

35TH

**BIENNIAL
REPORT**

AGRICULTURAL RESEARCH IN KANSAS

Director's Report for the Biennium July 1, 1988 to June 30, 1990

Letter of Transmittal

Office of the Director

***To the Honorable Joan Finney,
Governor of Kansas***

It is my pleasure to transmit herewith the report of the Agricultural Experiment Station of the Kansas State University of Agriculture and Applied Science for the biennium ending June 30, 1990. This report emphasizes more diversified and sustainable agriculture for Kansas. The research highlights include animal and crop production, water resources, environmental studies, animal and human health, and economic aspects of agriculture. In addition, there are lists of publications by Station scientists, lists of research projects still active and those terminated during the biennium, a record of personnel changes, and a financial statement for each year of the biennium.

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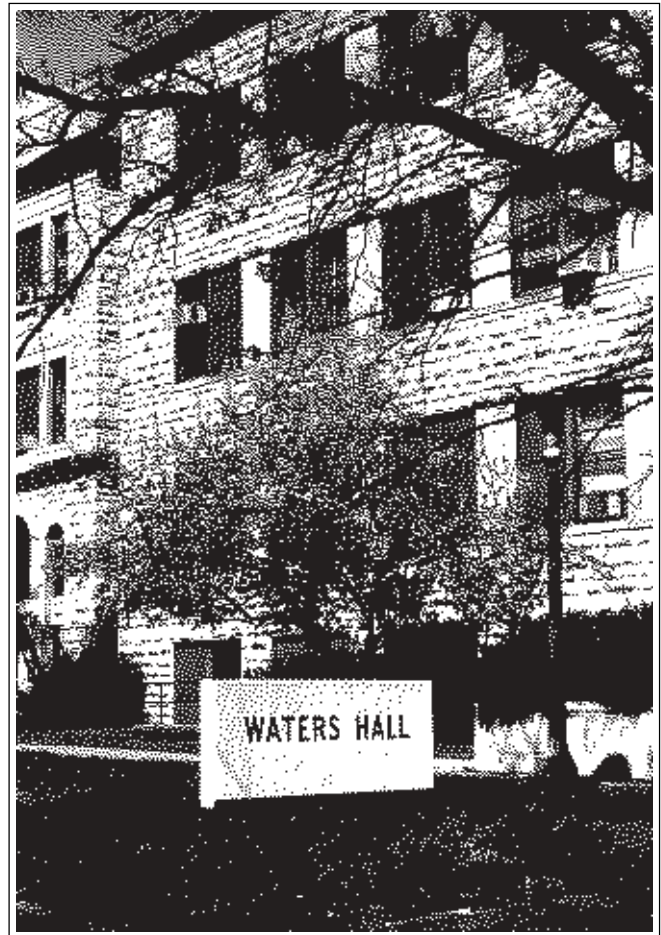
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Agricultural Research in Kansas

35th Biennial Report of the Kansas Agricultural Experiment Station

Report of the Director for the Biennium Ending June 30, 1990



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A Message from the Director



The Kansas Agricultural Experiment Station, through effective planning and implementation, has directed research efforts toward new areas of concern for Kansas agriculture. These involve diversity and sustainment of agriculture, value-added products, biotechnology, water quality, the environment, communities, and families. Concurrently, the critical base of agricultural programs has continued to be addressed through research. These include such areas as animal health and production, range management, and crop protection and production.

These programs are funded from a variety of sources, including base or formula funds, support from industry and agribusinesses, and grants obtained by faculty. All of these sources are vitally important. Without an aggressive and talented faculty to obtain extramural funding, the agricultural research program at Kansas State University would be less comprehensive and respected.

The accomplishments of Kansas Agricultural Experiment Station researchers are abundantly evident in this 35th Biennial Report. For the two-year period from 1988 to 1990, Station scientists published nearly 1000 research articles in journals, books, proceedings, trade publications, Station publications, and other forms for disseminating scientific information.

Looking ahead, Agricultural Experiment Station programs will benefit from several developments that took place during the biennium. New greenhouse space has helped strengthen research efforts in the departments of Plant Pathology, Agronomy, Horticulture, Forestry, and Entomology. In addition, planning moved forward with the Plant Sciences Center, which is critically needed for the support of research. Improved facilities help attract and retain quality faculty and also provide state-of-the-art capabilities in research and development for Kansas agriculture.

Walter R. Woods
Dean of Agriculture and Director
Agricultural Experiment Station

Research Departments, KAES

■ COLLEGE OF AGRICULTURE

Agricultural Economics
Agronomy
provides soil testing service
Animal Sciences and Industry
includes International Meat and Livestock Program
provides chemical analyses of feedstuffs
Entomology
provides Scanning Electron Microscope service
Forestry
Grain Science and Industry
includes Food and Feed Grains Institute, International Grains Program, and Agricultural Institute
Horticulture
Plant Pathology
includes Wheat Genetics Resource Center

■ COLLEGE OF ARTS AND SCIENCES

Biochemistry
Biology
provides plant identification service
Chemistry
Economics
Physics
provides laboratory equipment repair service
Sociology, Anthropology, and Social Work
Statistics
provides statistical consultation and assistance

■ COLLEGE OF BUSINESS ADMINISTRATION

Marketing

■ COLLEGE OF ENGINEERING

Agricultural Engineering
Chemical Engineering
Civil Engineering
Nuclear Engineering

■ COLLEGE OF HUMAN ECOLOGY

Clothing, Textiles, and Interior Design
Foods and Nutrition
includes Sensory Analysis Center
Hotel, Restaurant, Institution Management and Dietetics
Human Development and Family Studies

■ COLLEGE OF VETERINARY MEDICINE

Anatomy and Physiology
Laboratory Medicine
Pathology
Surgery and Medicine
Veterinary Diagnosis

■ BRANCH STATIONS/CENTERS

Fort Hays Branch Station
Northwest Research-Extension Center
Southeast Kansas Branch Station
Southwest Kansas Research-Extension Center

■ EXPERIMENT FIELDS

Cornbelt[†]
East Central[†]
East Central Horticulture[†]
Harvey County[†]
Irrigation^{††}
Kansas River Valley^{††}
North Central[†]
Pecan Field[†]
Sandyland^{††}
Sedgwick County[†]
South Central[†]

[†]Agronomy
[†]Agricultural Engineering
[†]Horticulture

More Diversified and Sustainable Agriculture

Diversification refers to a broadening of the agricultural base in Kansas to help stabilize the economy of the farm sector. Achieving this goal requires more than identifying new crops or other farm-based enterprises. It also involves new uses for traditional crops or products. In addition, producers must examine suitability to the Kansas environment; costs of production; consumer demand as reflected in price stability, availability, and proximity of markets; and long-term and short-term effects on the overall farm economy. When coupled with adequate market development, diversification can expand opportunities for Kansans engaged directly or indirectly in agriculture.

Sustainable agriculture involves practices, technologies, and social organizations that sustain the long-term production of crops and animals, while also conserving natural resources. Sustainment requires that agriculture be profitable to producers and supportive of rural communities and their quality of life. This approach involves reduced use of synthetic chemicals and increased use of management practices that protect the environment, like crop rotations to maintain soil fertility and biological control measures to check insects.

■ **ALTERNATIVE CROPS**

Although hard red winter wheat, grain sorghum, corn, soybean, and alfalfa will continue to be major crops in Kansas, several alternatives are being studied. Most of the crops mentioned below and many others in early stages of evaluation are grown each year at the Agronomy Research Farm north of the KSU campus.

White Wheat

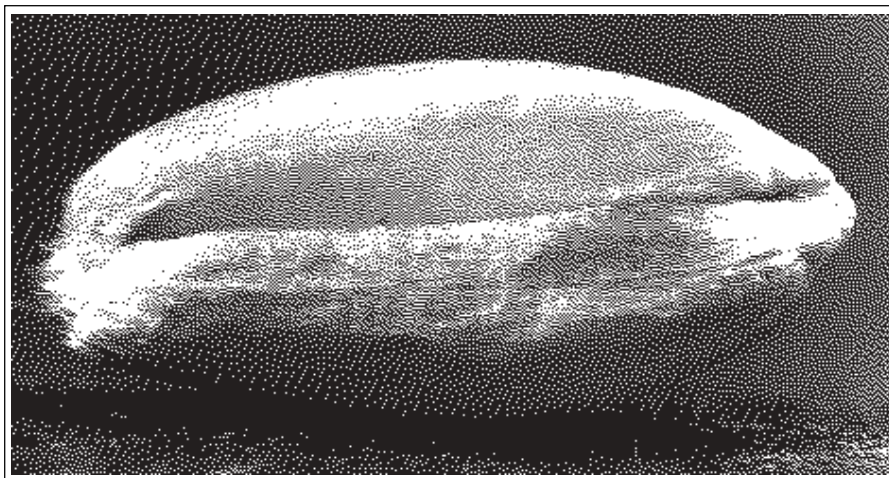
Hard white winter (HWW) wheat has several potential advantages over hard red winter (HRW) wheat. Its flour extraction rates are 2 to 3 percent higher, and the flour contains more protein. Some consumers prefer the less bitter taste and lighter color of products made with white wheat. Also, white wheat is preferred overseas, so it could help to expand export sales.

Successful introduction of HWW wheat into Kansas requires development of adapted varieties that are resistant to environmental stresses, pests, and preharvest sprouting and have excellent milling and baking qualities. The wheat also must be adaptable to current production practices used in the major growing areas of the state. Finally, a market for white wheat must be available. To accomplish these goals, the departments of Agronomy, Plant Pathology, Grain Science and Industry, and Agricultural Economics plus the Fort Hays Branch Station are cooperating in research projects.

Several selections of HWW wheats were evaluated for yield, and five of them consistently performed well. Other new crosses are being crossed again with Karl, a HRW wheat, to incorporate certain quality attributes. Five germplasm lines that are resistant to preharvest sprouting were registered in 1989. Seeds are available to

breeders for developing improved varieties of HWW wheats.

Some adapted germplasm lines containing resistance genes were developed for use in breeding programs for HRW and HWW wheats. These include resistance to Hessian fly, greenbug, soilborne mosaic virus, and leaf rust. In addition, sources of resistance to Russian wheat aphid have been identified. One experimental line has im-



proved capability for emergence, better than that of most semidwarf HRW wheats. The breeding program continues to further increase the protein level in HWW wheat kernels.

Hard wheat farina can be used to make pasta and is less expensive than durum semolina. In a milling test, HWW wheat produced 45 percent farina (slightly more than HRW wheat) and made acceptable spaghetti.

Flour from HWW wheat was used to make whole wheat hamburger buns. It can pro-

Hard white winter wheat has potential as a profitable crop in Kansas.

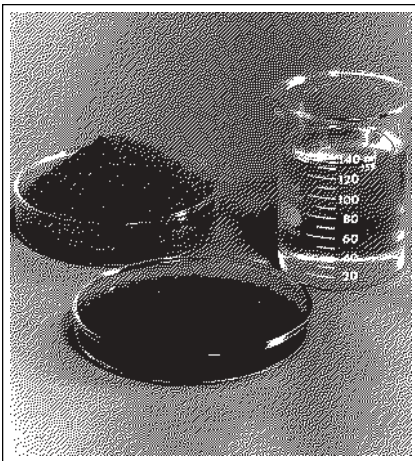
vide the nutrition of whole HRW wheat flour but with a lighter color and blander taste. Some adjustments in the baking formula were needed. Trained panelists were able to distinguish the HWW wheat buns by color and liked the taste as well as that of HRW wheat buns.

A market study examined the potential for food products that use wheat as an ingredient. Per capita consumption increased in the 1980s for white and whole wheat flours, pasta products, wheat-based breakfast cereals, whole wheat bread, and snack foods. HWW wheat could be used in the manufacture of many of these items.

Other economic studies are underway to determine the price premium that flour mills would be willing to pay for HWW wheat and the costs to elevator operators for separate handling and storage of HWW wheat.

Oil Crops

Some members of the Mustard Family have potential as alternative crops in Kansas for production of both edible and industrial oils. Rapeseeds are already being grown as sources of canola oil. This oil contains no cholesterol and has the lowest content of saturated fat of any edible oil. Most canola is produced in Canada, but the crop is suitable for the Great Plains area.



Rapeseed processing yields edible or industrial oil and meal for animal feed.

Production in Kansas has increased, but late planting and unsuitable varieties have limited yields. Planting should be done no later than Sept. 15. Some recommendations on varieties already have been made, but nearly 100 will be tested this year at five sites in different areas of Kansas. Results of these tests will allow producers to make better choices next year.

Other varieties of rapeseed and a related plant, crambe, contain oil that is not edible but has industrial uses. The plants require management similar to that used for the canola varieties. An analysis done in the Department of Agricultural Economics indicates that yields achieved in Kansas tests are high enough to bring a profitable price for the seed. Rapeseed and crambe seed are less expensive to process than soybeans because of their higher oil content. They could be crushed at existing facilities during the slack season with only minor adjustments to equipment. The industrial oil has many uses, particularly as a substitute for petroleum products.

A by-product of processing these seeds for either kind of oil is meal that can be fed to animals. An antinutritional chemical in the meal must be removed during processing or eliminated in the breeding of new varieties. Research is progressing in both areas.

A market already exists for more canola oil. Recently, the USDA organized a research effort in several states, including Kansas, to establish rapeseed and crambe as commercial crops by promoting markets for industrial oil and meal. In the future, producers may be able to choose varieties of rapeseeds on the basis of demand and price for several products.

Sunflower

The acreage of sunflowers grown in Kansas is increasing (195,000 acres in 1988). New marketing opportunities have been provided by two processing facilities for confectionary seed in Kansas and oil mills nearby in Oklahoma and northern Texas. However, the sunflower moth has become a major pest. The young larvae feed on pollen and flowers, and older larvae enter and feed in developing seeds. One larva can destroy nine seeds.

Entomologists at the Fort Hays Branch Station have noted that changing the planting date so that blooming is not synchronized with adult moth activity may be a partial and economic solution to the problem. Tests showed fewer larvae in sunflowers planted after mid-June. Numbers were so low that insecticide was not needed. Flowers of the late May plantings had the most larvae.

Further research at several locations in central Kansas gave similar results. Planting dates from late June to early July reduced sunflower moth infestations. Late planting would allow sunflowers to be used as a double crop after wheat. A slight reduction in yield may result, but limited application of insecticide may compensate and provide a good net return.

Delayed planting also may reduce damage by the sunflower stem weevil and a disease that it carries.

Pearl Millet

Pearl millet is a dietary staple in many areas of the world and is being proposed as an alternative, drought-resistant crop for Kansas. One problem in using this grain is its goitrogenic effect, which is caused by certain chemicals. The concentration of these anti-thyroid compounds is much higher in the bran. The small size of pearl millet grains and their firmly embedded germ have made fractionation difficult with traditional dry-roller milling. Recently, researchers in

the Department of Grain Science and Industry found that semiwet-roller milling could successfully separate the grain into fractions.

Feeding the various fractions to rats showed that the bran had the most adverse effects on thyroid function, as expected. Millet flour had the least adverse effects. The researchers tested yellow- and brown-seeded millet in addition to the more commonly grown gray-seeded. They found that the three varieties had different levels and activities of the antithyroid compounds. Therefore, the content of these chemicals could be reduced by selection and breeding. In the meantime, a semiwet milling process can be used to produce nongoitrogenic foods from pearl millet.

Pecan Production

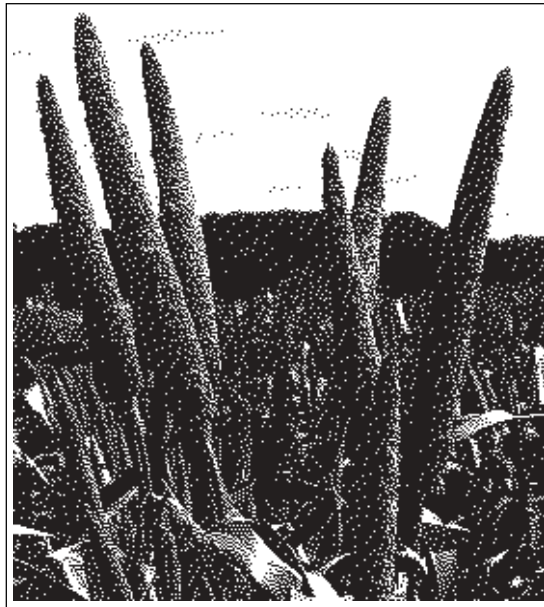
Growing pecans in eastern Kansas is a \$3.5 million-a-year industry. Pecan production in the state is based on native trees, which account for 90 percent of the acreage. In recent years, prices received for native pecans have remained fairly steady, whereas costs for production inputs have increased. This situation has led to a decrease in profits for producers.

Research by a horticulturist at the Pecan Experiment Field has shown that growers can improve profits by adopting a management plan that increases yields. Pecan trees need sunlight to produce nuts, so an orchard should be thinned to allow 10 feet between branches of adjacent trees. Individuals that bear few nuts, are damaged, or are susceptible to diseases can be removed. Proper nitrogen fertilization is probably the most effective way to increase yields. However, improved varieties that bear more nuts are available.

In addition, production costs can be reduced by limiting pesticide use. Economically damaging populations of insects do not occur every year. Scouting procedures can be used to determine when pesticide applications are really needed.

Improved Fruit

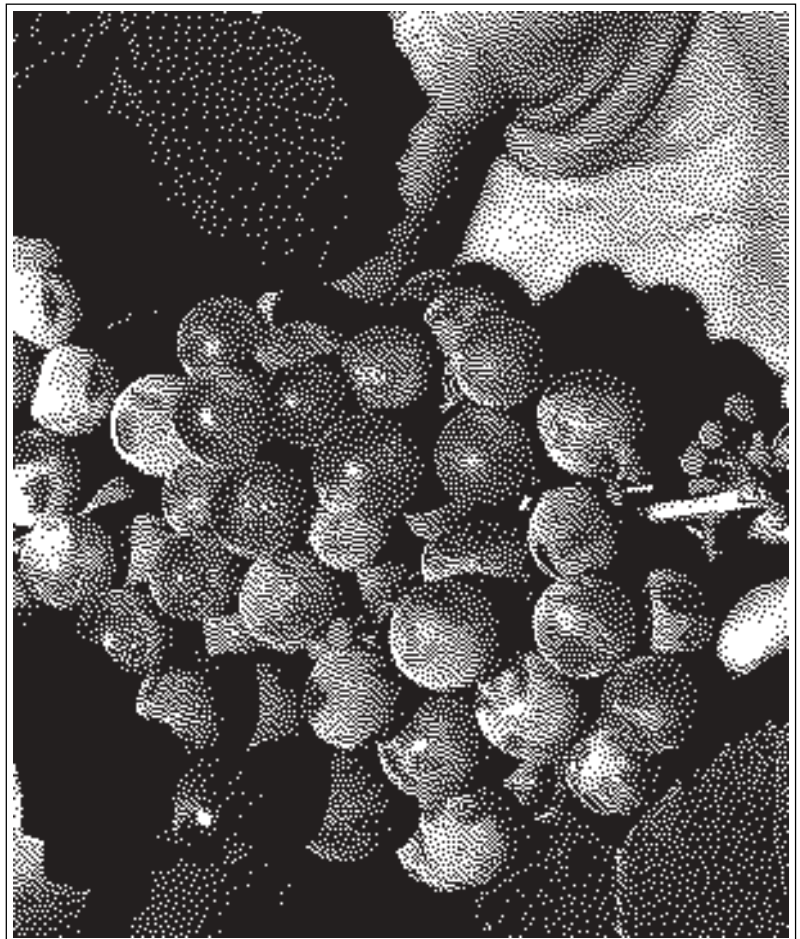
Crenshaw melons are high quality, orange-fleshed muskmelons. The new bush varieties of muskmelon permit commercial growers to use high plant densities and harvest more melons earlier in the season. Home gardeners can grow bush varieties in areas too small for standard vining varieties. Now researchers in the Department of Horticulture have developed a bush crenshaw melon adapted to the hot summers of Kansas. The immature melon is light green, which protects it from sunscald. As it matures, the skin turns golden yellow, making determination of ripeness easy.



New processing methods make pearl millet more useful.

The once large and prosperous grape industry in Kansas is experiencing a revival. Grapes now are grown commercially in at least 18 counties, but favorable environments and soils exist throughout the state. Grapes are marketed fresh or made into juice or jelly. Two commercial wineries are in operation, and several more are under construction.

Grapes are making a comeback in Kansas



Grape research includes evaluation of 40 cultivars for adaptation; fruit quality; and potential for processing into juice, wine, or raisins. Other projects involve grapevine sensitivity to herbicides, testing of chemical bird repellents, and tissue culture. The latter has identified cold-tolerant lines of grapes that will survive the winters in Kansas. Trials are underway to regenerate whole plants from some of these lines.

Marketing Christmas Trees in Kansas

Kansas growers of Christmas trees compete with growers from other states and sales of artificial trees. In 1989, the Kansas Christmas Tree Growers Association funded a study of marketing, which was conducted by two researchers in the Department of Forestry and an agricultural economist. Telephone interviews were conducted with members of 465 households.

The results showed that 82 percent of the respondents had purchased a Christmas tree in the previous year; 34 percent had natural trees, 46 percent had artificial trees, and 2 percent had both. Those who purchased

real trees had the following characteristics: they were members of 2- to 4-person households, middle to upper income, and middle aged; they lived in houses; and they had family gatherings. Forty-seven percent of those purchasing artificial trees said that they would consider buying a real tree again. Eighty-three percent of respondents preferred a Kansas-grown tree, but 57 percent did not know in what state their last tree had originated. Important selection criteria included shape, freshness, color, price, and friendliness of salesperson.

Several marketing strategies are suggested by these results. One is putting labels on Kansas-grown trees. Producers also need to be aware of buyers' preferences and provide the right kind of trees, as well as better information on tree care. Sellers need to locate along major routes or in shopping areas that are convenient to consumers. Marketing also needs to address the social aspects of family members choosing a tree together. Finally, disposal of trees by recycling them for wildlife or fish habitat should be advertised for buyers with environmental concerns.

■ **VALUE-ADDED**

The term value-added refers to increasing the value of an agricultural commodity by further processing. Some value-added products, like meat and cheese, have been made in Kansas for years. However, many other commodities have been shipped to other states for processing and manufacture. Now there is a facility to develop more value-added activities in the state.

During the biennium, an Agricultural Value-Added Processing Center was established at Kansas State University. The Center will conduct research in marketing, manufacturing, and packaging and will provide technical assistance, consulting, and regulatory guidance. It will encompass horticultural food products, meat, food and feed grains, and any other relevant products. Many KAES research projects will benefit from such expertise.

Meat Processing

A new laboratory processing center for meats was part of the recent renovation of Weber Hall. The facilities include an abattoir; state-of-the-art systems for processing and chilling beef carcasses; and complete processing capabilities, simulating current industry practices, for cured and fresh meats. Research by animal scientists is designed to improve the marketability of retail-ready meat

cuts and includes restructured, precooked, and vacuum-packaged products. Packaging techniques that prolong product shelf-life, ensure meat safety, and maximize consumer acceptance are being studied, as well as marketing, lighting, and display systems. Such work could have great economic impact. For example, if 20 percent of boxed red meat in Kansas were cut into retail-ready pieces, 1,500 meat-cutting jobs would be created, with annual wages of \$25 million. The value of the product would be increased by \$58 million each year.

Restructured Meats

Consumers demand meat products that are nutritious, palatable, convenient, and competitively priced. Research is underway in the Department of Animal Sciences and Industry to restructure less valuable carcasses and carcass parts into convenient, precooked, steak- and roast-like products. Scientists hope to reduce or eliminate salt, reduce fat, and increase dietary fiber of these products while maintaining taste.

Restructured meats have some problems, such as development of a rancid flavor. Tests with precooked, restructured beef roasts showed that cooking to a higher internal temperature and adding glucose along with salt and phosphate reduced the rancid flavor and did not affect other characteristics.

Better Frankfurters

Using a product from corn, a researcher in the Department of Foods and Nutrition has found a way to improve the nutritional quality and texture of frankfurters and bologna. Corn germ protein is used as a filler, extender, or replacement for meat proteins. This material provides more juiciness and better texture than currently used substitutes, such as nonfat dried milk and soybean protein. The corn germ protein also decreases fat and cholesterol content, making frankfurters and bologna more appealing to consumers.

More Healthful Hamburgers

In another project in the Department of Foods and Nutrition, flour made from corn germ protein was incorporated into ground beef patties. It had several beneficial effects. It increased water-holding capacity and decreased shrink and total losses during cooking, resulting in juicier and more tender patties. Also, contents of several mineral elements were increased and fat and cholesterol contents were lower.

Soybean Yogurt

The useful soybean already provides soy sauce, tofu, and a meat substitute. Researchers in the Department of Animal Sciences and Industry have developed a method to make yogurt from soy "milk," a liquid derived from the beans. The latter is very popular in China, where cow's milk is scarce. It can be fermented into yogurt that is high in protein and has no cholesterol. Calcium is also lacking but can be added during manufacture. A sensory taste panel gave the soybean yogurt a favorable rating, when some fructose was added to overcome the slightly beany flavor.

Extrusion Center

New facilities in the Department of Grain Science and Industry will allow the development of many value-added products. The Extrusion Center includes two large extruders, a dryer, and handling equipment, either donated by private companies or purchased through grants.

To make extruded products, the desired ingredients are blended into a fine powder and fed into the extruder. Steam, water, vitamin mixes, and other materials are added to the powder in a conditioning chamber, then the moist mixture enters a barrel with screw components. The mixture is pushed to the end of the barrel, where various attachments determine the shape of the end product.

The new equipment will be used for research on all types of extruded food and feed products, including ready-to-eat cereals, pet foods, textured proteins, and pasta. A major thrust



will be to develop value-added products from regional commodities, like grains and oil seeds.

Use for Wheat By-products

A researcher in Animal Sciences and Industry is studying new sources of protein supplementation for livestock. Such supplements can stimulate animals' appetites and improve digestion of forages.

Wheat milling by-products have potential for use as pelleted supplements. As much as 25 percent of wheat fractions are lost during flour milling. These wheat middlings are high in fiber and protein. Their use in a supplement could provide millers with additional income and provide cattle producers with a low-cost protein source.

Research continues to make processed meat products more healthful.



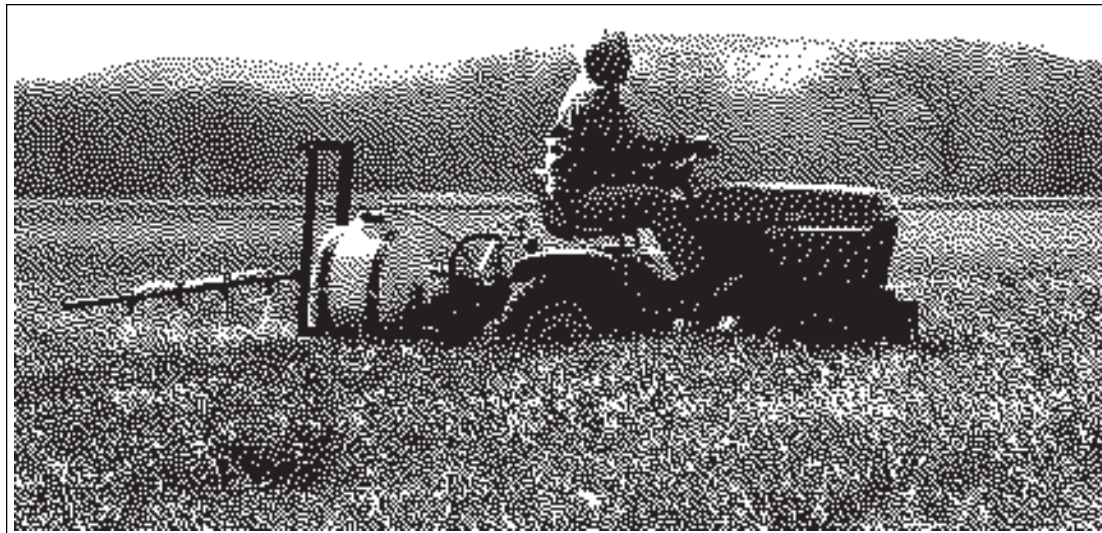
Many value-added products can be made in this extruder.

Wheat Starch

Starch from wheat can be used in baked goods and a variety of other food products. Researchers in the Department of Grain Science and Industry have modified wheat starch so that it forms a paste with thickening power, clarity,

and cold temperature stability. A specialty starch has been developed for use in the paper industry. Other formulations are being tested for applications as building-trade adhesives, cooking starches, and instant starches.

Applying the right amounts of nitrogen can limit soil degradation.



■ **SUSTAINABLE AGRICULTURE**

Many KAES research projects include aspects of sustainable agriculture. A few examples of relevant results are mentioned below; conservation tillage and other examples are discussed in the Research Highlights section.

Correct Use of Nitrogen

Nitrate leaching can occur in all types of soils. If excess nitrogen is applied, it is likely to move as water percolates through the soil.

Crop yields are increased by applications of nitrogen only up to a certain level. Additional applied nitrogen is wasted. Research by agronomists on several crops, grown continuously or in various rotations, seeks to find the best fertilizer rates for each situation. Other projects aim to minimize immobilization of nitrogen in surface residues. Consistent yield advantages have resulted from injecting rather than broadcasting liquid nitrogen fertilizer. The increased yields more than cover the expense of the knifing application.

Alfalfa is a forage crop that adds nitrogen to the soil.



Adverse Effects of Nitrogen

Research in the Department of Agronomy has shown that continued use of high rates of ammonium-based fertilizer can severely degrade soil. Even slightly excessive amounts of ammonium, when applied for a period of 20 years or more, can greatly lessen the soil's ability to retain critical nutrients. The excess nitrogen causes the soil to become acidic. This is accompanied by a buildup of aluminum, which is toxic to many crops. These results emphasize the importance of proper management of soil to avoid long-term damage.

Natural Nitrogen

Use of nitrogen fertilizers can be avoided by planting legume crops (e.g., clover, alfalfa, beans), which are able to convert atmospheric nitrogen to a form usable by plants. Adding a legume to a crop rotation instead of applying nitrogen can save at least \$5 to \$7 per acre.

Tests by agronomists indicate that corn or grain sorghum following soybeans can have higher yields than continuous crops without any nitrogen fertilizer. Yields can be increased even more by addition of moderate amounts of nitrogen.

Other benefits of a legume rotation are breaking the cycles of insects or diseases and discouraging growth of weeds like shattercane and Johnson grass.

Control of Stable Flies

Stable flies are pests that bite and suck blood from cattle, causing irritation and reduced performance. They are particularly prevalent around large feedlots in western Kansas. A tiny wasp that occurs naturally in these feedlots can help control flies.

An entomologist at the Southwest Kansas Research-Extension Center found that the wasp attacks fly pupae, so they never develop into adults. However, greater numbers are needed for effective control, so the natural populations must be supplemented by wasps raised by commercial insectaries. As research results continue to show the effectiveness of biological control, more parasitic insects will be available commercially.

Beneficial Beetles

Scale is a major insect pest of ornamental trees and shrubs in Kansas and throughout the United States. In particular, euonymous scale probably has caused millions of dollars of damage statewide. Spraying infested plants has been the only available remedy, but it is costly, hazardous to the environment, and not always effective. An entomologist is experimenting with natural control of scale by the lady beetle from Korea, distributed by USDA.

Lady beetles have been released on scale-infested euonymous shrubs. Their progress will be followed to see how well they control scale and how they adapt to the Kansas climate. This is the first introduction of lady beetles in the Midwest, so several attempts may be necessary to establish populations that can effectively battle scale.

Fighting the Russian Wheat Aphid

All plant breeding programs at KSU emphasize resistance to insects and diseases. Progress often is complicated by the appearance of new pests, such as the Russian wheat aphid (RWA). Insecticide treatments are available for immediate control of RWA, but sources of resistance to the insect are being tested as well.

An entomologist and a wheat breeder at the Fort Hays Branch Experiment Station have screened over 5,000 accessions of hard red

winter wheat for resistance to RWA. Plants were grown to the seedling stage in a greenhouse and infested with descendants of RWA collected in a Kansas wheat field. Forty-three of the wheats showed significant resistance. Most of these came from the USSR, Iran, and Afghanistan, the area where RWA originated.

Some of these promising wheats are being bred for further evaluation under field conditions and for study of how the resistance is inherited.

Biochemical Resistance to Insects

Amylase is an enzyme that breaks down starch in the digestive system of animals and insects. Many plants, including cereals like wheat, sorghum, corn, oats, and pearl millet, contain amylase inhibitors. These prevent the digestion of starch. Biochemists are isolating amylase inhibitors from cereals and trying to identify those that strongly attack insect amylase but have little or no effect on mammalian (human) amylase. So far, several promising inhibitors with activity against insect amylase have been isolated from wheat. The next step is to identify the genes controlling these inhibitors and to transfer these genes into desirable varieties of wheat. The presence of a chemical detrimental to insects would protect the plants from damage.



This "scare-eye balloon" keeps birds away from sorghum fields.

Research Highlights 1988 to 1990

■ ANIMAL PRODUCTION

Animal Breeding

Many private breeders cross animals to attain superior genetic traits. Therefore, KAES scientists in the Department of Animal Sciences and Industry have concentrated on basic research to discover procedures for genetic improvement. Such research frequently involves long-term projects.

Various studies include research on the effects of inbreeding on shorthorn cattle. Such research can lead to publication of sire evaluations, which provide genetic information for commercial producers. Another project considers the growth and feed-conversion efficiency of beef cattle. A new study of sheep and cattle considers genetics of reproduction.

Poultry have been studied from the viewpoints of social organization and behavior patterns. The goal is to determine which genetic stocks of chickens are best suited to living in the high-density, enclosed environments used by commercial producers.

Improving Feed for Cattle

Several studies by animal scientists have evaluated variations in diets and their effects on cattle performance. Additions of fat to finishing diets can increase the energy content, while making the particles more cohesive and reducing the dustiness of the feed. Tallow

Many research projects seek to improve the performance of beef cattle in Kansas.



added to a corn-based diet lowered feed intake slightly, but average daily gains were similar from diets without fat or with lower levels of tallow. Feed efficiency was best with 4 percent tallow, so this may be the optimum amount for use with corn.

Diets based on steam-flaked corn or sorghum with and without added fat also were tested for finishing steers. The addition of 4 percent

yellow grease increased average daily gains and feed efficiency. Steam-flaking the sorghum increased its net energy value nearly to that of corn. In fact, carcasses from the sorghum-fed cattle received a slightly higher yield grade.

Ultrasound—A New Tool

Continued research with ultrasound technology is improving its accuracy and expanding its applications in cattle production. A study at the Fort Hays Branch Station evaluated the repeatability of ultrasound measurements of backfat in live cattle and compared them to traditional carcass measurements. The differences between two ultrasound measurements of more than 200 cattle were very small. Overall, ultrasound measures for over 500 cattle averaged 8 percent less than carcass measures. Discrepancies were greater when backfat was thicker. However, traditional methods of evaluating carcasses have far more potential for error than ultrasound.

In addition to backfat thickness, marbling of muscle can be determined by ultrasound. Speckling in the ultrasound images from live cattle was highly correlated with carcass marbling scores. Ultrasound scanning to predict carcass grade as much as 148 days before slaughter could allow producers to cluster feedlot cattle into outcome groups for more efficient marketing.

Breed Differences in Meat Tenderness

Bos indicus breeds often are used in cross-breeding programs, because they provide the maximum amount of hybrid vigor when crossed with *Bos taurus* breeds. However, meat from *B. indicus* breeds often is less tender. Because tenderness is a major palatability trait that determines consumer acceptability, understanding what makes meat from these animals less tender is important.

Many factors can influence tenderness, including postmortem rates of pH and temperature decline, collagen content, type and length of muscle fibers, and postmortem activity of proteases (enzymes that break down proteins). Animal scientists tested all these factors in meat from Hereford-Angus cattle and crosses with Sahiwal cattle. Meat quality was similar, except for tenderness. Meat from H-A cattle was rated more tender by mechanical tests and trained taste panelists. The only biological trait that differed was the amount of a protease inhibitor present at 24 hours postmortem. This inhibitor slowed down protein degradation in the muscle during aging, making the meat tougher.

Custom Feedlots in Kansas

Increasing incentives exist for cow-calf producers or backgrounders to retain their cattle through the finishing phase. Although this can be more profitable, many producers lack the necessary facilities and must place cattle in a custom feedlot. To determine the services offered by such feedlots in Kansas, an agricultural economist conducted a survey. Questionnaires were returned by 66 custom feedlots, representing about 30 percent of those licensed in the state.

Results showed that the majority of cattle were sold live. All feedlots offered finishing of steers, heifers, and Holsteins, and 95 percent would finish calves. About 68 percent offered backgrounding, and less than 40 percent offered wheat or summer grazing. Few feedlots had a resident veterinarian or nutritionist, but most consulted such experts regularly. For most feedlots, the minimum acceptable lot size was 30 head.

About 88 percent were willing to feed cattle on a partnership basis; 62 percent charged interest rates similar to those of local banks. On arrival, cattle were processed at an average charge of \$5.31 per head. Average yardage charges were 5 cents per head per day. Average feed markup was 23 percent for feedlots not charging yardage and 16 percent for those charging yardage.

The results of this survey should help cattle producers choose a custom feedlot that best suits their operation.

Vitamin Beneficial to Swine

Folic acid is one of the B vitamins found in green, leafy plants. When breeding herds of swine move off pasture into drylots or confinement systems, this vitamin is missing from their diets. Researchers in the Department of Animal Sciences and Industry added folic acid to diets for gilts and found positive results. Feeding folic acid at a rate of 1.5 grams per ton of feed (costing less than \$1) resulted in one more live pig per litter. Folic acid is involved with protein and DNA synthesis, which are important for placental and embryo growth. Its presence in the diet increased embryo survival.

Better Diets for Swine

Early weaned pigs are fed a high nutrient-density diet containing 40 percent milk products and 10 percent added fat. Although sow's milk also is high in fat, some young pigs have trouble utilizing the dietetic fat. Another nutrient, carnitine, is quite high in sow's milk and may be involved in digestion of fat. A recent study in the Department of Animal Sciences and Industry considered

the effects of adding carnitine to starter diets. Results showed an improvement in feed efficiency of pigs receiving carnitine. However, the optimum dose must be determined.

The nutritional value of raw soybeans is limited by the presence of proteins called trypsin inhibitors.

However, new types of soybeans lacking these inhibitors are available for use in pig diets. Animal scientists tested two methods of processing these soybeans: roasting and extrusion. In a 35-day trial with 100 pigs, the extruded, inhibitor-free soybeans gave the best average daily gain and feed efficiency.

In a related study of finishing pigs, animal scientists compared diets containing soybeans and/or sorghum in grain form or extruded. Extrusion involves heat and compression, which disorganize the structure of starch granules in cereal grains. The starch is then more easily attacked by digestive enzymes and may be used more efficiently by pigs. Use of extruded soybeans and sorghum separately or together improved efficiency of gain. The best growth performance resulted from the combination of both extruded grains.

Marketing Feeder Pigs

An agricultural economist examined the potential, profitable, hedging opportunities that the live hogs futures market has offered



Custom feedlots in Kansas offer a variety of services.

Additives and processed grains in swine diets improve feed efficiency.





Improved Sheep Production

The number of sheep raised in Kansas has increased in recent years, partly because of the opening of a lamb slaughter facility in the state. Kansas ranks 12th in the nation for producing sheep.

Research at the Northwest Research-Extension Center included further study of the effects of artificially extended photoperiod on lamb growth. Previous work showed a small but positive response. The combination of extended daylight hours and zeranol implants was tested with over 300 crossbred lambs.

During the 58-day trial, implanted lambs in natural light showed improved daily gain and the greatest feed efficiency. In the extended photoperiod, implanted and non-implanted lambs grew at similar rates. At the end of the feeding period, the implanted, natural-light lambs weighed 3.9 pounds more than the non-implanted, natural-light group. Both groups in extended light were intermediate. In this case, the response to an implant predominated over any response to increased light.

Researchers also continued looking for ways to increase the number of lambs born each year. The Rambouillet ewes popular in Kansas are not as productive as such other breeds as Finn and Booroola Merino.

Rambouillet ewes have been bred to Booroola and Finn rams, as well as Rambouillet rams, and their female offspring subsequently have been bred several times. The crossbred ewes consistently produced more lambs than the straightbred Rambouillets, with the number of lambs born per ewe ranging from 15 to 33 percent greater. However, preweaning death losses were higher for lambs born to Booroola-cross ewes. This may be related to their smaller size, which limits their ability to consume enough feed to meet their gestation and lactation needs.

Bison Thriving on Prairie

In the autumn of 1987, bison were introduced to the Konza Prairie Research Natural Area. The animals adjusted quickly to their spacious, fenced-in area, and their numbers have increased every year. Biologists have begun to study their grazing habits and effects on the vegetation.

Results from 2 years show that bison grazing has a significant impact on big bluestem, a dominant, warm-season grass in eastern Kansas. Grazing was limited mostly to areas that had been burned at the beginning of the year. Within areas, bison selected patches with a high cover of big bluestem and other grasses

Some breeds of sheep frequently produce twins.

feeder pig finishers from 1980 through 1988. Results indicate that profitable hedging opportunities were frequent but generally were not sustained at high frequencies beyond 6 months. Opportunities to improve returns by hedging relative to cash marketing were often present, although not always at a profit. Overall, the results suggest that the live hog futures market is a valuable tool for a feeder pig finisher to consider in a marketing plan.

Better Packaging for Pork

Packaging with a modified gas atmosphere offers a longer product life for pork cuts, including loins. Researchers in the Department of Animal Sciences and Industry tested various combinations of carbon dioxide and nitrogen or oxygen gases with conventionally and ultra-chilled pork sides. Ultra-chilling reduced carcass shrink but had no other effects. The mixture with oxygen had the most adverse effects: more off-odor, higher microbial counts, less desirable color, and reduced display life. Other treatments showed variable results in comparison to vacuum-packaging.

Use of 100 percent carbon dioxide for packaging gave better results. Length of storage was the primary factor influencing shelf life of whole pork loins and their retail chops. Although microbial counts were acceptable in loins stored up to 19 days, discoloration of meat was obvious after 11 days and greatly reduced display life. Overall characteristics of bone-in pork loins were superior with this modified atmosphere packaging than with more traditional systems but for a limited time span.

but few forbs. Tiller density of big bluestem decreased throughout the year. At the end of the season, aboveground biomass was 80 percent lower for grazed than for ungrazed big bluestem. Plants grazed in 1988 had lower total leaf areas throughout the 1989 season and lower relative growth rates early in the season.

Animal scientists have taken advantage of the presence of bison to study aspects of their di-

gestion. They have compared the microbial populations in the rumens of bison and cattle, noting some organisms in common and some unique to each species. They have identified all members of one major group of rumen organisms, ciliated protozoa, typically present in bison. In feeding studies, they have observed the effects of these microbial populations on digestion of high- and low-quality forage.

■ ANIMAL HEALTH

Preventing Liver Abscesses

The grain diet of feedlot cattle causes excess acid, which irritates the inner lining of the rumen and causes bleeding. The blood transports bacteria from the rumen to the liver, where they form abscesses. Cattle with abscesses gain slower and are less efficient, and the damaged livers are condemned for human consumption.

Researchers in Animal Sciences and Industry developed a method of detecting liver abscesses in live cattle via ultrasound scanning. Further work will determine when in the finishing period the abscesses start to form. Antibiotics administered at that time would be most effective. A vaccine to prevent formation of abscesses also is being tested with the aid of ultrasound to check its effectiveness.

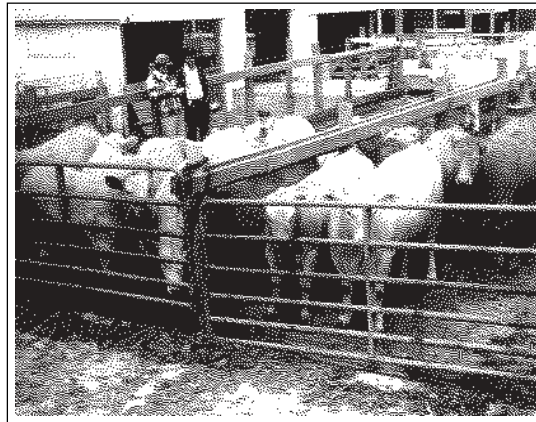
The combination of these new techniques could reduce the \$15 million annual loss to the U.S. cattle industry caused by liver abscesses.

Immune System of Cattle

The immune system is a complex mechanism that living organisms use to recognize invading pathogens and protect themselves against infections. Several current research projects are seeking to understand exactly how this system works and to improve immunity of cattle against several diseases.

One project in the Department of Anatomy and Physiology is studying stress-induced and viral-induced suppressions of the immune system. Results show that a hormone, interleukin, can alleviate this suppression. The combination of a conventional vaccine followed by treatment with recombinant interleukin-2 greatly boosts the immune system of calves. The optimal dose of interleukin-2 has been found, and now interleukin-1 is being tested. Hormones must be used carefully; too little will not be effective and too much will cause illness.

Another study in the Department of Laboratory Medicine is developing a better type of



Crowded conditions in feedlots cause health problems in cattle.

vaccine against the virus that causes bovine respiratory disease. Annual losses from this disease amount to over \$50 million in Kansas. Most vaccines use live or modified viruses, which always carry the risk of introducing the disease to healthy animals. The new vaccine contains anti-idiotypes, which are structurally similar to the virus and fool the immune system into responding.

Tracking Face Flies

Face flies are serious pests of livestock in Kansas. They cause eye irritation and transmit the pathogen that causes pink eye. In the winter, these flies hibernate in church steeples and the attics of houses. They tend to return year after year to the same buildings.

An entomologist has found some fly-infested buildings near Manhattan. By studying the behavior of the flies and the characteristics of the buildings, he hopes to find out why they migrate to the same place and how to control them. Results so far indicate that flies prefer buildings with steep, gabled roofs and congregate near the tops, where temperatures are colder. In warmer areas, the flies remain active, use up their energy reserves, and die. Owners of susceptible buildings should screen all vents leading to the attic to prevent flies from entering.

Rabies in Kansas

All animals in Kansas that are suspected of having rabies are submitted to the Veterinary Diagnostic Laboratory at KSU for examina-

tion. Data concerning the number of animals submitted and the number diagnosed as rabid have been recorded since 1966. These data were compiled to serve as baseline information to detect any changes that might occur in the status of rabies in the state.

The striped skunk was the primary animal with rabies. Although about 15 times less frequently diagnosed, domestic cats were second, followed by bats. A correlation was

found among the number of cases of rabies for these animals. Thus, an increase in the number of rabid skunks may indicate that the incidence of rabies in other animals also will increase. When many rabid skunks are found, veterinarians should remind cat owners to be sure that their animals are vaccinated. The general public also should be informed that a higher risk of exposure to rabies exists from cats and other domestic animals.

KAES received a significant donation of hard red winter wheat germplasm in 1990.



■ CROP PRODUCTION

Plant Breeding

The wheat breeding program is one of the oldest KAES projects and has contributed greatly to the state's wheat industry and economy. Many Kansas-adapted varieties have been released, each representing 10 to 12 years of research.

High quality seed improves establishment of wheat seedlings.

Soybean breeding aims at developing drought- and disease-resistant varieties. Although many private companies also are working on better soybean varieties, university research is still needed.

A corn breeding program was started years ago by the USDA. The main emphasis has been to increase drought and heat tolerance of corn grown in Kansas. Additional work has increased the yields of both yellow and white corn.

The breeding program for sorghum is the newest. It focuses on resistance to drought, diseases, and insects. Researchers are developing germplasm with the desired characteristics. Then the germplasm will be released to private companies that produce hybrid sorghum seeds.

A smaller project involves improving the seed production of gamagrass, a native perennial species. Gamagrass has potential as an alternative crop for forage.

These programs are centered in the Department of Agronomy, with a unit for wheat at the Fort Hays Branch Station.

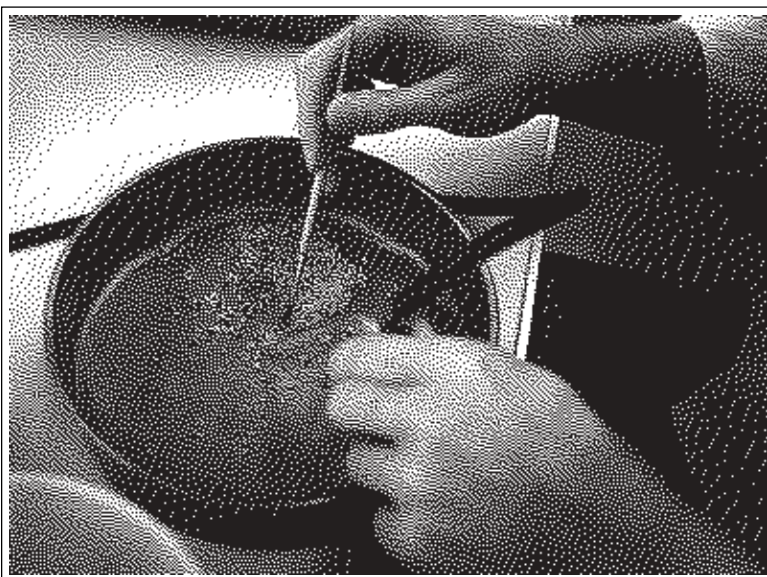
Gift to Wheat Breeding Program

Pioneer Hi-Bred International, Inc., donated to KSU the hard red winter wheat (HRWW) germplasm and commercial varieties it had developed over the past 20 years. The company dropped its HRWW breeding program because it was unprofitable. KSU was chosen to receive the materials because it has excellent research facilities and an outstanding reputation as a provider of certified seed.

This gift is an important contribution not only to KSU but also to breeding programs and wheat producers across the Great Plains. This source of diverse genetic material will enhance the Wheat Genetics Research Center and the breeding research in Manhattan and Hays. In addition, germplasm will be available to other universities, and industry will have access to commercial varieties.

Quality of Wheat Seed

Seed quality is related to size, weight, and protein content. Seedling development in wheat can be determined partly by growth (length and weight) of the coleoptile, a protective covering of the emerging shoot, and by emergence in the field. A study at the Fort



Hays Branch Station examined the relationship of seed quality to coleoptile growth and field emergence of two semidwarf varieties of winter wheat. Large size and high kernel weight resulted in both greater coleoptile growth and emergence; high protein content also increased coleoptile growth. Thus, using wheat seed of high quality can enhance seedling performance and establishment of the crop.

Plant Reactions to Greenbugs

Entomologists at the Fort Hays Branch Station compared the reactions of sorghum hybrids that were resistant and susceptible to greenbugs. The insects damaged seedlings of both hybrids within 7 days. However, when the greenbugs were removed, the hybrids responded differently. The resistant plants resumed normal growth, whereas growth of the susceptible plants was reduced. Twenty-one days after insect removal, the fresh weight of roots from formerly infested, susceptible plants was 33 percent that of roots from noninfested plants. This reduction in root growth could predispose sorghum plants to drought injury and increase lodging.

Sorghum Adapts to Drought Stress

Ethylene is a gaseous hormone that is produced by all plants in small amounts. However, when plants are stressed by temperature, mechanical damage, flooding, or drought, they produce more ethylene. Researchers in the Department of Agronomy measured the ethylene production of sorghum plants grown in dry conditions. Cultivars known to be drought-resistant generated more ethylene than cultivars that are drought-sensitive.

The adaptive advantages for resisting drought provided by ethylene relate to its role in leaf abscission and reducing stem elongation. A cultivar that can reduce its leaf area and decrease its height during drought may have a better chance of survival than a cultivar that keeps growing. The smaller plant will lose less water through its leaves and, thus, conserve water in its tissues.

Profitable Soybeans

An evaluation of 8 years of data from the Southeast Kansas Branch Station showed that yields from double-cropped soybeans after wheat can vary greatly. In a good year, they are comparable to yields of full-season soybeans. Agricultural economists conducted a risk analysis of a representative farm in the area. For all classes of risk preference, a 2-year rotation of wheat, double-cropped soybeans, and full-season soybeans was preferred. In cases where labor, machinery, or field time limit the number of acres planted,

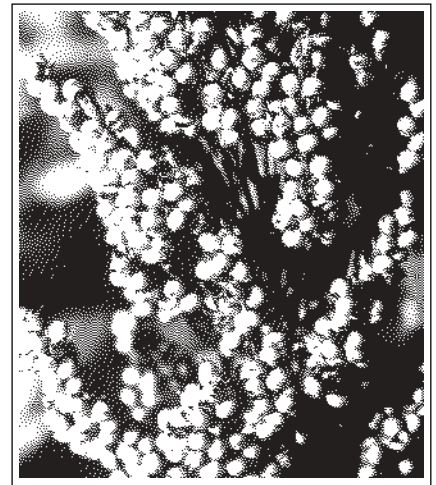
producers may prefer to double-crop on just part of the wheat acreage or not at all.

In Kansas, rainfall usually is low in late summer, when soybeans are flowering and setting seed. Also, soybean prices frequently are lower in the fall harvest season. If soybeans could be planted in spring and mature by midsummer, yields and profits might be increased. In southeast Kansas, short-season soybeans (maturity groups 00, 0, and I) planted in April yielded as much as full-season soybeans planted in June. Economic analysis showed that the most profitable plan was planting group I soybeans in April.

Better Alfalfa

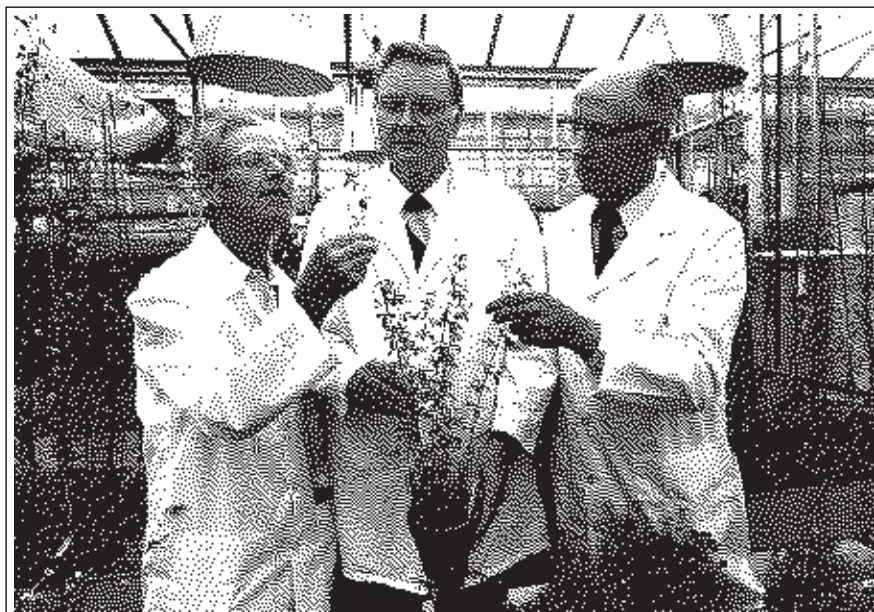
Cooperative work among researchers in the departments of Agronomy, Entomology, and Plant Pathology has resulted in development of 25 pest-resistant types of alfalfa. The process can take as long as 20 years.

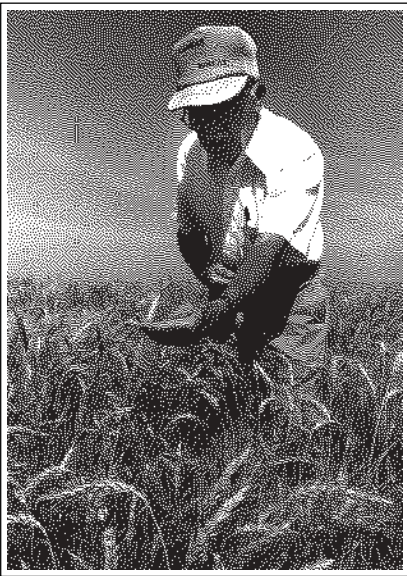
Seeds of two alfalfas, KS71 and KS153, were released to plant breeders in 1989. Both are resistant to several diseases plus pea aphid, spotted alfalfa aphid, and blue alfalfa aphid. In addition, KS71 has tolerance to alfalfa weevil, and KS153 has tolerance to frost damage. Another recent release, KS208, is resistant to five diseases and three insects. KS206 is derived from a plant with resistance to pea aphid, spotted alfalfa aphid, and bacterial wilt. It shows high in vitro regeneration of



Sorghum may resist drought by producing more ethylene.

New varieties of alfalfa are grown and tested in a greenhouse.





Karl Finney inspects the new cultivar of hard red winter wheat named for him.

plants and can be used in developing new germplasm.

Varieties of alfalfa with glandular hairs on their stems and leaves have been introduced into the breeding system. The glands excrete a sticky substance that repels or traps insects, thus preventing further infestation. Glandular hairs are excellent defense mechanisms, because they simultaneously control several insect pests.

Resistant plants contribute to the establishment and maintenance of crops and to forage quality and yield.

Frost-tolerant plants show superior growth in autumn, which could give growers one additional harvest.

Kansas is an important battleground for diseases and pests of alfalfa because of its central location. Insects and diseases can enter from all regions of the country. Research by KAES scientists has developed alfalfa populations that are among the most resistant in the world.

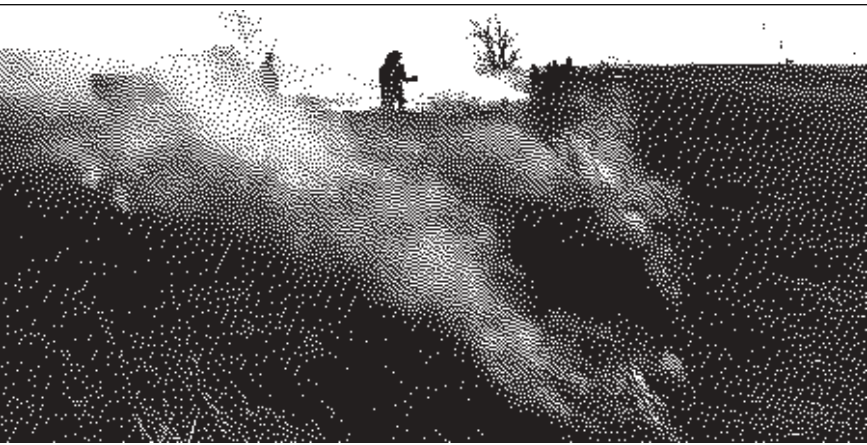
■ RANGE MANAGEMENT

With more than 40 percent of Kansas land used for grazing livestock, KAES researchers are examining ways to improve range management.

Burning of Range

Investigations into the benefits of range burning have been conducted since the early 1900s, longer than at any other university. Early studies showed that burning pastures in late spring did not reduce range productivity and resulted in 30 pounds of added weight gain per steer.

Spring burning is essential to maintain native grasses.



Other New Releases

Several new wheats were released during the biennium. Hard red winter wheats included KS89WGRC3 and KS89WGRC6, both resistant to biotype D Hessian fly; KS89WGRC4, resistant to biotype D Hessian Fly and biotype E greenbug; KS89WGRC5, resistant to Hessian fly, greenbug, and soilborne mosaic virus; and KS89WGRC7, resistant to leaf rust. In addition, Karl wheat was registered. This cultivar is best adapted to central and eastern Kansas. It has yield and grain volume weight superior to those of Arkan and Newton, excellent milling and baking qualities, and high protein content. Karl is resistant to soilborne mosaic virus and spindle mosaic virus and has improved tolerance to tan spot. The name honors Karl Finney, an internationally known cereal chemist, who made outstanding contributions to improving the milling and baking qualities of hard red winter wheat in Kansas.

A cultivar of eastern gamagrass, Pete, was registered for use in the eastern Great Plains. It resembles wild types but matures earlier than other native warm-season grasses and remains green until frost. It's useful for pastures (grazing), hay, and reestablishment of native prairie.

Current research focuses on the long-term effects of burning on the ecosystem. Properly timed burning improves forage quality and does not decrease nutrients available in the soil. One study showed that photosynthesis of the canopy of prairie plants was greater in a burned area when plenty of water was available. However, after a dry period, the plants in the unburned area were more productive. Thus, the benefits of burning can be affected by environmental conditions.

Stocking Rate

Intensive-early stocking of range (2.5 times more than the normal rate) promotes the growth of warm-season grasses. These predominate in the tallgrass prairie, where this system works well. However, farther west near the Fort Hays Branch Station and beyond, this high rate would damage the grass. Lower rates of early season grazing can still provide advantages there. Stockers can be put on feed sooner or sold during the traditionally strong midsummer market.

Controlling Weeds

Weed control is a consideration in maintaining productive range. Burning eliminates many types of weeds and brush but not all. Tall shrubs and trees cause more problems than herbaceous weeds, because they shade

the grasses and decrease forage production. An agronomist is experimenting with combined burning and herbicide application to control certain kinds of brush, like blackberry.

To reduce environmental pollution, herbicides are sprayed directly on trunks of trees, spotted near roots, or used as pellets that are scattered on the ground around plants.

Yucca is a particular problem in western Kansas, where pasture burning is limited. It's a very hardy plant with a woody base and long roots. The amount of yucca has doubled in recent years, since use of the one effective herbicide was suspended. A new herbicide is being tested. It's applied only once, but then requires 4 to 6 years to kill the plant.



■ GRAIN RESEARCH

A New Tester for Wheat Hardness

The Federal Grain Inspection Service (FGIS) still relies on the traditional, visual method for classifying wheat. However, this method is not adequate for identifying new varieties, which often combine traits of hard and soft wheats. For example, Arkan has kernels that look like soft wheat but mill and bake like hard wheat.

A federal working group on wheat classification has been formed to develop a new system. The FGIS will designate an official standard to measure hardness. A single-kernel hardness tester developed by an agricultural engineer and grain scientists at KSU is being considered for use.

This hardness tester measures the force it takes to slice or crack a wheat kernel. It can slice 200 kernels a minute and records force readings at one-half millisecond intervals, taking from 300 to 500 readings per kernel. In a test of more than 1,000 commercial samples from all over the United States, the instrument misclassified less than 1.5 percent of the samples as compared to FGIS visual classification. Maximum force to cut the kernel is the most reliable indicator of hardness, but researchers are continuing to improve the instrumentation to give better separation between hard and soft wheats. The tester has been patented and is ready for commercial production.

When a more sophisticated classification system has been established, millers and bakers may be able to contract with farmers to grow a particular wheat for a specific purpose. Certainly, the economic and milling problems associated with mixtures of hard and soft wheats will be eliminated.

Stable Form of Vitamin C

Vitamin C is an essential nutrient in the diets of cultivated fish and shellfish, some birds, guinea pigs, and primates. However, vitamin C is one of the least stable ingredients in formulated feeds and processed foods. A researcher in the Department of Grain Science and Industry has developed a new, modified form of vitamin C, known as ascorbate 2-polyphosphate (AsPP), which is hundreds of times more stable than ascorbic acid. AsPP is already being used around the world in diets for cultured fish. It also may be useful in foods as an antioxidant and antibrowning agent, as well as a nutrient.



Intensive early-season grazing can be profitable to producers.

New varieties of wheat have kernels that are difficult to classify.

Crop stubble reduces soil erosion and conserves water.

*photo by
Larry Murphy*



■ CONSERVATION TILLAGE

Scientists from several departments and branch stations/centers of KAES are developing a strong research base on which to make recommendations to farmers practicing conservation tillage. An increasing number of farmers produce crops with reduced tillage, many in compliance with the 1985 Food Security Act. That legislation asked farmers to complete conservation plans for highly erodible cropland.

Kansas has more than 10 million acres of cropland that fit into that category. Most conservation plans include reduced tillage practices, which involve managing straw and stubble left from crop harvests. Recent surveys indicate that 35 to 40 percent of the state's farmers practice conservation tillage, with 2 percent using no tillage.

KAES research by agronomists in Manhattan and at the branch stations clearly shows that conservation tillage is a desirable and beneficial management system in most areas of the state.

Saving Soil

Organic matter has been declining in Great Plains soils. The decline is related to biological oxidation of humus when soil is aerated by tillage and to physical loss of topsoil by water and wind erosion. More surface residue and less tillage should reduce or at least stabilize loss of soil organic matter. In fact, several years of conservation tillage can restore significant amounts of organic carbon and nitrogen to soils. Rotations including crops that produce a lot of residue (like sorghum) also increase organic content of soil.

Increased Yields and Water

A long-term study at the Southwest Kansas Research-Extension Center has indicated that reduced tillage increased yields of both crops in wheat-fallow and wheat-sorghum-fallow (WSF) systems. Reduced tillage also increased the amount of soil water at planting by 1.2 and 1.8 inches for wheat and sorghum,

respectively. Water use efficiency was increased for these crops in the WSF system under reduced tillage.

Fertilizer Use

A fertilizer study at Manhattan compared application methods in grain sorghum grown under conservation tillage. Urea-ammonium nitrate solution was surface broadcast or knifed into the soil. Sorghum receiving the surface application performed poorly, whereas that receiving the knifed-in application produced significantly higher grain yields. It also had high nitrogen contents in grain and tissue. These results indicate that the most efficient use of nitrogen fertilizer can be achieved by avoiding residue contact during application.

Fertilizer management for wheat and sorghum with several tillage systems was investigated at the Fort Hays Branch Station.

With no tillage, starter nitrogen applied with the seed gave the highest net return on dollars invested. However, additional nitrogen applications sometimes were required for highest yields.

Controlling Diseases

Wheat residue left on the soil surface can harbor organisms that cause diseases (tan spot and cephalosporium stripe) in the next crop of wheat. Therefore, reduced-tillage systems for wheat, especially in central and south-central Kansas, must involve rotation with other crops. Research has shown that growing another crop for just one year can reduce early-season tan spot by 55 percent, even with the maximum amount of residue. Moldboard plowing to bury the infected residue had a similar effect.

Economic Advantages

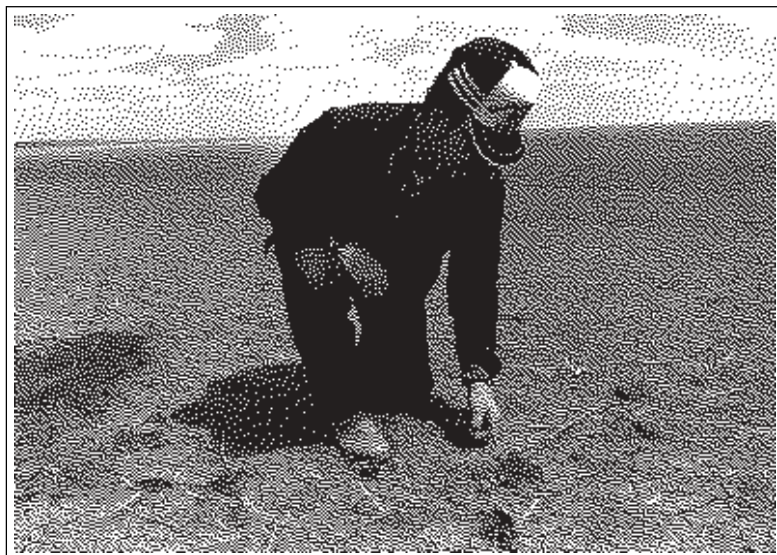
The benefits of conservation tillage are clear, but is it profitable? A study by agricultural economists and agronomists showed that returns depend on the combination of tillage systems and crops. Three tillage systems were compared for continuous corn, continuous soybeans, and a corn-soybean rotation in northeast Kansas. The highest net returns for each tillage system resulted from the corn-soybean rotation. The no-till system had the highest net returns when corn was included. Conventional tillage had the highest returns only with continuous soybeans. When payments for corn from government commodity programs were included, variation in returns but also net returns were reduced. Under the conditions used in this study, producers who seek to reduce risk would prefer a no-till corn-soybean system without participation in a government program.

Predicting Wind Erosion

Although conservation tillage can reduce its effects, wind erosion is still a major problem in Kansas. A team of USDA researchers associated with the Department of Agronomy is developing a new system to predict wind erosion. It will replace the current system initially produced at KSU in 1965.

The new prediction system consists of a computer model that generates simulated weather patterns and soil surface conditions to calculate the amount of erosion that will take place on a particular piece of land. The submodels include crop, soil, weather, erosion, decomposition, tillage, and hydrology. These furnish information to each other in various combinations, just as the conditions they describe interact to affect the occurrence and extent of erosion.

The model uses data collected at frequent time intervals, because conditions can change rapidly. For example, soil can dry out within a few hours after a heavy rain and be susceptible to wind erosion again. Validation of the model against data from field studies has



shown it to be very accurate in predicting erosion under various conditions.

With a better tool for predicting soil erosion, soil conservation agents will be able to recommend preventative measures to avoid further loss of valuable cropland.

During droughts, wind erosion can cause severe loss of soil.

photo for Wichita Eagle Beacon by Fernando Salazar

■ WATER RELATIONS

More Efficient Water Use

Effective scheduling of irrigation conserves water and energy. Because soil moisture measurements are costly and time consuming, KAES researchers have developed a scheduling system using stage of plant growth. Water applied at the right time will be used more efficiently by the plants. Corn that was irrigated three times (at 8, 9, and 10 weeks after emergence) yielded almost as much as fully irrigated corn (five or six applications). Soybeans did equally well with only two irrigations at the correct growth stages.

Better Production of Vegetables

A cropping system developed by a researcher in the Department of Horticulture can double vegetable or fruit production, while conserving water resources. The system involves use of drip irrigation with a mulch of black plastic film and is applicable to small gardens or large commercial plots.

The plastic tube for irrigation, with holes for water release, is buried about 3 inches deep in the soil, and then the plastic mulch is laid on top of the soil. Holes are cut in the film for transplanting or seeding vegetables and fruits.

The system has several advantages for crop production. The soil warms up faster in the spring, plants grow more quickly, water can

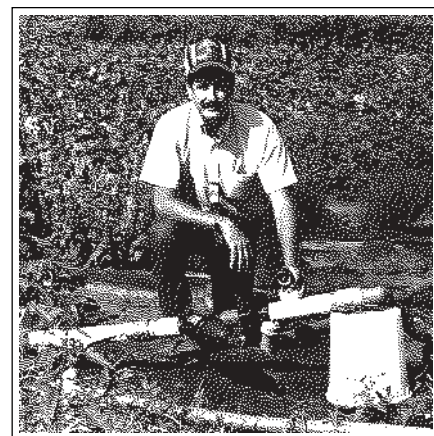
be supplied slowly to the roots, weed control is excellent, and produce is cleaner. Growers usually can market their produce 10 to 14 days earlier than usual, which often means getting a higher price.

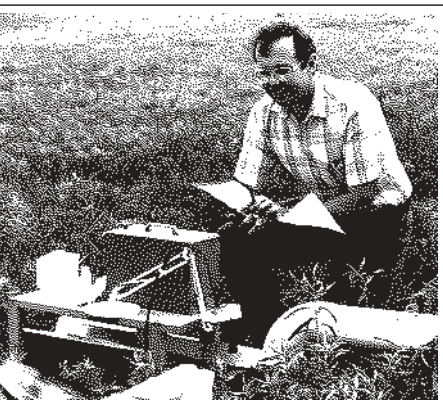
Environmental benefits include less water use and less contamination of groundwater. For the same acreage, drip irrigation uses only half the water required for overhead irrigation. Fertilizer can be injected into the irrigation water in small amounts. The tube prevents leaching into the soil. Photodegradable plastic film, which slowly breaks down from exposure to sun, is being tested. It would eliminate the problem of removing and disposing of the mulch every year.

Irrigating Crops

Drip irrigation also can be adapted for use with field crops like corn. Agricultural engineers are testing a system at the Northwest Research-Extension Center. The system involves a network of underground pipes with small holes along their lengths through which water seeps out and wets the soil. Successful implementation of drip irrigation could reduce water use for crops by 20 to 35

Drip irrigation reduces water use and improves crop production.





This specific ion meter measures chemicals in groundwater.

percent. The system delivers water near the crop's roots, where it is needed, and evaporative losses are reduced. Such savings are important in the dry climate of western Kansas, where irrigation is prevalent but water supplies are limited.

Chemical Movement in Soil

Extensive use of pesticides and fertilizers threaten water quality. The movement of chemicals in soil depends on climate, rainfall,

soil properties, and management practices. Agronomists are cooperating with researchers in other departments to determine how agricultural chemicals move into groundwater. Results show that atrazine movement is limited to sandy soils, where low concentrations have been detected at depths as great as 15 feet. In heavier soils, atrazine decomposes rapidly. Alachlor tends to degrade quickly and does not seem to move through soil.

Information like this can help producers to use pesticides more wisely and avoid further contamination of water.

■ ENVIRONMENTAL RESEARCH

Climate of Northwest Kansas

The climate of a region is an important natural resource. It determines the type of vegetation that predominates and the adjustments necessary for comfortable life styles.

Through centuries of influence, it has played a major role in determining the types of soil that develop. Understanding climate and its variability is important for predicting future climate and for evaluating activities that impact the environment.

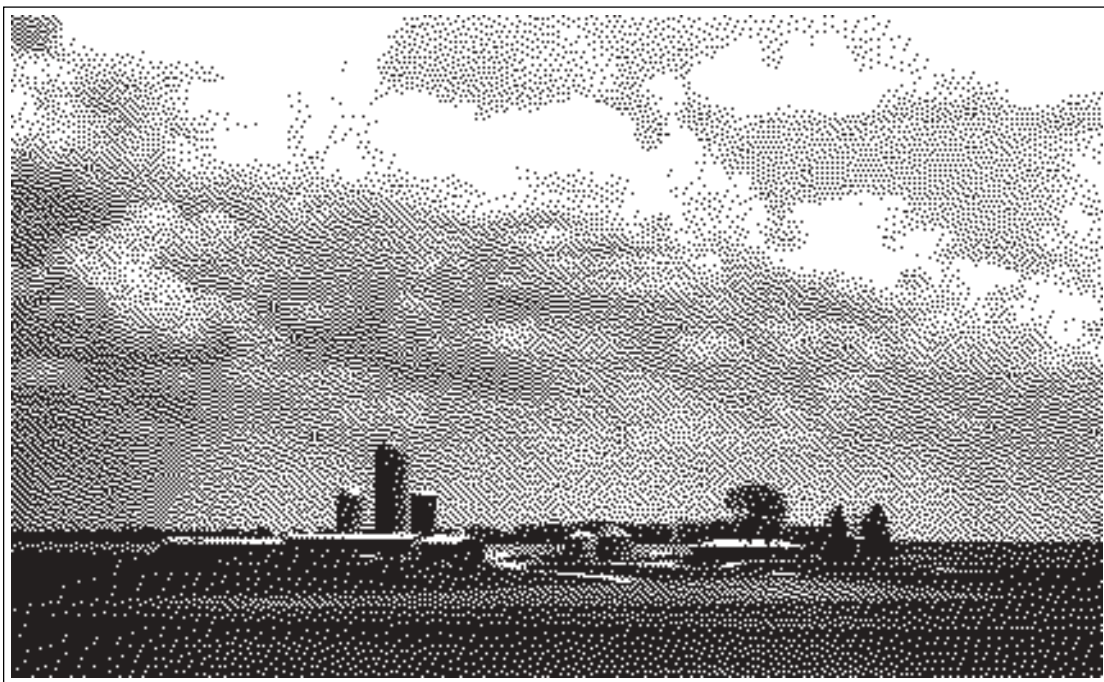
A report from the Northwest Research-Extension Center reviews the physical causes of climate and the history and types of weather data collected at Colby. A series of tables and figures summarize 100 years of weather observations.

The physical factors include the Rocky Mountains, which run north and south and lie

across the path of the jet stream flowing from the west. They cause the air to rise and become cooler. Most of the moisture in the air falls on the western slopes, so that the area east of the mountains (including western Kansas) is very dry. Elevation above sea level influences temperature. Because western Kansas is higher, minimum temperatures are lower and temperatures cool more at night than in eastern Kansas.

A weather station was established at Colby in 1888-89 but then was closed and reopened in 1892. Daily records have been kept there ever since. The Colby Branch Station was established in 1914 and also began keeping weather records. In 1957, the official weather station was moved to the branch station. A network of weather stations was set up in 1980, linking the five branch stations and experiment fields around the state. The network was automated by 1984, and data are collected and stored by a computer. Data in-

The climate of Kansas is variable: perfect weather can follow a severe storm.



clude daily maximum and minimum temperatures, rainfall, wind direction and speed, relative humidity, solar radiation, and soil temperatures.

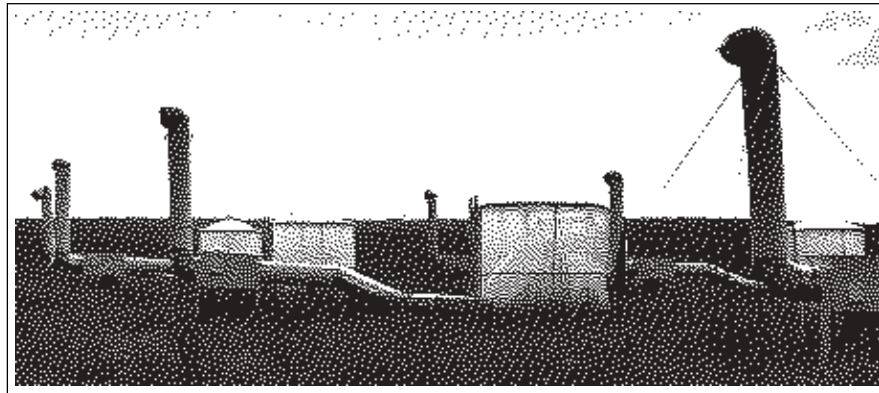
Excess Carbon Dioxide—Good or Bad?

Scientists agree that carbon dioxide in the atmosphere is increasing every year and probably will be double the present level by 2050. However, no one knows how this increase will affect the plants that are the basis of our food supply. Research is underway at 13 sites in the United States to determine the effects of carbon dioxide on major crops and native plants of economic value. The research plots in Kansas are located in Manhattan and Hays.

The concern here is how the tallgrass prairie would react to increased carbon dioxide and how changes in the grasses would affect grazing animals. Researchers are considering the growth, water use, and forage quality of plants.

Small closed chambers have been placed on the prairie, and carbon dioxide is pumped into them at normal and twice-normal levels. Fans exchange the air every 20 seconds, and the environment is monitored continuously by computers.

Larger open chambers are used for grazing tests with sheep. Cattle did not fit in the chambers, and sheep are more discriminating grazers. They tend to choose a higher quality diet and, therefore, should provide more data about the plants. Every 2 weeks, the sheep graze in the chambers where plants have been growing in either normal or elevated amounts of carbon dioxide. Each sheep has a



surgical opening in the esophagus, whereby plant material it swallows is shunted into a collection bag for later analysis.

Preliminary results indicate that many prairie grasses thrive in increased carbon dioxide. However, big bluestem (a warm-season grass) does not react as much as cool-season grasses. Thus, higher levels of carbon dioxide could change the species composition of the prairie. Because less nitrogen is available in the soil when cool-season grasses predominate, this shift could decrease overall productivity. Other variables that affect these results are being studied as well.

In a related study, wheat and sorghum also showed favorable reactions but only under drought stress. The increased carbon dioxide seemed to compensate for lack of water and allow plants to grow normally. This effect could be important, because temperatures are supposed to rise along with carbon dioxide levels. The Great Plains could be warmer and drier in the future.

High-tech “dinosaurs” are used to study effects of carbon dioxide on plants.

Wichita Osage orange is a tree suitable for landscape use.

■ **HORTICULTURAL RESEARCH**

The Wichita Center

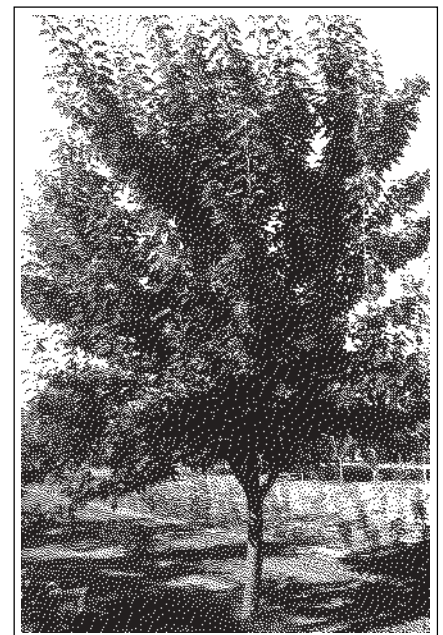
The 20th anniversary of the Horticulture Research Center in Wichita was celebrated in 1990. The center started because of local interest by horticulturists, businesses, and civic groups. With encouragement by the Wichita Chamber of Commerce, the Wichita Area Development (WAD) purchased 40 acres of land and leased it to KSU as a site for conducting research on horticultural crops. Today the center conducts research on woody ornamentals, turfgrass, fruits, and vegetables. It includes a headquarters building, two equipment-storage and shop buildings, and a greenhouse.

At the anniversary celebration, WAD announced plans to transfer the property to KSU. This is an expression of confidence in the horticultural research programs planned

and supervised by two horticulturists at the center.

A recent success of that research is the release of a cultivar of Osage orange (named Wichita) for landscape planting. Wichita is a male, thornless tree that grows to about 10 meters in height and has no fruit. It can be propagated readily by hardwood cuttings.

Osage orange trees are grown in windbreaks and shelterbelts throughout the Great Plains. They also have potential as street trees in polluted urban areas and as landscape trees in dry areas. However, for these additional uses, the large



fruits and hazardous thorns are undesirable. A male tree that was nearly thornless was discovered near Wichita and was used to develop the new cultivar.



Colorful native flowers like *Echinacea* can be adapted to cultivation.

Other projects include developing a dogwood and several rhododendrons that will thrive in the hot, dry conditions of Kansas.

Wildflowers for Cultivation

Many of the colorful wildflowers of the Great Plains would be suitable for cultivation in gardens. However, germination of seeds is often poor in cultivated situations. A researcher in the Department of Horticulture has determined the best conditions for germination of purple

coneflower (*Echinacea purpurea*) and two related species. These plants have showy pink to purple flowers. Exposure to light or to cold temperatures was needed for germination of all species. Only one species grew from direct seeding into the field in the spring. Greenhouse-grown transplants gave the best stands of the other two species.

Turfgrass

Creeping bentgrass (*Agrostis palustris*) is a cool-season turfgrass that is often used on golf course fairways. Atrazine can control weeds in warm-season grasses and does not damage them. However, it can damage cool-season grasses. It also poses environmental threats because it gets into groundwater and runoff from sprayed areas.

To test atrazine's effect on creeping bentgrass, small amounts were applied in irrigation water for 20 days. The results showed that this grass is very sensitive to atrazine. Toxic effects were noticed at concentrations much below those recommended for use of the herbicide.

■ ECONOMICS OF AGRICULTURE

Economic Linkages

An economist produced the most recent of a series of input-output models that was started over 20 years ago. An input-output model is a quantitative framework of analysis for examining the complicated interdependence within the production systems of an economy. KAES is particularly interested in the current linkages of agriculture with the rest of the state's economy. The model used survey data collected in Kansas through interviews by trained personnel plus data from federal and state government agencies.

The model includes four large tables. The inter-industry transactions matrix describes

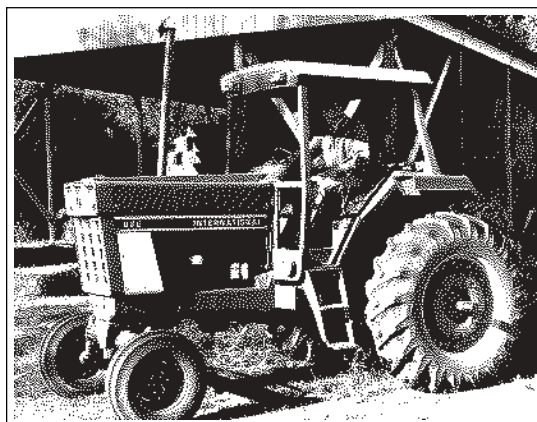
the flow of goods and services between all individual sectors of the economy in a given year. The direct requirements matrix indicates the requirements needed from each industry for a particular industry to produce an average \$1.00 of output. The last two—the direct and indirect requirements matrix and the direct, indirect, and induced requirements matrix—measure the interactions among industries. Each matrix includes 68 industry sectors, 6 final payment sectors, and 7 final demand sectors.

Use of this model can answer practical questions such as: What is the impact of a drought on the Kansas economy? or How will policies to control water quality and quantity affect specific sectors of the Kansas economy?

Estimating Value of Old Tractors

Estimating the value of farm equipment is an important aspect of farm management. An agricultural economist has developed a better way to determine the value of used tractors. The method uses a simple worksheet to calculate the value. Three facts about the tractor are required: list price of the model when new, current age, and PTO horsepower. The KAES report on this research includes a sample worksheet and a lengthy table listing brands, models, and prices.

This method provides an alternative to using the undepreciated value, which is unsatisfactory for new income tax procedures. Recent



A new method more accurately estimates the value of old tractors.

changes in tax laws have underpriced the equipment value that farmers report on their net worth statements.

Kansas Farmland

A group of agricultural economists gathered data from 23,637 sales of farmland in Kansas totalling nearly 5 million acres for the period 1971-1987. They found that the statewide, weighted-average price per acre increased from \$158 in 1971 to \$659 in 1980 then dropped to \$297 in 1987. Generally, smaller tracts of land had higher prices per acre. Seventy-three percent of the sales were of 160 acres or fewer. The highest prices per acre oc-

curred in the Northeast and Southcentral districts and the lowest prices in the Northcentral and Northwest districts. Thirty-five percent of total sales occurred in the months of March, April, and May. Farmland sales by financial institutions increased from 4 percent of total sales in 1984 to 37 percent in 1987. Farms with the highest percentage of cultivated acres sold for the highest prices.



Grain production and transportation are interdependent and affected by other links in the state's economy.

■ **LAND USE IN KANSAS**

Public Access to Private Land

Most of the land in Kansas is privately owned and used for agriculture. Studies were conducted by a researcher in the Department of Forestry to determine the feasibility of expanding the recreation resource base in Kansas by utilizing private, forested land. A survey included 11 counties in eastern Kansas and 8 counties in western Kansas; 1,460 responses were received.

Nearly 40 percent of the respondents allowed nonrelatives to use their land for recreation, especially hunting, fishing, observing nature, and hiking. Fifty-seven percent of respondents reported problems, like trespassing on posted land, property damage, and littering. Most respondents were not informed about liability laws relating to recreational access to their land.

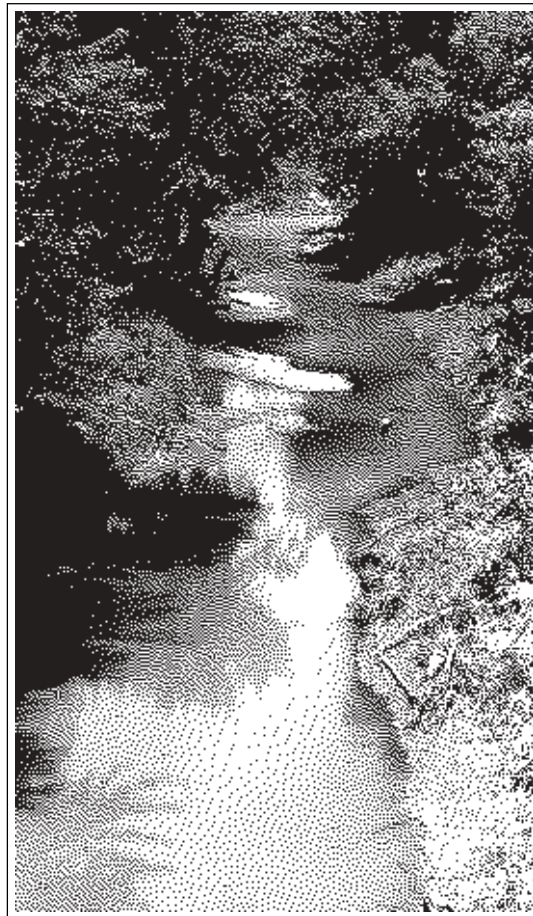
The number of land owners who indicated interest in a state-assisted, public access system was sufficient to provide the acreage proposed by the Department of Wildlife and Parks. However, if such a plan is implemented, land owners need more information about liability, and recreationists need to be educated to respect people's land.

Use of Windbreaks by Hunters

Windbreaks are planted around agricultural land for their obvious effect of reducing wind erosion. However, they also serve as habitats for wildlife that would otherwise be scarce because of the lack of forests in the Great Plains. Two researchers in the Department of Forestry surveyed licensed hunters in Kansas about their use of windbreaks. Useable questionnaires were returned by 842 individuals.

Kansas hunters spend 41 percent of their hunting time in or adjacent to windbreaks. If more windbreaks were available, 80 percent

of the respondents would hunt in them more often. The mean amount of time spent in windbreaks was 55 percent for quail hunters, 40 percent for deer hunters, and 23 percent for pheasant hunters. Important attributes of windbreaks for hunting were being adjacent to crops, having ground cover, and having dense vegetation. Extending these results to all hunters in the state gives an estimate of 1.4 million hunter days annually in windbreaks and accounts for \$31 million in revenue.



Private land is available for recreational use.

Windbreaks provide habitat for wildlife and hunting opportunities.



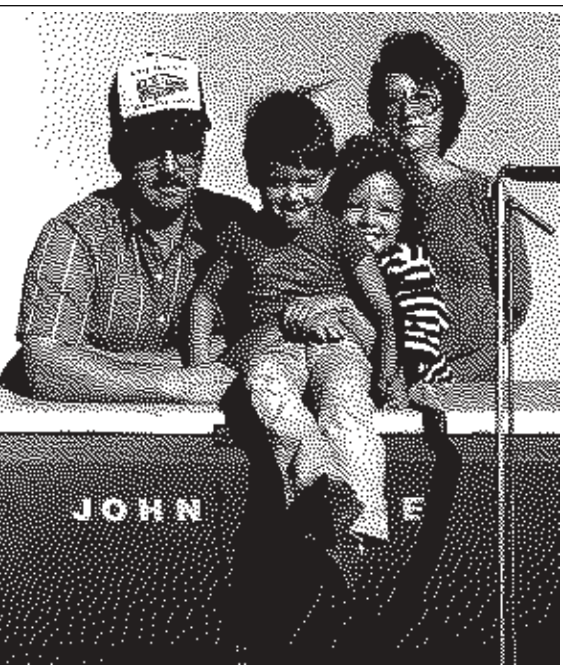
Throughout the Great Plains, the number of windbreaks is declining and their quality is deteriorating. If this trend continues, wildlife populations may decrease, and both the quality and quantity of hunting opportunities will be affected negatively. This would have adverse economic consequences, especially for small, rural communities that depend on income from hunters.

■ CHILD DEVELOPMENT

Rural Children's Environment

Three groups of rural children, initially 3, 6, and 9 years old, and their families were assessed during three, annual, home visits. Researchers in the Department of Human Development and Family Studies gathered information on the home environment and parental relationships and administered intelligence tests to the children.

The results indicated that the quality of children's home environment and their mother's alienation have strong effects on later intelligence scores. Maternal alienation can lower their I.Q. estimates, whereas a good home environ-



Childrens' development can be affected by home environment.

ment can enhance intellectual performance. Effects of socioeconomic status can be mediated by the quality of the home environment.

Rural communities are particularly vulnerable to the consequences of social isolation, because their members are more reluctant to seek external support than are their urban counterparts. Mothers who feel alienated spend less time with their children, which explains the negative impact on their intellectual development.

The Value of Pets

Research in the Department of Human Development and Family Studies has confirmed what children already knew: they need pets. Parents were questioned about themselves, their homes, and their preschool-age children, and the children were tested. Results showed that young children learn skills that improve their social competence with their peers. For example, children with pets showed more empathy towards other people than those without pets. In addition, having a pet tended to improve children's verbal intelligence scores and their ranking on an age-adjusted developmental scale.

■ HUMAN HEALTH

Rapid Tests for Microorganisms

Part of the food science program in the Department of Animal Sciences and Industry is developing and testing rapid methods to identify microorganisms that contaminate food. One of these is *Clostridium perfringens*, which was grown in the laboratory in broth and ground beef. Four methods of recovering the bacterium were compared. Fung's double tube method (developed at KSU) gave higher recovery in less time and at the lowest cost per test.

While testing several media containing dyes, KAES researchers discovered one that encourages growth of *Candida albicans* and

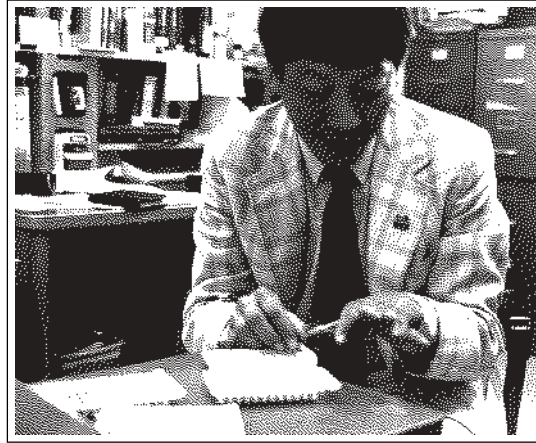
makes it fluorescent. This yeast is a major pathogen of humans, often found in environmental samples. Its rapid identification is important. After 24 hours of incubation, the medium is exposed to ultraviolet light and then put under fluorescent light. *Candida* is the only organism visible under these conditions. Further tests at a medical center showed that the new method is 99.5 percent specific for quickly identifying this yeast.

Seeking Basis of Inherited Blindness

Retinitis pigmentosa (RP) is the term applied to a set of inherited eye defects. The condition starts as a kind of night blindness in the teen years; then the retina slowly deteriorates until complete blindness ensues by middle age. No cure is known.

Occasionally, eye tissue is donated by RP sufferers who die at a young age, before severe damage occurs. Because of this lack of research material, scientists study the molecular chemistry of defective animal eyes for clues to the onset of the disease. As a result of generations of close inbreeding, certain dog breeds have developed retinal defects similar to RP.

A researcher in the Department of Biochemistry uses eye tissue from these dogs, mice, and occasionally humans to study the most basic chemical messengers of sight. These are the proteins and enzymes that convert incoming light into electrical impulses, which the brain remembers as an image. Cell products called antibodies are used as probes to identify the many retinal proteins. Each antibody binds only with a specific kind of protein, so the same tissue can be used many times. In this long-term project, the roles of important proteins that have been identified will be determined. Understanding how they work when



These trays are used in a rapid test for microorganisms.

they are correctly assembled will help discover which proteins, when not correctly assembled, contribute to retinal deterioration.

Such basic research may lead to diagnostic screening tests for genetic retinal defects and even to a cure for RP.

■ INTERNATIONAL AGRICULTURE

A team of scientists, including agricultural economists and agronomists, was involved for several years in an agricultural improvement program in Botswana. The program ended in 1990. Botswana is a sparsely populated country that borders the northern edge of the Republic of South Africa and imports about 80 percent of its food. The researchers showed farmers how to adapt methods to the harsh and varying climate, as well as involving them in experimental projects to improve production.

Available and low-cost inputs can help farmers to reduce risk and optimize labor use. One project addressed recycling two on-farm resources, cereal stover (stalks left after grain harvest) and manure, in grain sorghum production. Results after 3 years showed that manure gave the greatest increase in grain yields. Stover used on the soil surface to possibly lower soil temperature and control wind and water erosion had a negative impact on grain yield. Incorporating stover into the soil also increased yields but not as much as using manure. Returns to labor were very positive. Increased yields gave income equivalent to that

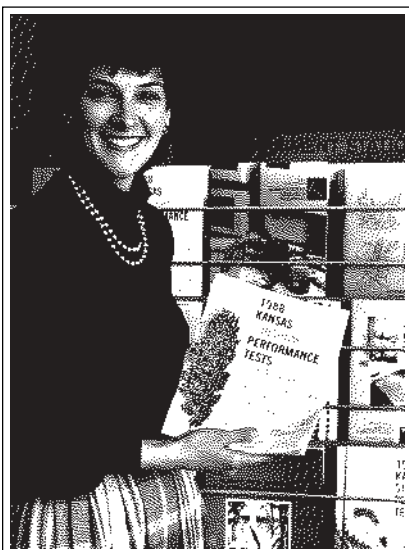
from at least 30 days of off-farm work.

Other projects in Botswana involved production of grain sorghum and pearl millet, including effects of seed quality on stand development, grain and forage yields and stover quality from different varieties, and effects of tillage on soil moisture and grain yield.

Agronomists also have worked in Morocco, evaluating the effects of weeds on grain crops, testing various herbicides for weed control, and developing methods to improve the production of fall-planted cereals.

Research has improved sorghum production in Botswana.





KAES publishes at least 25 Reports of Progress each year.

■ EDITORIAL OFFICE

A total of 1,150 manuscripts received contribution numbers during the biennium, and 837 (73 percent) were edited. The average number per month was 48. A record number of 603 manuscripts was processed in 1990. The categories of manuscripts were:

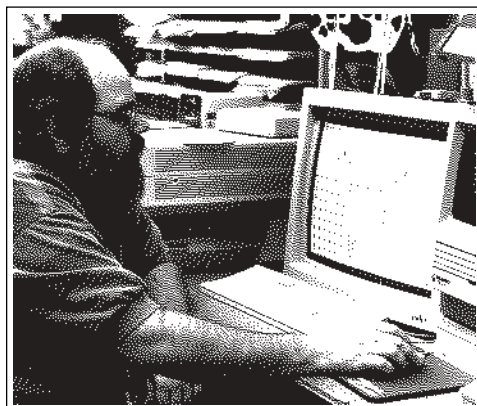
Journal articles	800
Proceedings of meetings	124
Department reports	71
Station publications including 4 Bulletins	63
Books or chapters	61
Trade publications	14
Extension publications	9
Computer programs	8

A survey of users of KAES annual Reports of Progress showed that the current format is acceptable. Articles are written in a concise but technical style with several tables and/or figures to illustrate results. County agents and other readers indicated that the detailed information is useful.

During the annual, combined conferences of KAES and Cooperative Extension, the editorial staff again helped organize successful poster sessions. This chance to share progress on current projects is a popular part of the conference.

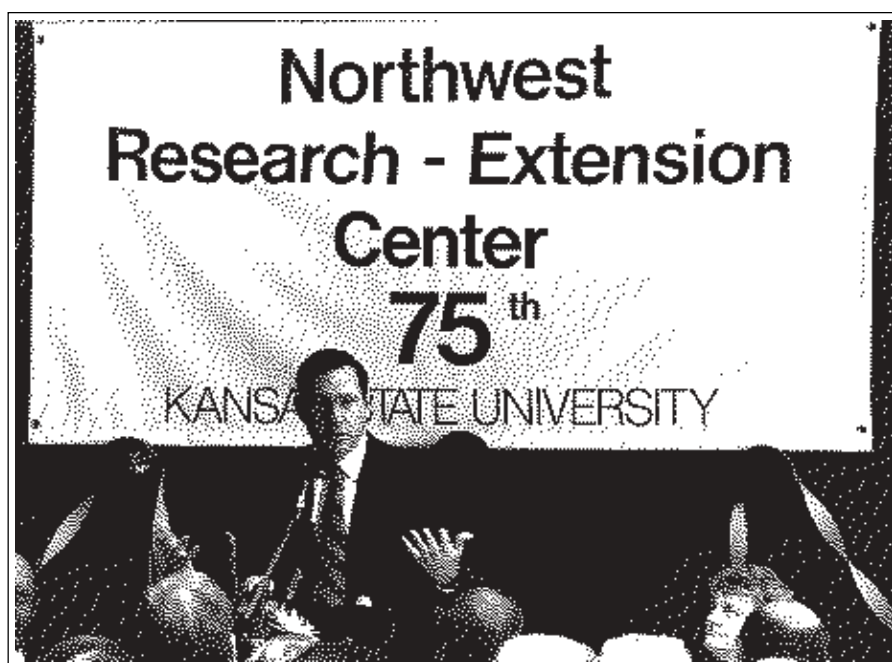
The editorial staff has taken on a new responsibility; writing and publishing the semiannual Ag Report. This update on research, extension, teaching, and alumni activities is distributed to all alumni of the College of Agriculture. Publication of the report involves conducting interviews, editing submitted articles, taking photographs, and preparing camera-ready copy on a computer.

The part-time position of Assistant Editor has been replaced by a student intern position. Each year, an outstanding senior in Agricultural Journalism is sought for the job. This student helps prepare the Ag Report and also conducts interviews and writes news releases about KAES research.



Many KAES publications are designed on a computer.

Former Governor Michael Hayden was one of the speakers at this anniversary celebration in Colby.



Personnel Changes*

■ APPOINTMENTS

Duane Acker, animal sciences and industry

Mark J. Arns, animal sciences and industry

Andrew P. Barkley, agricultural economics

Janet E. Benson, sociology, anthropology, and social work

Leonard E. Bloomquist, sociology, anthropology, and social work

Gary W. Brandt, surgery and medicine

Gerald Buonopane, foods and nutrition

Judy H. Cox, surgery and medicine

Cody P. Coyne, surgery and medicine

Gary Dick, entomology and southwest Kansas research-extension center

Penelope Diebel, agricultural economics

Hermann J. Donnert, head, nuclear engineering

Barry C. Dover, entomology

Steven S. Duncan, agricultural economics

Glenn S. Elliott, laboratory medicine

A. Steve Freeman, southwest Kansas research-extension center

Casey B. Frye, animal sciences and industry

Roch E. Gaussion, horticulture

Robert Goodband, animal sciences and industry

Barry Goodwin, agricultural economics

W. Barney Gordon, agronomy

Jeffrey Gwitz, grain science and industry

Jay Ham, agronomy

Joe Hancock, animal sciences and industry

Dale Hawley, head chemistry

Louis A. Heaton, plant pathology

Reinee Hildebrandt, forestry

Scot H. Hulbert, plant pathology

Alan Knapp, biology

William Lamont, horticulture

Nancy Lewis, foods and nutrition

Linda Clarke Martin, animal sciences and industry

Judy B. Miller, hotel, restaurant, institution management and dietetics

Richard Oberst, pathology

Martin Oppenheimer, head, sociology, anthropology, and social work

Joseph V. Paukstelis, chemistry

Gary Pierzynski, agronomy

Prasad Potnis, clothing, textiles, and interior design

Channa Rajashekar, horticulture

Randal Raub, animal sciences and industry

Charles W. Rice, agronomy

J. Scott Smith, animal sciences and industry

Alan B. Stevens, horticulture

Johna R. Veatch, veterinary diagnosis

Larry Wagner, agricultural engineering

Dennis Whyte, clothing, textiles, and interior design

David W. Wrisht, human development and family studies

■ RESIGNATIONS

David E. Cox, biochemistry

Cornelia B. Flora, sociology, anthropology, and social work

Jan L. Flora, sociology, anthropology, and social work

G. William Fortner, biology

Peter Gibbs, animal sciences and industry

George V. Granade, southeast Kansas branch station

Robert G. Helgesen, entomology

William G. Ikins, animal sciences and industry

Edward T. Kanemasu, agronomy

David E. Kissel, agronomy

Nancy Lewis, foods and nutrition

Steven E. Lommel, plant pathology

Don W. Morishita, southwest Kansas research-extension center

James A. Robbins, horticulture

Dennis Sigler, animal sciences and industry

James B. Sisson, agronomy

■ RETIREMENTS

Lewis E. Browder, plant pathology

James E. Cook, pathology

Lester J. DePew, entomology and southwest Kansas research-extension center

Louis R. Fina, biology

E. Beth Fryer, foods and nutrition

George Herron, southwest Kansas research-extension center

Ernst K. Horber, entomology

Paul L. Kelley, agricultural economics

John B. Sjo, agricultural economics

Robert J. Raney, agronomy

Oliver G. Russ, agronomy

E.L. Sorensen, agronomy

Marian C. Spears, hotel, restaurant, institution management and dietetics

John G. Wingfield, grain science and industry

■ STAFF CHANGES

L. Dean Bark

from: physics

to: computer systems office

Kurt C. Feltner

from: associate dean and associate director KAES

to: director-at-large, north central regional association of agricultural experiment station directors

George E. Ham

from: head, agronomy

to: associate dean and associate director KAES

James J. Higgins

from: professor, statistics

to: head, statistics

Gerry L. Posler

from: professor, agronomy

to: head, agronomy

**permanent appointments at rank of Assistant Professor or above, from July 1, 1988 through June 30, 1990*

Station Publications

(July 1, 1988 to June 30, 1990)

■ BULLETINS

- 654 Analysis of Net Returns to Conservation Tillage Systems for Corn and Soybeans in Northeast Kansas
- 655 The Kansas Input-Output Model: A Study in Economic Linkages
- 656 Rapeseed and Crambe: Alternative Crops with Potential Industrial Uses
- 657 Frequency of Profitable Hedging Opportunities and Improved Returns for Feeder Pig Finishers, 1980-1988

■ REPORTS OF PROGRESS

- 551 1988 Kansas Performance Tests with Winter Wheat
- 552 Estimating the Value of Used Farm Tractors
- 553 1987 - 1988 Floriculture Investigations
- 554 Dairy Day 1988
- 555 1988 Cattle Feeder's Day
- 556 Swine Day 1988
- 557 Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland, 1989
- 558 1988 Fruit Research
- 559 1988 Vegetable Investigations
- 560 1988 Kansas Corn Performance Tests
- 561 Kansas Fertilizer Research 1988
- 562 1988 Kansas Sorghum Performance Tests
- 563 1988 Kansas Sunflower Performance Tests
- 564 1988 Kansas Soybean Performance Tests
- 565 1988 Kansas Variety Tests. Spring Oats, Spring and Winter Barley, Spring Wheat
- 566 1988 Kansas Alfalfa Performance Tests
- 567 1989 Cattlemen's Day
- 568 Kansas Sheep Research 1989
- 569 Kansas Farmland Sales and Characteristics: 1971-1987
- 570 Roundup 1989
- 571 1989 Agricultural Research. Southeast Kansas Branch Station
- 572 1989 Field Day Report. Southwest Kansas Research-Extension Center
- 573 A Survey of Custom Cattle-Feeding Practices in Kansas
- 574 1989 Turfgrass Research
- 575 Geraniums: Cultivar Evaluations 1989
- 576 1989 Agricultural Research. Northwest Research-Extension Center
- 577 1989 Kansas Performance Tests with Winter Wheat Varieties
- 578 39th Annual Report of the Wheat Quality Council 1988
- 579 Marketing Christmas Trees in Kansas
- 580 Dairy Day 1989
- 581 Swine Day 1989
- 582 Public Access to Private Kansas Lands for Recreation
- 583 1989 Kansas Corn Performance Tests
- 584 Chemical Weed Control for Field Crops, Pastures, Rangeland, and Noncropland 1990
- 585 1989 Vegetable Investigations
- 586 1989 Kansas Sorghum Performance Tests

- 587 Kansas Fertilizer Research 1989
- 588 1989 Kansas Variety Tests Spring Oats, Spring and Winter Barley, Spring Wheat, and Winter Triticale
- 589 1989 Kansas Alfalfa Performance Tests
- 590 1989 Kansas Sunflower Performance Tests
- 591 1989 Kansas Soybean Performance Tests
- 592 Cattlemen's Day 1990
- 593 Kansas Sheep Research 1990
- 594 Climate of Northwestern Kansas
- 595 1989 Bedding Plant Field Trials
- 596 1989 Fruit Research
- 597 Roundup 1990
- 598 Conservation Tillage Research 1990
- 599 1990 Agricultural Research. Southeast Kansas Branch Station
- 600 1990 Field Day Report. Southwest Kansas Research-Extension Center
- 601 1990 Woody Ornamental Evaluations
- 602 1990 Agricultural Research
- 603 1990 Turfgrass Research
- 604 Farmers and Cattlemen: Survey of Kansas Farm Operators' Opinions on Agriculture and Public Policy

■ KEEPING UP WITH RESEARCH

- 99 Pinching Poinsettia Cultivars
- 100 Economic Evaluation of Season-Long and Intensive-Early Stocking Systems

■ SPECIAL PUBLICATIONS

- Agricultural Research in Kansas: Thirty-fourth Biennial Report of the Agricultural Experiment Station, 1986-88
- Ag Facts

SUFFIX LETTERS FOR CONTRIBUTION NUMBERS (pages 33-80)

- A** Proceedings of Meeting or Symposium
- B** Bulletin published by KAES; Book or Chapter for Book
- C** Computer Program
- D** Department Report
- E** Extension Publication (co-authored by a KAES researcher but published by Cooperative Extension or externally as educational material) or research by an Extension person to be published in a refereed journal.
- J** Journal
- S** Station Publication: Report of Progress, Keeping Up With Research, Special Publication
- T** Trade Publication

Categories are based on information received before manuscripts are published. Place of publication sometimes changes after the contribution number is assigned.

Station publications including Bulletins are available from KAES Editorial Office. Department Reports are available only from the appropriate department office. Copies of journal articles or other outside publications must be obtained from the authors.