement program are focused on stability of production, improved disease resistance, and improved milling and baking quality. Weather fluctuations are frequent and expected by Kansans. We are continuing to emphasize better heat tolerance in variety development. Likewise, in efforts to reduce soil and water erosion, minimum or no-till management will be utilized by wheat farmers. In some cases this type of management will be mandated by the farm bill. Wheat varieties with better resistance to diseases will have to be available for farmers to plant. Leaving residue on the surface of the soil reduces soil and water erosion, but at the same time it increases the frequency of diseases and insects that attack wheat.

Milling and baking quality has traditionally been and continues to be a major goal in the wheat research program. Wheat produced in Kansas has to be desired by both domestic and international buyers.

Wheat varieties in the future will look much the same as their predecessors of previous years. They will be different in their improved ability to tolerate and produce well under stress. They will have better disease and insect tolerance. They will have increased milling and baking quality. A new wheat variety released by the KAES is a composite example of many different research accomplishments: plump seed, disease resistance, drought tolerance, and bread quality, to name a few. Each scientist and program at KSU works together to collectively make sure new varieties contain all the correct traits.

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LIVESTOCK REPRODUCTIVITY

Jack G. Riley
Head, Department of Animal Sciences and Industry

The animal reproduction group in the Department of Animal Sciences and Industry is a leader in developing estrus synchronization compounds and demonstrating factors affecting effective use of those compounds. Basic data collected on initiation of cycling in postpartum beef cows have provided an essential link in developing a management program to ensure cyclicity early in the breeding period.

Integrated Reproductive Management

Using data generated at KSU and elsewhere, an integrated reproductive management program for beef cattle has been developed. This program is an economic, decision-making, software computer program designed to do cost accounting and production efficiency calculations. Surveys are made for individual producers that identify areas of reproductive inefficiency for which management changes are recommended. The surveys also identify areas for which additional research is needed.

Reproduction Efficiency

Several production recommendations have evolved from basic research. For example, it is possible that Kansas dairy producers could realize more than $632,000 (based on 43,000 cows in the DHI-testing program) in potential gross income if they would incorporate the practice of utilizing the veterinary prescription hormone prostaglandin $F_{2\alpha}$. When cows are presented to the veterinary practitioner at a routine herd health visit, those cows not yet inseminated because of missed heats (about 10 percent of the herd), or those found open or 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. The Department's research demonstrated that conception will occur 21 days or 14 days earlier than in untreated controls for the two groups of cows. This results in a savings of $21 per cow for the former and $42 per cow for the latter group of problem cows. To maximize the potential economic advantage of this management tool, cows must be inseminated according to signs of estrus, or inseminated at 72 and 96 hours after the injection of prostaglandin $F_{2\alpha}$.

Pregnancy

Researchers have demonstrated that pregnancy rates of dairy cows at repeat services (third services) will increase by 10 percent if the cows are given the veterinary prescription hormone, gonadotropin-releasing hormone (GnRH), at the time of the third insemination. These so-called repeat-breeders are found in all herds, representing about 25 percent of all cows. With an increase in pregnancy rates of such cows, about 10 percent more cows would be salvaged annually, because these cows would subsequently calve and remain in the herd for an additional lactation. This would result in an additional $750 per cow beyond the salvage value of the cow and the extra milk she would produce in her next lactation.

In total, for 43,000 cows enrolled in the DHI-testing program in Kansas, this would potentially increase gross income of dairy producers by over $806,000 annually.

Sheep

Because of the seasonal nature of reproduction in sheep, most spring-born lambs are marketed at a time when annual prices are at their lowest level. Our work with ram-exposure of anestrous ewes has shown that seasonal variations can virtually be eliminated with this management technique. This allows Kansas sheep producers a management option that could result in lambs being marketed at more economically advantageous times of the year.

Embryo Survival

Approximately 20 percent of pig embryos die during the second week of pregnancy. Work at KSU has identified secretion of several hormones during the critical period and the ways these hormones affect embryo survival is being studied. If embryo survival were increased 15 percent, the U.S. sow herd could be reduced by about one million sows for an annual savings of approximately $154 million.

BIOTECHNOLOGY

Fred W. Schwenk
Head, Department of Plant Pathology

The term biotechnology covers a variety of activities. It is most commonly used for work with recombinant DNA. This involves identifying genes for specific functions and then transferring and/or rearranging genes within or among organisms (plants, animals, bacteria, fungi, etc.) that may or may not be related.

Biotechnology can also include tissue culture and organism regeneration, gene cloning, molecular genetics, and gene regulation.

The KAES supports biotechnology research in several areas. Most projects are interdisciplinary, involve more than one department or college, and represent a basic research thrust. Selected examples of biotechnology research in the Experiment Station follow:

Plants

Wheat Regeneration and Transformation: Current research includes efforts to regenerate plants from wheat protoplasts and to develop procedures to transform wheat plants. The ultimate goal is to transfer agronomically useful genes to wheat cultivars through genetic engineering. Transfer of genes that impart resistance to insect and disease pests is a primary focus.

Wheat Genome Mapping; DNA Fingerprinting: The first genetic map of wheat is being constructed. Specific locations of several hundred genes have been identified on wheat chromosomes. The ability to pinpoint a specific gene location with a specific plant characteristic, by DNA

fingerprinting, will vastly improve plant development techniques. New varieties, with specific characteristics, can then be developed much quicker.

Plant Regeneration: Alfalfa is being regenerated from tissue culture, both from very small plant parts and from protoplasts (individual plant cells from which the cell wall has been removed). Related studies include transforming alfalfa (i.e., introducing new genes by genetic engineering) by incorporating agriculturally useful genes that impart pest resistance or other useful characteristics.

Animals

Animal Gene Mapping: Maps locating specific genes on animal chromosomes are being developed. These can be used to develop DNA fingerprinting systems to quickly and accurately locate genes for heritable diseases in domestic animals.

Recombinant Porcine Somatotropin effects on growth performance and carcass characteristics of finishing swine are being investigated. This includes examining the effects of porcine somatotropin on nutrient requirements of swine as well as its effects on pork quality.

Insects

DNA Fingerprinting: DNA probes are being developed to monitor levels of parasitism of greenbug on sorghum. This should reduce pesticide use. DNA probes can be used to show exactly which species of parasites are causing the parasitization, and they will do it more rapidly and with less expense than current methods.

BT Toxins: BT toxins are proteins which are produced by a bacterium and which have insecticidal properties. They are considered environmentally safe. These toxins can be applied directly to plants, or genes for producing these toxins can be transferred directly into plants. To prevent the buildup of resistant insect populations, genes which impart insect resistance to this toxin are being identified through molecular genetic techniques.

Diseases

Plant Virus Resistance: Mutants have been developed to determine why some plants are resistant to viruses. Symptom development can be traced to specific locations in the virus. Agropyron, a wheat relative that is resistant to wheat streak mosaic virus, is being used to understand how to develop wheat varieties that also are resistant to this disease.

Monoclonal Antibodies to Cattle Diseases: Monoclonal antibodies have been prepared to bovine herpesvirus-1 (BHV-1) and bovine virus diarrhea (BVD), two viruses which cause diseases of major economic significance in cattle. These antibodies are being used as diagnostic reagents by many laboratories throughout the United States.

Nitrogen Fixation Improvement: Strains of fast-growing rhizobia have been isolated that will nodulate soybeans and are adapted to Kansas soils. The nitrogenase genes are being characterized and will be transferred to other rhizobial strains to enhance their efficiency.

Gene Cloning for Disease Resistance Development: Genes for toxins from greenbugs will be cloned to produce usable quantities of the enzyme to screen new sorghum lines for resistance to greenbug. This will increase the speed and accuracy of developing resistant sorghum lines, and is expected to reduce the pressure associated with the appearance of new greenbug biotypes.

Human

Protein Structure and Function: A highly specific protein inhibitor of the activated Hageman factor, a serine proteinase involved in blood coagulation, has been isolated from pumpkin seeds. The knowledge gained may be useful in designing and producing drugs of non-blood origin to treat blood and cardiovascular diseases.

A cDNA clone that encodes a corn inhibitor of high selectivity to human activated Hageman factor (Factor XIIa) has also been isolated. The gene has been transferred to yeast and the inhibitor expressed. Mutants of the inhibitor will be studied to determine their interactions with the clotting factor.

CROP RESEARCH GOALS

For over 100 years the Kansas Agricultural Experiment Station has benefitted the citizens of the state by providing the research base for a progressive agricultural industry. Agricultural research in general and research in crop and livestock reproductivity in particular have contributed significantly to agricultural advances and the state's economy. Farmers and ranchers benefit directly from crop germ plasm with improved yield, insect and disease resistance, and nutritional quality; and from animal seed stock that impacts enhanced rate of gain, feed efficiency, and weaning weight. Consumers, ultimately, are the most important beneficiaries.

This report focuses on research programs and developments enhancing crop and livestock reproductivity in Kansas.

Crops in Kansas: Field crops are big business in Kansas. In 1988-89, crops (wheat, sorghum, corn, soybeans, and hay) accounted for 50 percent, livestock (cattle and swine) accounted for 45 percent, and miscellaneous enterprises provided 5 percent of the value of production for Kansas agriculture. Kansas ranks first nationally in the production of wheat and sorghum for grain and silage. Other important crops are hay, alfalfa, corn, and soybeans. Crops provide 35 percent of agriculture's cash receipts and 25 percent of the jobs in the state's food production system. Crop production supports many agribusinesses, including the important livestock, meat packing, flour milling, and other industries.

Plant Breeding Programs: K-State plant breeders work to improve the state's important crops, including wheat, grain sorghum, corn, soybeans, alfalfa, melons, and dry beans. Each plant breeding program emphasizes improved product quality, nutritive value, and pest resistance. In addition, numerous plant breeding efforts involve increasing the nutritional value and digestibility as well as improving the processing

of soybeans and feed grains for animals. Plant breeding programs also increase the adaptability, reliability, and profitability of such alternate crops as pearl millet and sunflowers.

RESEARCH THRUSTS IN CROP BREEDING AND RELATED AREAS

Wheat

Wheat Breeding Team: Kansas, the number one wheat state, produces 18 percent of the nation's wheat. K-State's wheat breeding team is nationally recognized for developing germ plasm and varieties with enhanced disease and insect resistance, breadmaking and milling quality, and yield. The group works closely with scientists from other state, federal, and private laboratories.

Karl: The variety Karl was released in 1989. In 1990, Karl was not only the highest yielding variety in statewide tests in both Kansas and Oklahoma, it was also the highest in overall grain protein content. This is the first time that a variety has been tops in both yield and protein content. Because of its performance on the farm and in the milling industry, Karl could add an additional $4 million to $6 million dollars to the state's economy each year for the next several years.

Other Germ Plasm: Development of a wheat-rye translocation with resistance to Hessian fly in wheat is the first example of such a genetic source.

Pioneer Gift: K-State's position having the leading publicly supported hard red winter wheat breeding program was greatly enhanced by Pioneer's gift to K-State of its entire wheat program. Included were 130,000 hard red winter wheat breeding lines and the varieties 2157, 2158, 2163, 2172, and 2180.

Soil-Borne Mosaic Virus: From 1976 to 1978, soil-borne mosaic virus (SBMV) was the most destructive wheat disease in Kansas. Losses during those years averaged over $39 million annually. Resistant varieties are the only method of control and, beginning with Newton, the last 6 varieties developed and released by the KAES are all resistant to SBMV. During the last three years, losses to SBMV have fallen to less than $7 million annually.

Wheat Streak Mosaic Virus (WSMV): Losses to wheat streak mosaic virus for the years 1986 to 1989 averaged 5.4 percent and equate to an average loss of $42 million dollars. Screening procedures and techniques to identify or develop resistant germ plasm are important research objectives.

High Protein Varieties: The demand for high grain protein is increasing in domestic and foreign markets. The last four wheat varieties developed by the KAES have had the genetic potential to produce grain with protein levels of 1 to 2 percent higher than the most popular varieties being grown at the time.

Hard White Wheat: K-State's leadership in demonstrating the feasibility of producing hard white winter wheat has led to commercialization of this new class of wheat. Wheat growers have formed a trade

group to market hard white wheat, a miller is selling Kansas white wheat flour on the national market, and a grocery chain is promoting bread baked from white wheat flour, and additional markets for baked goods are being developed.

Five sprouting-resistant germ plasm lines have been released to plant breeders. The new releases have excellent sprouting resistance, good plant type, large kernels, and high grain protein. In addition, five hard white wheat selections are being evaluated in advanced yield trials.

Research is under way on the use of hard white wheats to produce Middle Eastern breads, ready-to-eat cereals, oriental noodles, and other pasta products. Storage and stability tests are being performed, particularly for ready-to-eat cereals.

Stable Forms of Vitamin C: Developing stable forms of vitamin C has been a continuing research thrust. Stable vitamin C has great potential in milk replacers, in starter feeds, and in drinking water. It has also proven stable for use in extrusion cooking and other feed processing methods. The value of stable vitamin C in aquaculture feeds is estimated to be $3.5 million to $4 million annually.

Russian Wheat Aphid: The Russian wheat aphid, first discovered in the United States in 1986, now infests 17 western states, including Kansas. Damage estimates exceed $200 million annually. At the Ft. Hays Branch Agricultural Experiment Station, more than 10,000 wheat accessions have been screened. Over 50 lines with some resistance to Russian wheat aphid have been identified. The most resistant lines are now being backcrossed into the best available varieties and breeding lines.

High Temperature Stress: High temperature stress during wheat grain filling is a primary factor limiting yields in Kansas. This injury has been traced to a specific protein, and a technique for rapid screening of genotypes resistant to high temperature has been developed.

Early Senescence: Rapid senescence of wheat, a characteristic related to high temperature stress, has been found to be preventable by cooling the plant roots. Potentially, overcoming these stresses with resistant varieties could increase yields by 10 percent or more, worth $80 million annually in Kansas.

Fungicides and Foliar Diseases: Management practices using fungicides for controlling foliar diseases offer much promise in assuring crop reproductivity if timed correctly. In 1989 at The Colby Research-Extension Center, average yields of six winter wheat varieties were increased 25 percent by the use of fungicides. In 1990, however, foliar diseases were negligible and the effects of fungicide applications were insignificant regardless of variety.

At the Harvey County Experiment Field, fungicide treatments significantly increased yields of Newton in 1988, 1989, and 1990. Fungicides effectively increased the yield of Karl only in 1990.

Large-Scale Milling and Baking Tests: The purpose of this wheat improvement program is to ensure development of varieties with improved milling, baking, and end use properties. Varieties with improved milling and baking quality include Arkan, Norkan, Dodge, and Karl. Karl has flour yields 2 to 3 percent higher and protein levels 1.5 to 2.0 percent

higher than varieties like Newton and Tam 107. This will make Kansas wheats much more competitive in markets requiring high protein flours.

Wheat Genetics Resource Center

Wild Wheats: The largest collection of wheat's wild relatives in the United States is housed in the KSU Wheat Genetics Resource Center (WGRC). Wild wheats provide important sources of disease and pest resistance as well as genetic diversity. The center collects, maintains, and evaluates genes in wheat and wheat relatives. The task of domesticating and transferring these genes to useful germ plasm for use by plant breeders is a major WGRC responsibility.

Host Plant Resistance: Goatgrass, a grassy plant related to bread wheat, carries genes resistant to important insects and diseases in wheat. By crossbreeding with wheat, WGRC scientists have developed germ plasm resistant to leaf rust, soil-borne mosaic virus, Hessian fly, and greenbug. This new germ plasm will provide potentially inexpensive and environmentally safe control of these diseases in the high yielding wheat varieties of tomorrow.

Visiting Scientists: Numerous scientists from other states and countries work in the WGRC laboratory and learn gene transfer and chromosome identification techniques. The international scientists are competent scholars who commonly come for 6-12 months, usually with all or part of their salary paid by their own government. Visiting scientists work on WGRC projects, develop new knowledge and skills, and leave behind a wealth of research data. This past year, international scientists came from Russia, Germany, Japan, China, Poland, and India.

Wheat Genetics Road Map: Using molecular markers consisting of wheat DNA fragments cloned in bacteria, WGRC scientists have constructed the first working map of the wheat genome. By identifying the precise location of specific genes, it becomes possible to more quickly and accurately develop better wheat varieties. The DNA road map for wheat is 18-billion-base pairs long, and WGRC scientists have identified 180 molecular markers along the map. With these markers, scientists can begin to scan the gene inventory of the wheat plant, decode agronomic genes, and provide unprecedented opportunity for manipulating the wheat plant for human use.

By comparison, the equivalent road map for humans is slightly smaller (15-billion-base-pairs), and 300 molecular markers have been identified. Many laboratories are involved in the human genome mapping initiative, with a budget to date of $4 billion. By contrast, the success in the wheat genome mapping project has occurred in WGRC laboratories at a cost of $250,000.

Grain Sorghum

KSU Sorghum breeding efforts centered at Manhattan and Hays provide plant breeding support to a 3.4 million acre, $480 million industry. Cooperating disciplines include agronomy, entomology, plant pathology, grain science, and animal science. KS 30, the first biotype C greenbug resistant line, was developed at Hays. However, with the advent of new greenbug biotypes, new sources of greenbug resistance are being sought.

Interdisciplinary Efforts: Scientists in the departments of agronomy, entomology, animal sciences, grain science, and at Fort Hays have cooperated in the release of 36 germ plasm bulks, two new sources of chinch bug resistance, and the development of a technique to screen sorghum for improved livestock feeding value. Research to increase the effectiveness of foliar and soil insecticide used on greenbug and chinch bug is a continuing research objective.

Chinch Bug Resistant Germ Plasm: The chinch bug is an important grain sorghum pest in eastern Kansas. Germ plasm releases KS 94 and KS 95 carry chinch bug resistance and were jointly released to commercial sorghum hybrid seed producers by the Kansas and Nebraska experiment stations. The releases were based on work in Kansas. Chinch bug resistant hybrids could reasonably be expected to outyield nonresistant hybrids by 5 bu/a. If grown on 1,000,000 infested acres, the return to Kansas farmers would total $15 million. Two additional sources of resistance have also been identified.

Greenbug: In 1990, about 7 to 10 million bushels of sorghum were lost to greenbug infestations and, coupled with the cost of chemical control, cost Kansas producers an estimated $21 to $27 million. A K-State objective is to discover new sources of greenbug resistance. So far, over 22,000 accessions from several collections have been screened. Three potential new sources of resistance have been found and one new source of resistance was released by the KAES this year.

Maize Dwarf Mosaic Virus (MDMV): MDMV, the most serious viral pathogen in sorghum, is transmitted by the greenbug. We estimate that 3 to 5 million bushels of sorghum are lost to this disease annually because susceptible plants, even greenbug resistant plants, may be killed by MDMV. The development of MDMV resistant germ plasm continues to be an important research objective.

Diversification: In current sorghum hybrids, all female parents are derived from the same cytoplasm. This uniformity increases the risk that an insect or disease pest could devastate the entire sorghum crop like Southern corn leaf blight ravaged the corn crop in the early 1970s. KSU scientists are investigating the use of alternative sources of sterile cytoplasm. Each alternative source has unique problems which must be overcome before they are readily usable in developing commercial hybrids.

Forage Sorghum: Genetic improvement of quality traits are important to those who produce or feed forage sorghum. Increasing the rate of gain and decreasing the amount of forage necessary to maintain good health are important research objectives. Traits currently under investigation include such grain characteristics as waxy endosperm, yellow endosperm, large seed size, and plant factors such as brown midrib, bloomless, and juicy stalks.

Alfalfa

The development of alfalfa varieties that are winter hardy and resistant to a variety of insect and disease pests is a major research thrust. Pests for which resistances have been developed include bacterial wilt, anthracnose, spotted alfalfa aphid, pea aphid, potato leaf hopper, summer black stem, and downy mildew.

Blister Beetles: Blister beetles contain a toxin, cantharidin, that can be fatal to horses. Blister beetle infested hay from Kansas has killed horses valued at over $1,000,000 and devastated a valuable interstate market. Researchers have identified 7 species of beetle in Kansas, each with its own seasonal abundance, tendency to cluster, and contribution to risk. In highly infested fields, high-risk harvest practices can trap upwards of 70 beetles in a single flake of hay. The least-risk harvest resulted from using a self-propelled swather without conditioning rollers and equipped with wide-set wheels that straddle the hay.

Corn

The K-State white corn breeding project is developing drought-tolerant lines and germ plasm with hard endosperm to reduce handling and processing losses.

Soil Insecticides: Recommendations for using insecticides on insects that attack corn are based on research conducted by the KAES. Corn rootworm control is the primary insect of concern in Kansas. Others include the black cutworm, wireworm, and white grubs.

Integrated Pest Management: Losses to Kansas corn producers caused by European corn borers average $10 million annually. K-State has developed and validated computer models that reduce required scouting efforts for European and southwestern corn borers. They also can be used to evaluate the economic advisability of pesticide applications. Avoiding unnecessary treatments results in savings approaching $14 per acre, but timely treatments also can avoid preventable losses of up to $20 per acre. Nebraska and Iowa have requested permission to adopt the Kansas model for their use.

Soybeans

Fluctuations in seasonal rainfall and temperature patterns commonly result in dramatic changes in soybean production in Kansas. Consequently, the development of superior varieties that are well adapted to the Kansas climate is a major thrust of the K-State soybean breeding and genetics program.

SOYSELECT: SOYSELECT is a computer software program to assist Kansas growers, extension agents, and others in selecting the optimum variety for their farm location. This decision aid will be released with the results of the 1990 Soybean Variety Performance Test bulletin in early 1991. The economic potential is readily apparent. For example, if less productive varieties were replaced with varieties with a 5 percent yield advantage on 10 percent of the soybean acreage, Kansas producers would increase yields by 24,000 bushels and profits by $144,000 annually.

Variety Release: Variety KS4390 has been released by the KAES. Foundation seed is available from KSU, and the new variety has a 6 percent yield advantage over Sparks and Spencer in Kansas.

Soybean Cyst Nematode: This pest could cost southeast Kansas producers millions of dollars in damages if preventive steps are not taken.

Research at the Southeast Kansas Branch Experiment Station has shown that crop rotation is an effective means of management once the disease has been diagnosed.

Scepter Herbicide: At the Sandyland Experiment Field, all soybean varieties in performance tests are treated with Scepter herbicide to determine yield effects. Scepter gives excellent weed control in most soybean varieties on sandy soils, but it does damage some varieties.

Pearl Millet

Program Objectives: Pearl millet is a promising crop for Kansas. It evolved on sandy soils in the dry tropics similar to where sorghum evolved on clay soils. Therefore, the maturity requirements and heat and drought stress reactions of the two species are similar. The grain yield potential of pearl millet appears equal to sorghum. However, grain nutritional quality may equal that of corn as measured by feeding trials with cattle, swine, and poultry. The objective of the breeding program is to develop dwarf, grain-type hybrids that are adapted to mechanized farming conditions in Kansas and that have improved characteristics of stand establishment; seed set and size; grain quality and yield; and resistance to lodging, insects, and diseases.

Hybrid Millets: In 1989 on sandy soils at the St. John Experiment Field, the yield of 11 advanced millet hybrids was compared to grain sorghum (DeKalb DK39y). The millets yielded from 4 to 76 percent more grain than the sorghum control. On clay soils, however, the experimental pearl millets yielded less, only 60 to 90 percent as much as sorghum. On silt loam soils, the yields of several millet hybrids were comparable to sorghum yields. To date, disease and insect problems on pearl millet have been minor and greenbug resistance under field conditions has been excellent. Such resistance enhances the value of pearl millet as an alternative crop, because Extension surveys show that (1) 750,000 acres of sorghum were treated one or more times in 1990 to control greenbugs, and (2) 40,000 to 50,000 acres of sorghum may have been infested with aphids resistant to insecticides.

Proposed Millet Releases: Several pearl millet lines, previously tested in hybrid combinations, are being considered for release by KSU in winter 1990-91. If commercial seed companies and farmers accept this new crop, there could be a significant reduction in the amount of insecticide applied to western Kansas acreages.

Barley

Winter Barley: Varietal development efforts at the Northwest Research-Extension Center at Colby have resulted in a new winter barley with excellent winter hardiness and an 11 percent yield advantage.

Sunflowers

Program Objectives: The list of adapted alternative crops in western Kansas is limited. However, Kansas produces about 200,000 acres annually and ranks third nationally in sunflower production. Thus, sunflower production should be considered an established crop rather

than an alternative choice. The excellent quality of Kansas produced confectionery sunflowers, compared to the variable quality of northern production areas, is giving Kansas a significant share of the U.S. market. Kansas has the opportunity to become the leading U.S. producer of confectionery sunflower.

Date-of-planting Results: Date-of-planting studies show that delaying planting to late June and early July has little effect on yield but significantly affects the incidence of head moth, stem weevil, and rhizopus head rot infections. Early plantings usually required 2 or 3 applications of insecticides to control head moth and the spread of rhizopus head rot, whereas late plantings usually require only one and sometimes no application of insecticides.

Efforts to transfer drought, insect, and disease resistance from wild to domestic sunflower have been successful as shown by reduced infestation of head moth, stem weevil, and by leaf retention under drought stress.

Rapeseed

Food and Industrial Varieties: K-State works with other states, the Kansas Board of Agriculture, and private industry to evaluate the potential of commercial rapeseed production in Kansas. Canola is a specialized food crop developed from rapeseed with less than 2 percent erucic acid. Rapeseed varieties used for industrial products must contain 40 percent erucic acid as a minimum and cannot be used for human consumption.

Winter Hardiness: Currently, varieties of canola and industrial rapeseed grown in Kansas are not sufficiently winter hardy. A canola performance test was initiated for the 1990-91 crop with six locations and four participating seed companies. K-State also is cooperating with USDA and seven states in developing industrial or high erucic rapeseed. In cooperation with the University of Idaho, KSU is using four F4 bulk populations of winter rapeseed. These populations should segregate for winter hardiness, multiple pest resistance, yield, and adaption. The objective is to develop adapted canola and industrial varieties over a three-year period.

Eastern Gamagrass

Eastern gamagrass is a high quality, high yielding, warm-season perennial forage grass. Previously the use of this grass was severely restricted because of poor seed production. "Pete" Eastern gamagrass is a joint release by KSU and the USDA/SCS Plant Materials Center at Manhattan, Kansas. Potentially, the new variety is expected to produce 3 to 8 times more seed than previously available varieties. Enhanced seed production will greatly increase the use of Eastern gamagrass.

Forestry

Conservation Tree Planting Program: For 34 years, State and Extension Forestry has conducted a Conservation Tree Planting Program, selling low-cost tree and shrub seedlings to Kansas landowners for conservation planting in response to the Clark-McNary Act. More than

38,000,000 seedlings have been sold for windbreaks, woodlots, erosion control, wildlife habitat, and Christmas trees. Increased emphasis is being placed on planting forested buffer strips along streams for water quality benefits.

In 1989, an interagency agreement between the departments of Wildlife and Parks, Corrections, Transportation, and State and Extension Forestry established the Wildlife Habitat Center at El Dorado Correctional Work Facility. One of the goals of the center is to establish a seedling nursery to supply trees and shrubs for the Conservation Tree Planting Program. The first crop of seedlings will be distributed during the spring of 1991.

Tree Improvement: A tree improvement program complements the Conservation Tree Planting Program. Forest productivity is enhanced by collecting seed from specific areas and stands and by developing new hybrids to meet particular needs. All available means are used to upgrade the seed and propagation stock in the Conservation Tree Planting Program.

HORTICULTURE

Crenshaw Melons: Crenshaw melons are high quality, late-ripening, nonnetted, vining melons. The Department of Horticulture has developed a new, improved crenshaw melon. The new release is a bush rather than a vining type. Mature plants attain a diameter of about three feet and are suitable for use in home gardens and in high density commercial plantings. Fruits ripen within about a one-week period or about two weeks ahead of the earliest commercial varieties. The new release is less susceptible to sunscald than standard crenshaws and ripens to an easily determined and attractive golden yellow.

Grapes: Since 1985, more than 40 cultivars of grapes have been evaluated for adaptation, fruit quality, and important horticultural traits. Research has also identified genetic variability for sensitivity of grapevines to 2,4-D herbicides. In addition, a potential chemical bird repellent (dimethyl anthranilate) has been identified. Alternate formulations are now being evaluated to avoid possible damage to grape vines.

Ornamental Plants: The multiplication and morphogenic potential of *Acer, Quercus,* and other ornamental species is being determined using selected culture media and growth regulators. In vitro multiplication systems, including shoot tip, lateral axillary bud, and leaf and stem cultures, are being developed. Greenhouse-grown seedlings, in vitro-cultured seedlings, indoor-forced dormant branches, and etiolated plants are being used to procure explants.

Intensive Vegetable Production Systems: Research using plastic mulches, drip irrigation, and small grain (wheat) windbreaks in an intensive vegetable production system can increase production of western shipping type muskmelons fivefold (15,000 melons/acre) over conventional bare-ground production. This substantial production increase is coupled with a 50 percent reduction in water use and a significant decrease in wind and water erosion.

RELATED RESEARCH

Although this report emphasizes the role of genetic improvement in impacting crop and livestock productivity, improved management and other technological advances also play an important role. A few examples are cited below.

Weed Control

Biological Control: Incorporating genetic resistance is a cost-effective, biological-control mechanism in varieties and hybrids. Similarly, indigenous microorganisms are being isolated from Kansas soils and evaluated for biological control of annual brome species (cheat, downy brome, and Japanese brome). Initial laboratory screenings have identified 85 isolates which inhibit root elongation of downy brome and 65 isolates which inhibit root elongation in Japanese brome. Forty-two of the latter isolates also inhibit downy brome. Promising isolates will be evaluated in growth chamber studies and field trials.

Developing Weed Management Systems and Strategies: Research at Hays demonstrated that the economic threshold for treating winter annual grasses in wheat varies with changes in downy brome density, cost of control, wheat price, and potential wheat yield. To increase production and protect water and environmental quality, growers want to know when to best apply postemergence herbicides. Where downy brome reached densities of 24, 40, and 65 plants/per square meter within 14 days after wheat emerged, yield was reduced by 10, 15, and 20 percent. When downy brome emerged 21 or more days later than winter wheat, yield was not reduced. Timing and management are critical.

Fertilizer

Fertilizer Use in Western Kansas: Adequate soil fertility is essential for plant production and reproduction. The natural fertility level of some western Kansas soils has declined; therefore, profits from farm crops are not possible without adding supplemental nitrogen. In such areas, research shows that winter wheat regularly responds to rates of nitrogen as low as 20 to 40 pounds per acre. The added nitrogen increases production efficiency and stabilizes production during periods of drought.

Fertilizer Use Efficiency: Fertilizer efficiency is an important research thrust. A North Central Regional research study is focused on soil and plant tissue tests to determine actual plant needs and optimum application times and amounts for nitrogen fertilizer. Other scientists are studying the use of inhibitors to control nitrogen release rates and their effect on nitrogen loss and use in no-till planted sorghum. The use of pelleted lime and lime sources on soil pH, cost efficiency, and impact on crop yield and fertilizer use efficiency also is being studied.

Alternate Crops: Inclusion of non-traditional crops in rotations breaks pest cycles, lessens dependence on pesticides and tillage for pest control, and provides growers another tool for managing farm resources more effectively. For example, such alternate crops as winter rapeseed are routinely evaluated for their adaptability in northwest Kansas and other locations. Winter rapeseed can be marketed for human consumption (Canola) or as an industrial oil.

Cropping Systems: In fallow areas considerable erosion can occur where land is left idle to enhance soil moisture storage and nutrient availability. Research has shown that some fallow areas lend themselves to more intensive cropping which increases ground cover, decreases runoff, increases soil moisture storage, decreases evaporative losses, and increases net farm income.

Conservation Tillage: In low rainfall areas research demonstrates the efficacy of decreasing the number of tillage operations, combining reduced tillage with limited herbicide use, or controlling weeds with herbicides alone. Those practices maintain a soil surface covered with residue for longer periods and increase net farm income while reducing pesticide movement into streams.

The effectiveness of ridge tillage, reduced tillage, and stubble mulch tillage is being compared at multiple locations. Research at the East Central Kansas Experiment Field showed a 40 percent better stand under heavy rain conditions with sorghum planted on raised seedbeds (ridge-top plantings) compared with conventional tillage systems.

Crop Rotation: Wheat planted in wheat residue in central Kansas is subject to such pathogens as tan spot and cephalosporium stripe that propagate on wheat residue. In this area, reduced tillage systems for wheat must involve rotations with other crops. During 1988-1990, rotation out of wheat for one year or moldboard plowing reduced early-season tan spot by 55-60 percent.

Endophyte Infected Fescue: Approximately 90 percent of the 25 million acres of tall fescue in the United States is thought to be infected with a toxin producing endophytic fungus. Tall fescue also is the predominant cool season forage in southeastern Kansas. The loss to cattlemen from infected forage approximates $793 million annually. Research in southeastern Kansas has demonstrated that interseeding white clover into endophyte infected fescue can decrease losses by about 65 percent (a potential $515 million savings). In addition, white clover fixes atmospheric nitrogen and reduces the need for nitrogen fertilizer.

LIVESTOCK RESEARCH GOALS

Animal scientists at K-State search for production techniques and technological advances to meet the needs of Kansas producers, the livestock industry, and the consuming public for safe, nutritious, and wholesome meat and livestock products. Recommended production and protection systems must be cost-effective and profitable for producers, yet affordable and desirable for consumers. The research emphasis is on management skills and scientific advances, reduced costs, improved health, higher birth rates, lower mortality, rapid gains, higher quality, and improved profitability. Animal scientists at K-State work to anticipate problems, develop procedures, and find solutions that will maintain Kansas as a leader in the U.S. livestock industry.

Livestock in Kansas: Animal agriculture in Kansas covers a wide range of domestic animals. Livestock and livestock products account for nearly 65 percent of cash receipts from farms and ranches in Kansas.

Nearly one-third of the state's crop production and essentially all range and pasture production are used in support of the animal agriculture industry.

Kansas is the leading beef slaughtering state in the nation and ranks third among the states in cattle and calves on farms and third in cattle and calves on grain feed. In 1989 there were 5.7 million cattle and calves on farms. Cash receipts from farm marketing of livestock and livestock products totaled more than $4.2 billion in 1988. The combined livestock and crop industries generate $6.5 billion annually in cash receipts and together form the economic base of the state.

Livestock Reproductivity Programs: The goal of genetic improvement and reproductivity programs is to produce, protect, and market animals that utilize feed effectively, gain weight rapidly, and increase profitability on the farm and in the feedlot. To improve reproductivity, K-State animal scientists focus attention on management skills and animal health, nutrition, the reproductive cycle, heat detection and synchronization, pregnancy checking, weaning weight, and an integrated approach to reproduction management. Breeding protocols, which reduce days open and decrease variations in the breeding cycle, are important management goals.

RESEARCH THRUSTS IN LIVESTOCK REPRODUCTIVITY AND RELATED AREAS

Beef

Reproductive Performance: A beef cow has little economic value unless she produces a calf each year. Reproductive efficiency entails both a high conception rate and a short postpartum interval; the latter is important because the cow/calf enterprise is seasonal, and continuity is dependent on conception within 90 days of parturition. With more than 1,500,000 cows in Kansas herds, the cow/calf enterprise is a significant factor in the Kansas economy.

The cost of reproductive failure is estimated to be $300 per animal. The present failure rate is about 15 percent; if that can be reduced by as little as a third, the economic benefit would approximate $22,500,000 annually. Other economic gains would also be substantial. As many as one-half the earlier born calves could weigh 40 pounds more at weaning. If artificial insemination techniques were adopted, they could weigh an additional 30 pounds more because of improved genetics.

Estrous Synchronization: This is an important research objective because synchronization of estrous facilitates the use of artificial insemination, allowing producers to utilize proven calving-ease sires, reduce calving difficulty, and use semen from bulls that are generally too expensive to purchase. Successful synchronization of estrous also results in an abbreviated calving season, enhanced labor efficiency, and reduced mortality.

The KSU animal reproduction group is a leader in developing estrous synchronization compounds and demonstrating factors affecting their effective use. KSU scientists also are examining the use of commercially

available estrous synchronization compounds and hormones to induce puberty and synchronize estrus in yearling virgin heifers. Basic data collected on initiation of cycling in postpartum beef cows have provided an essential link in developing management systems to ensure cyclicity early in the breeding period.

Suckling and Estrous Cycles: Cows that nurse a calf have longer intervals from calving to ovulation, estrus, and conception than cows without a calf. Research at K-State has shown that calves delay estrous cycles in cows by mechanisms other than suckling.

Improving Reproductive Performance with MGA: Important problems associated with yearling heifer selection include calving difficulty and low pregnancy rates due to a high incidence of non-pubertal heifers. MGA (melengestrol-acetate) has been shown to be effective in inducing puberty in virgin heifers. At the beginning of the breeding season, 91 percent of heifers receiving MGA were pubertal, compared to 77 percent of the control heifers. More important, inducement of puberty did not affect subsequent reproductive performance.

Using Prostaglandin (PGF) to Increase Fertility: Increasing the number of cows that conceive during the breeding season is the easiest method of increasing cow-herd profitability. In addition, the earlier in the breeding season that cows conceive, the earlier they will calve the following year, resulting in a heavier calf at weaning. Research trials demonstrated that a single injection of PGF, administered between 25 and 35 days after calving, can increase the pregnancy rate by 9 percent. However, response to treatment may be reduced or absent if cows are in poor body condition or receiving inadequate nutrition.

Kansas Bull Tests: The economics of beef production over the last 20 years and consumer desire for lean beef have dictated a change in the genotype of cattle used for breeding. The Kansas Central Bull Tests have helped facilitate this change by providing a uniform post-weaning environment, where superior bulls can be identified and selected.

Integrated Reproductive Management: Using data generated at KSU and elsewhere, an integrated reproductive management system program for beef cattle has been developed. The system utilizes an economic decision-making software designed to perform cost accounting and production efficiency calculations. Surveys are completed for individual producers which identify areas of reproductive inefficiency for which management changes are recommended. The surveys also identify areas for which additional research is needed.

Rumen-Escape Lipid and Reproduction: Early returns to cyclicity can improve overall reproductive efficiency in beef cows. More cows cycling at the beginning of the breeding season should result in a higher average weaning weight, because more calves are born early in the calving period. Research elsewhere suggests that inclusion of dietary lipid could hasten the return to estrus.

It is apparent from this and other research that lipid feeding is capable of enhancing cyclicity in the postpartum cow. Sixty-seven percent of lipid-fed cows exhibited a normal first estrous cycle as compared to 33 percent for cows not receiving lipid.

Dietary Energy and Reproduction: Along with many other factors, the length of the breeding season and the percentage of cows calving early in the calving season influence the efficiency of beef production. Both factors can be influenced by good reproductive management.

Twenty-eight Hereford/Angus cows were utilized to determine the effects of dietary energy level before and after calving on the reproductive function and production in suckled beef cows. Low levels of dietary energy before calving resulted in losses of body composition prior to calving, reduced calf birth weight, lengthened intervals from calving to ovulation, and decreased milk production and calf weight. Low levels of dietary energy after calving decreased measures of body composition after calving, reduced the percentage of cows that ovulated following calving, and decreased milk production and calf weight.

Data were collected from 11,494 bulls of 32 breeds that completed the Kansas Central Bull Tests over a 17-year period.

Weights, frame scores, scrotal circumferences, and prices of bulls increased significantly over 17 years. Angus had the greatest increase in birth weight, average daily gain during test, adjusted yearling weight, and frame score, whereas Simmental had the greatest increase in adjusted weaning weight. Backfat and ribeye area decreased over this period. Large frame score had the greatest effect on increasing sale price of bulls. Gelbvieh bulls with heavy birth weights sold for less, whereas heavy birth weight Limousin and Polled Hereford bulls sold for more.

Managing Beef Genotypes: To maximize profit from a beef production system, the management system must match the genotype. In a computer simulation based on KSU tests, cattle bred and managed to be moved directly from weaning to feedlot and slaughtered at a young age produced the greatest profit. Cattle that were too small or too large, and management systems that increased age at slaughter, were less profitable.

This accelerated system of production allows a producer to take advantage of superior genetics and the economic opportunities they provide, especially with retained ownership. The beef industry has the opportunity to continue to produce high quality beef, while reducing days to slaughter by taking advantage of more efficient feed conversion by younger animals. In addition, less shrink, lower trucking costs, fewer sick days, a reduction in medication, lower marketing costs, and reduced interest costs are associated with the accelerated production system.

Cattle Germ Plasm Evaluation (GPE): The primary objective of the GPE research program is to characterize different biological types of cattle for economically important traits from conception to consumption. This research program is the largest, most comprehensive of its kind, and the results are utilized worldwide. Each cycle involves different breeds and biological types.

The basic procedure involves mating Hereford and Angus cows to representative sires of different breeds. Steer progeny are slaughtered. Carcasses are fabricated into closely trimmed retail cuts, and meat is evaluated for palatability. Heifer mates are retained and evaluated for maternal traits. Breeds differed significantly in slaughter and carcass

traits, dressing percentages, carcass composition, marbling, and meat tenderness. Breeds did not rank the same for marbling as they did for tenderness.

Cow/Calf Profitability Case Studies: During 1987 and 1988, Extension personnel conducted numerous economic analyses of cow herds using the BEEFpro cattle management computer program, with emphasis on developing a thorough cost/return analysis.

The information, collected in individual consultation sessions, represents the records from 56 Kansas cow herds in 1987 and 1988 which were relatively profitable years in the cow/calf business. The herds were divided into three profitability groups based on net cash returns per cow unit.

Gross returns and costs on a per cow unit basis were extremely variable, with the bottom one-third of the group essentially breaking even, whereas the high one-third of the group averaged $228.40 per head in net cash returns. Both operating and fixed costs were major determinants of profitability. Reproductive rate (calves weaned per cow exposed) was the major variable affecting profitability.

Profitability and Ultrasound Technology: The sale of fed cattle for slaughter is the single largest source of income in Kansas. K-State researchers are investigating a procedure to significantly increase revenue from feedlot marketings. It involves marketing strategies that cluster cattle into groups according to optimal carcass specifications at a common time. An ultrasonic technique has been developed that predicts future carcass merit and enables the projection of an optimal market date for each animal. Validation experiments indicate that an increased profit of $20 per head could be expected.

Beef Quality and Ultrasound Technology: Marbling (intramuscular fat) is a primary indicator of quality and imparts desirable taste, juiciness, and tenderness to beef. Because the American public is willing to pay a premium for quality, this country is a "Choice" beef society and likely to remain so. Up to now there has been little research on marbling in cattle, because the trait could not be determined until the animal was slaughtered. K-State research has advanced to the point where ultrasound technology can be use to monitor marbling development in live animals. This will facilitate adoption of production strategies to take advantage of this important trait.

Marbling and the ability to grade Choice within a reasonable period in the feedlot is very important economically. Currently, the price premium for a USDA Choice carcass is about $60 more than for a USDA Select carcass (a carcass that is deficient in marbling).

Swine

Litter Size: Thirty percent of potential pigs per gilt, about four pigs at farrowing, is lost by either embryonic or fetal death. Recent reports indicated that pigs are marginally deficient in folic acid during gestation and that additional riboflavin enhances embryo survival. In a recent test, neither farrowing rate or litter size was affected by feeding folic acid or riboflavin to gilts during gestation. However, in other tests at K-State

a significant improvement in embryo survival because of riboflavin was observed. Thus, it may be possible to improve litter size by feeding riboflavin to gilts that otherwise would not completely utilize their uterine capacity.

Starter Diets for Pigs With Porcine Plasma: Previous research indicated that soybean protein may cause morphological and immunological changes to the small intestine of newly weaned pigs. This results in reduced nutrient uptake, growth rate, and feed intake. Milk protein is often included in starter pig diets to offset some of the detrimental effects of soybean proteins in the diet. The use of dried whey and dried skim milk have been demonstrated to be particularly advantageous.

KSU research trials have showed that dried porcine plasma has an equal, if not better, feeding value than milk protein.

Starter Diets for Pigs with Specially Processed Soy Products: The desire to wean pigs early has resulted in the use of diets high in milk products which provide greater compatibility with the pig's digestive capabilities. Although the performance of pigs fed milk containing diets is greater than for simple corn-soybean meal diets, the milk-product diets are more expensive. Research was conducted to determine the effect of three potential replacement products (soy protein isolate, soy protein concentrate, and modified soy flour) for milk products in the diet.

Replacing the protein from dried skim milk with specially processed soy products resulted in slight depressions in performance early in the nursery phase of feeding. However, as the processing techniques became more elaborate (i.e. isolate > concentrate > modified soy flour), utilization of the products improved.

Nursery Diets, Soy Products, and the Small Intestine: Recent interest in replacing milk products in weanling pigs with less expensive soy products has led to concern about mild allergic responses to soy proteins causing malabsorption in the small intestine. Experiments were designed to test the effects of replacing the protein from milk products with specially processed soy products on the functional integrity of the small intestine in weanling pigs. Nine different diets were fed to 66 pigs averaging 21 days of age. Of the specially processed soy products, soy protein isolate had the greatest nutritional value in simple diets, but the soy products were of similar nutritional value in complex diets.

Sow and Litter Performance: Two studies designed to evaluate the effects of additional niacin on sow and litter performance have been completed. Dietary treatments were formulated to provide sows with either 5 or 10 times the level of supplemental niacin in the control diet. The results suggest that first-litter sows fed the intermediate level of additional niacin during gestation and lactation had fewer total pigs born and born alive. However, these sows had more pigs at weaning, better pig survival, and heavier litters at weaning than those fed the control diet. In addition, the decrease in pigs born and born alive during the first pregnancy was not observed during the second pregnancy.

Sheep

Increasing Lambing Percentage: Most ewe flocks in western Kansas consist of grade Rambouillet ewes, frequently imported from Texas or

New Mexico. Spring-born ewes in these flocks are often bred for fall lambs. Such matings generally result in a 110-115 percent lamb crop, a rate that is not economically feasible.

Researchers at K-State are seeking new methods for increasing the size of fall lamb crops. The effect of the Finn breed on lamb crop size is well documented. The Booroola Merino breed also is recognized as a breed conducive to prolificacy. The trait is quantitative in both breeds, but the inheritance is less complex in the Booroola.

Performance Characteristics: Research shows that reproductive performance is consistently higher for crossbred ewes. In a study with Rambouillet, Finn/Rambouillet, and Booroola Merino/ Rambouillet ewes, ovulation rates were highest for the Booroola crosses, intermediate for Finn cross ewes, and lowest for straight Rambouillet ewes. Data combined over three lamb crops showed that 66 percent of the Finn cross ewes that lambed produced multiple births compared with 54 percent for the Booroola crosses and 23 percent for straight Rambouillet ewes.

Seasonal Reproduction Problems: Because of the seasonal nature of reproduction in sheep, most spring-born lambs are marketed when annual prices are at their lowest level. Research with ram-exposure to anestrous ewes has shown that seasonality in breeding programs can virtually be eliminated. This management technique will allow Kansas sheep producers to produce and market lambs at a more economically advantageous time.

Katahdin Sheep: The Katahdin are hair sheep that were developed in Maine. Their out-of-season reproductive performance under Kansas conditions will be evaluated beginning with the 1990 fall lamb crop.

Supplemental Light and Zeranol Implants: Animal scientists are studying the effects of zeranol implants and artificial light used to extend daylight hours on the growth rate and feed efficiency of feedlot lambs. Zeranol implantation improved average daily gain for natural-light lambs during the first 30 days. Implanted lambs grew faster than nonimplanted lambs in both natural and extended light environments from 30 to 58 days. Implanted natural-light lambs grew fastest over the 58-day feeding period.

Dairy

1990 Agway Inc. Young Scientist Award: Jeffery S. Stevenson, Associate Professor in the Department of Animal Sciences, received the 1990 Agway Inc. Young scientist award June 26, 1990, at the 85th annual meeting of the American Dairy Science Association at North Carolina State University, Raleigh.

Dr. Stevenson's research has focused on establishing breeding protocols to reduce days open and reduce the variation in calving intervals in dairy cattle. His work in demonstrating the reduced efficacy of prostaglandin $F_{2\alpha}$ in the lactating dairy cow compared with the dairy heifer has shed new light on the problem associated with synchronizing estrus. His published work also has shown that age of the corpus luteum has an effect on the efficacy of prostaglandin $F_{2\alpha}$. He demonstrated the benefits gained by the administration of gonadotropin-releasing hormone (GnRH)

at the time of artificial insemination. He also found the positive effects of using GnFH in postpartum cows.

Parturition and Recombinant Somatotropin (rBST): The ability of somatotropin to stimulate milk production has been known since 1937. With the development of recombinant technologies (biotechnology), substantial amounts of somatotropin are available for large-scale use in dairy cattle. rBST increases milk production in dairy cows by shifting nutrient flow from body fat to the mammary gland for increased milk production. K-State researchers are actively addressing this problem, because the potential use of rBST in commercial dairy herds demands a full understanding of the metabolic and hormonal changes that occur during treatment.

Veterinary Medicine

Clinical Veterinary Services for Small Ruminants (Sheep, Goats, and Llamas): Those services focus on strategies to enhance productivity and reproductivity and include: (1) pregnancy diagnosis and research using an ultrasound instrument; (2) assessing breeding soundness of rams by physical characteristics and by collecting and analyzing semen; (3) laparoscopic intrauterine insemination of ewes; and (4) a study of health care in the U. S. sheep industry. The goal is to provide services that assist small ruminant producers to be cost-effective, maintain flock health, and enhance profitability.

Inhibiting Scar Tissue Formation: Veterinarians have evaluated pharmaceuticals that inhibit the production of internal scar tissue within the body such as the thorax and abdominal cavity. Scar tissue can cause infertility in cattle or horses, especially if it involves the uterus or results in sequestration of bacterial infection. Therapeutic use of adhesion inhibitory pharmaceuticals is particularly beneficial in large animals with severe cases of bacterial pneumonia or surgery in the abdominal cavity.

Endotoxemia: Laboratory investigations have focused on identifying pharmaceuticals that inactivate endotoxins liberated by a wide variety of gram negative bacteria. Toxins can cause a variety of diseases in cattle and swine. Endotoxemia also increase the incidence of abortion and infertility. Endotoxins are frequently released into the bloodstream during overwhelming bacterial infections like diarrhea or pneumonia in neonatal calves, piglets, lambs, and foals. Unfortunately, those conditions are associated with a high mortality rate, and there is a real need to find cheaper, more effective treatment.

Respiratory Diseases: Diseases in the respiratory tract of cattle cause an estimated $225 million yearly loss to the cattle industry. Severe fibrinous pneumonia accounts for a substantial portion of that loss, whether due to death loss or to reduced productivity. K-State veterinarians have developed a model useful in experimental studies with pneumonia. The model affords the opportunity to further study pathogenic and treatment factors associated with this kind of pneumonia.