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Southwest Research-Extension Center: Another 50 Years of Progress (1957-2007)

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Southwest Research-Extension Center: Another 50 Years of Progress (1957-2007)

Cover Page Footnote

Compiled and edited by Lawrent (Larry) Buschman.



ANOTHER 50 YEARS OF PROGRESS (1957-2007):

HISTORICAL REVIEW OF THE SECOND 50 YEARS
OF THE KANSAS STATE UNIVERSITY
SOUTHWEST RESEARCH-EXTENSION CENTER
AT GARDEN CITY, KANSAS



Kansas State University Agricultural Experiment Station
and Cooperative Extension Service





Current center head, Bob Gillen (right), and current center coordinator, Randy Currie, standing in front of the Southwest Research-Extension Center office building at 4500 East Mary Street, which was completed in 2000.

ANOTHER 50 YEARS OF PROGRESS (1957-2007):

**HISTORICAL REVIEW OF THE SECOND 50 YEARS
OF THE KANSAS STATE UNIVERSITY
SOUTHWEST RESEARCH-EXTENSION CENTER
AT GARDEN CITY, KANSAS**



First building on the station that served as residence, office, shed, and stable.

*Page 3
View of station in 1918 with the 1913 office building (center) and two residences.*

Material for "Another 50 Years of Progress" was compiled and edited by Lawrent (Larry) Buschman, Department of Entomology and Southwest Research-Extension Center, Garden City, Kansas.

PHOTO CREDITS

Alam: Back cover #4 & 5, page 50, page 52, page 53 #1, page 54, page 76 #1; **Buschman:** Front cover #8, #9, page 1, page 7 #6, page 16 #1, page 20, page 22 #2, page 28 #1 & 2, page 30 #1 & 2, page 31 #2, page 42 #1 & 2, page 42 #1 & 2, page 43 #1 & 2, page 44 #1, page 46 #2, page 48, page 49 #1, page 51 #1; **Coyne:** page 7 #5;

Elliot: Back cover #1 & 8, page 6 #1, page 11 #1, page 29, page 34, page 35 #1, page 40, page 45 #2, page 58, page 65 #1, page 67 #3, page 68 #2 & 3, page 70 #2, page 71 #1, page 72 #1 & 2, page 74 #2 & 3, page 75, page 76 #3; **Holman:** page 22 #1, page 25 #1; **Klocke:** page 36 #1; **Morishita:** page 38; **All other photos are from the SWREC archives.**

FRONT COVER CAPTIONS (clockwise from upper left)

1) Youth baking bread as part of a 4-H program. 2) Sample analysis 1935. 3) Sample analysis 1970s. 4) Combine 1937. 5) Four mules pulling a riding lister. 6) Cattle feed processing facility 1970. 7) Stacking hay 1946. 8) A modern hay swather. 9) Current center coordinator, Randy Currie, and center head, Bob Gillen, standing in front of the center office building, which was completed in 2000.

BACK COVER CAPTIONS (top left to lower right)

1) Cattle feed bunks at the station. 2) Aerial view of the station in 1963. 3) Two mules used for field work 1938. 4) Kent Shaw in front of the Mobile Irrigation Laboratory educating young people about water resources and conservation. 5) Mahbub Alam explaining irrigation sprinkler characteristics. 6) Aerial view of the station 1990. 7) Workers standing in front of a shock of sorghum. 8) Normon Klocke explaining the new linear move sprinkler system installed in 2002. 9) The first water-drive sprinkler in operation on the station during the 1960s and 1970s.

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Kansas State University Agricultural Experiment Station and Cooperative Extension Service

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RESEARCH PROGRAM

Larry Buschman and Robert Gillen

The Garden City Branch Experiment Station was established in 1907 with a lease of 320 acres located about 5 miles northeast of Garden City. The early inventory included one building (office, tool storage, and stable), seven tillage implements, a farm wagon, and two horses. The station has since grown to encompass almost 1,100 acres; modern offices, shops, and laboratories; up-to-date machinery; and computer technology that the early scientists could not have dreamed of.

Change has been constant over the years at the station, a reflection of changes in the agricultural industry of southwest Kansas. At one time or another, research projects have addressed dryland and irrigated crop production; crop breeding and genetics; production of lambs, hogs, turkeys, dairy cattle, and beef cattle; horticulture; and crop and livestock entomology. As farms in the region became less diversified, research at the station came to focus primarily on dryland and irrigated crop production.

Although research topics have changed over time, the basic mission of the station has not changed since 1907. That mission is to serve the people of western Kansas by developing new knowledge and technology to sustain long-term, profitable production of crops and livestock while conserving natural resources and assuring food safety.

Andrew B. Erhart, former superintendent at the Garden City Branch Experiment Station, compiled a history of the first 50 years of the experiment station. Erhart's publication, "50 Years of Progress" is out of print but is available on the web at: <http://www.oznet.ksu.edu/swao/50yrsprogress.pdf>. The current review will focus mainly on the second 50 years of the station's history.

LAND HOLDINGS

The Garden City Branch Experiment Station was established in 1907 with the Finney County Commission leasing 320 acres of land to the Kansas State Board of Regents. This initial 99-year lease later was extended through 2087 to assure the long-term presence of the station and allow construction of a new office building. Later land additions included the purchases of 99.5 acres to the west in 1937 and 136 acres to the south in 1949. These three tracts, 555 acres, are the core land area for the experiment station.



The 1948 office building.

The 1948 office with the six-room addition, which was used until 2000.

Current K-State Dean of Agriculture, Fred Cholick, speaking at a Garden City field day.

Research center office and greenhouses built with the help of the advisory committee.

Page 7

Garden City Experiment Station Superintendents and Heads: Andy Erhart, Gerald Greene, George Herron, Jim Schaffer, Pat Coyne, and Bob Gillen



Over the years, several other tracts have been included in the station. From 1948 to 2002, the Garden City Company granted a no-cost lease on 80 acres northwest of Holcomb to be used for irrigation and agronomic research. Research on this tract first used ditch water for irrigation and later switched to well water. That site also included a sub-surface drip irrigation system. The station leased a tract of land with a center pivot sprinkler one mile east of the main station from 1977 to 1987. This land was used to produce forage for the cattle feeding project and for dryland cropping research. In 1980, the station added another lease of 30 acres one mile east of the main station for dryland and irrigated crops research on sandy soil. Since 1981, the Finnup Foundation has granted a lease on 160 acres two miles north of the main experiment station for dryland and irrigated agronomic research. Land resources for the experiment station currently total 1,078 acres, including 471 dryland acres and 366 irrigated acres. In 1986, the Tribune Branch Station was combined with the Garden City Branch Station as a satellite unit. This added 268 acres of cropland, 333 total acres.

FACILITIES

Erhart described the facilities as meager in the early years of the station, which now consists of 27 buildings. Several changes in the second 50 years are particularly noteworthy.

An intense tornado and hail storm struck Garden City and the experiment station on June 23, 1967. Of the 40 buildings on the station at that time, 20 were destroyed and the remainder suffered major damage (see pages 8-9). The destruction was so severe that the state legislature made a special appropriation of \$331,500 for reconstruction. Most of the steel buildings currently on the station are a result of this reconstruction. Erhart accomplished this huge task under budget and proudly returned \$19,360 to the state treasury.

In 1963, the station's research advisory committee developed a proposal to build a "research center" that included a soil testing laboratory, offices, a library, a meeting room, and greenhouses.

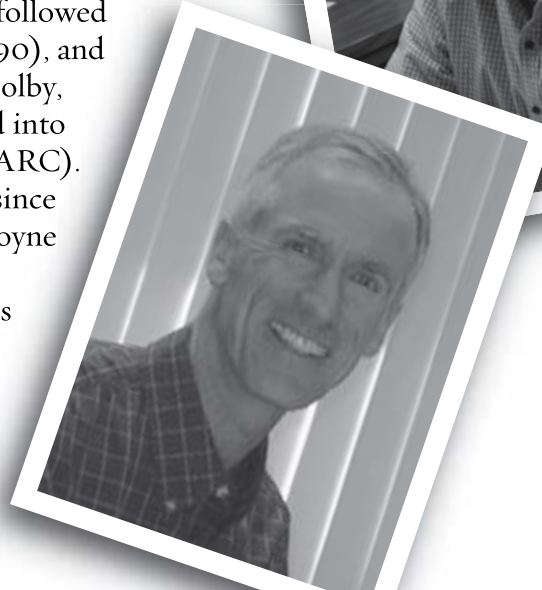
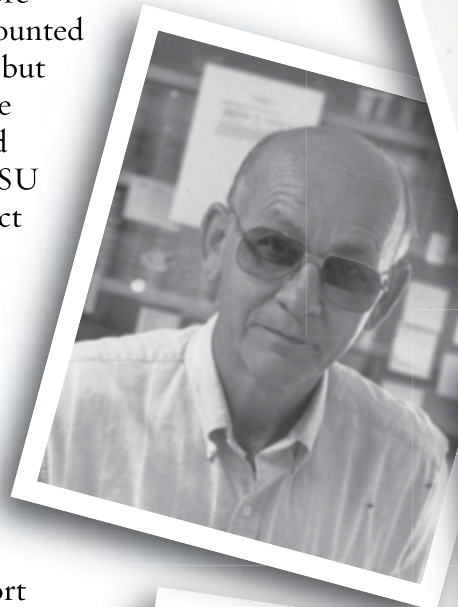
Half of the funding for the building came from private donations raised by the committee; this was matched by a state appropriation. The building was completed in 1967 at a cost of \$70,000 and is still in use.

A major change occurred in 2000 with the completion of a new office building. The old office building had been in use since the 1940s and was very small and inadequate. The area extension office had moved away from the experiment station in 1969 to lease more suitable space in Garden City. Several efforts were mounted over the following years to replace the office building but adequate funds could not be raised. Finally, during the 1990s, funding rules for state buildings were modified and the station was allowed to take a loan from the KSU Foundation to build a new office building. This project was significant for two reasons. First, it improved the functionality and appearance of the research station. Second, it allowed the southwest area extension staff to move back to the station. Having research and extension personnel in the same facility increases coordination of research and extension efforts and allows K-State to deliver better services to the public.

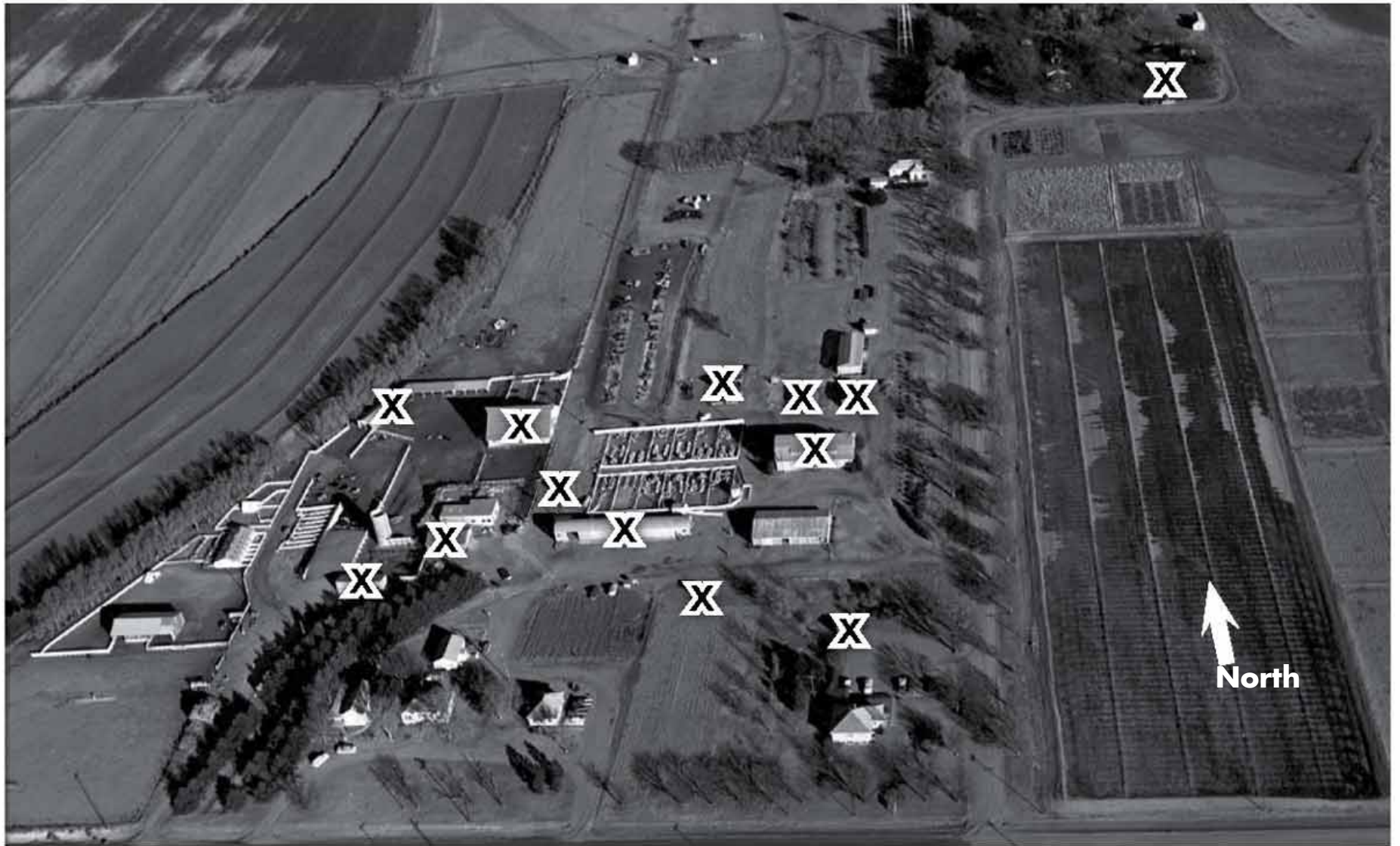
Housing for the superintendent, scientists, and support staff was once common on experiment stations throughout the Great Plains, and the Garden City Branch Experiment Station was no exception. Homes “on station” gave it the feel of a small rural community. However, maintenance costs increased as the homes aged and transportation improvements reduced the need for on-station housing. Closing the beef cattle feeding operations also reduced the need for housing on the station. Four of six residences on the station were eventually removed. One remaining residence is occupied by the farm manager and the other is used to house graduate students who come from Manhattan to do summer research projects.

LEADERSHIP

Erhart listed the first eight superintendents of the Garden City Branch Experiment Station. Andrew Erhart served as superintendent for 28 years (1948-1976), by far the longest tenure of any superintendent at Garden City. Erhart was followed by Gerald Greene (1976-1981), George Herron (1981-1990), and James Schaffer (1990-1995). In 1995, the Garden City, Colby, Hays, and Tribune experiment stations were consolidated into the **Western Kansas Agricultural Research Centers (WKARC)**. Patrick Coyne, who had been head of the center in Hays since 1985, became the first head of the combined WKARC. Coyne was followed by Robert Gillen in 2006. The WKARC head is stationed at Hays, so a local research coordinator is designated at each center. Charles Norwood served as the first local coordinator at Garden City (1995-2000) and was followed by Randall Currie (2000-present).

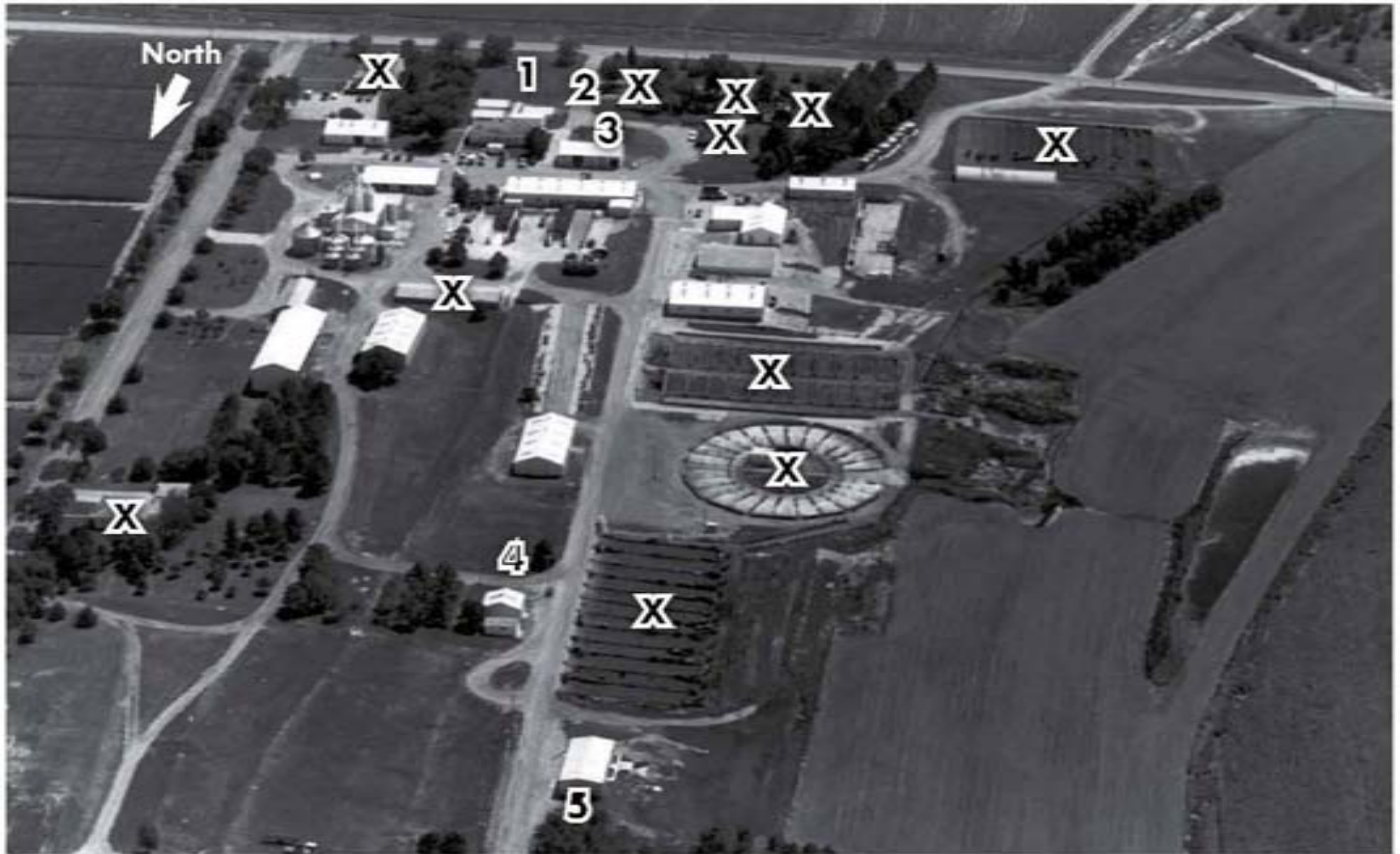


1963 PHOTO



X BUILDINGS DESTROYED IN 1967 TORNADO

1990 PHOTO



X STRUCTURES REMOVED SINCE 1980

1-5 STRUCTURES ADDED SINCE 1980

ADVISORY COMMITTEE

Public support has long been important to the station's success. This is confirmed by the original land lease from the Finney County Commissioners in 1907 and a cash gift from the Garden City Industrial Club in 1911 to drill the first irrigation well at the station.

A long and fruitful tradition was started June 15, 1961, when the Garden City Experiment Station Research Advisory Committee was organized by a group of farmers and county agents representing 26 southwestern Kansas counties. The purpose of the committee was to give farmers an opportunity to advise and aid the station in development of its research program. The first officers were Clifford Mayo, president; Clarence Lynch, vice president; and Marvin Odgers, secretary. One of the committee's first efforts was raising half of the cost to build the research center building in 1963. The committee still meets with station faculty annually and continues to be an important partner in developing research priorities and direction.

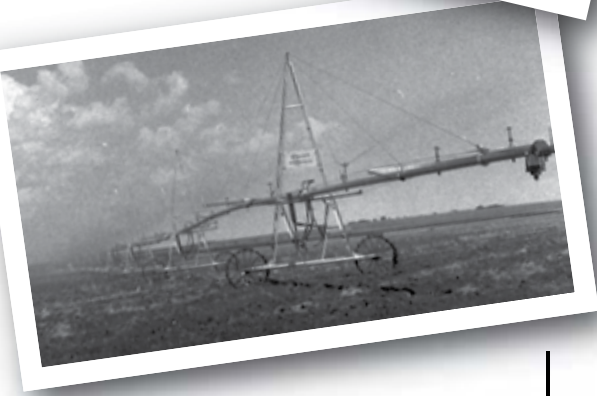
During the late 1970s, the committee helped the station lease the "Russell Land" east of the station so the station could do more work with sprinkler irrigation and work on "sandier land." It was also instrumental in raising more than \$60,000 for irrigation equipment at the site.

Producers had pointed out for many years that the station was not doing research on true "sandy land." During the 1990s the committee worked with the Ogallala Task Force to develop the Western Kansas Irrigation Research Project. The Kansas legislature appropriated funds for this proposal starting in 1995, with the understanding that private donations would help build the necessary infrastructure. Water rights for 1,500 gallons-per-minute diversion and a 30-year no-cost lease of 260 acres south of Holcomb were negotiated with Sunflower Electric Company in 2000. Plans were developed and faculty hired for the "Sandhills Irrigation Research Unit," but the fund drive to raise \$2.1 million in private funds was ultimately unsuccessful and the project was terminated. However, the legislature has continued to appropriate a smaller amount of funds to enhance irrigation research at Garden City and Colby.



Dedication of a new well-head and engine on the "Russell Land" with some of the individuals responsible for obtaining the new equipment: (l to r) Ralph Grothusen, unidentified, Don Shaw, Stan Leland, Gerald Greene, and Orin Miller.

A water-drive center pivot sprinkler system in operation on the experiment station during the 1960s and 1970s.



EDUCATIONAL PROGRAMS

Although research has always been the primary purpose of the experiment station, efforts were made from the beginning to show the results to those who could use them. Thousands of visitors have been welcomed to the station and the experimental plots over the years. In addition, field days have been conducted several times each year to showcase the newest research and make results directly available to the public. In recent years, the station has sponsored a wheat tour in May for winter crops and a fall field day in August for summer crops. Annual cattle feeder's days were held when the beef project was active.

Results of research projects have been published in various pamphlets, field day reports, the popular press, and scientific journals. Many of the more recent publications are available on the K-State web site, while older publications are shelved in the station and campus libraries. Station faculty repeatedly have been called on by newspaper, radio, and television reporters to explain research results or interpret the impact of current events, such as extreme weather or plant disease outbreaks, on southwestern Kansas agriculture. Erhart had a weekly radio program for many years and the scripts for these programs were deposited in the K-State library by Larry Kepley, a long-time member of the research advisory committee.

TRAGEDY

On May 19, 1980, George Homer and John Walters, employees at the experiment station, were killed in a tragic accident. Apparently, Homer entered a grain bin to clear a problem with grain feeding to the auger and was overcome by the lack of oxygen. Walters tried to rescue him, but was also overcome by the lack of oxygen. The men were wearing gas masks and thought they were safe, but the masks were not the correct type. The incident drew considerable press and emotions were high for quite some time.

This accident serves as a reminder that farming is one of the ten most dangerous occupations and university personnel are not immune. Safety is a very high priority at the station.

SOUTHWEST RESEARCH-EXTENSION CENTER

In 1986, the Tribune Branch Experiment Station was combined with the Garden City Branch Experiment Station. The new unit was called the Southwest Research-Extension Center. In 1990, **James (Jim) Schaffer** was asked to supervise both the southwest area extension specialists and Garden City station project leaders at the **Southwest Research-Extension Center (SWREC)**. However, when Schaffer left in 1995, **Patrick (Pat) Coyne** was asked to supervise the three western Kansas experiment stations (Hays, Colby, and Garden City), but not the extension specialists. The head of the Western Kansas Agricultural Research Center (WKARC) has been stationed at Hays, with a research coordinator stationed at each center. In 2006, **Robert (Bob) Gillen** became the WKARC head.

In 2000, the **Southwest Area Extension Office** moved into the new office building at the center, bringing the two administrative units into the same physical location once more. The SWREC and the area extension office operate as independent organizations. However, there is extensive collaboration among research and extension faculty at the SWREC. New faculty carry both research and extension responsibilities to help blur the boundaries between the two organizations.



Research presentation to producers during a recent field day program.

Jim Schaffer, former center head, giving a television interview during a fall field day program.

LIVESTOCK RESEARCH

Jeff Elliott

Animal scientists who have served at Garden City include: **Dudley W. Arnett** (1967-72), **George V. Davis** (1972-82), **Robert (Bob) W. Lee** (1983-85), **Robert (Bob) T. Brandt, Jr.** (1985-1988), **Arthur (Steve) Freeman** (1989-1993), and **Kelly K. Kreikemeier** (1994-1998). Early trials with lambs, dairy, swine, and turkeys were carried out in Garden City by station employees under the direction of K-State animal scientists located in Manhattan. This changed with the growth of the cattle feeding research and an animal scientist was located in Garden City.

Brown Swiss replacement heifers.

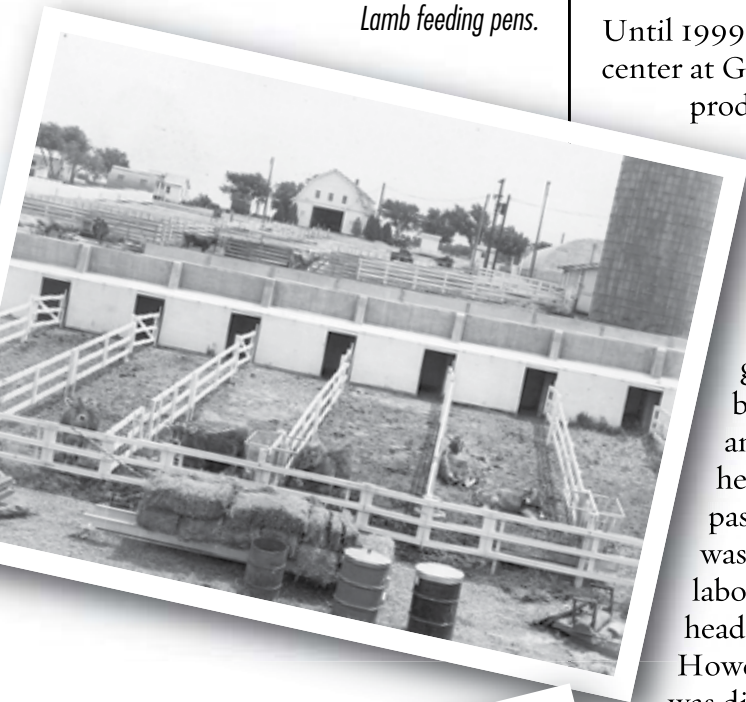
Lamb feeding pens.

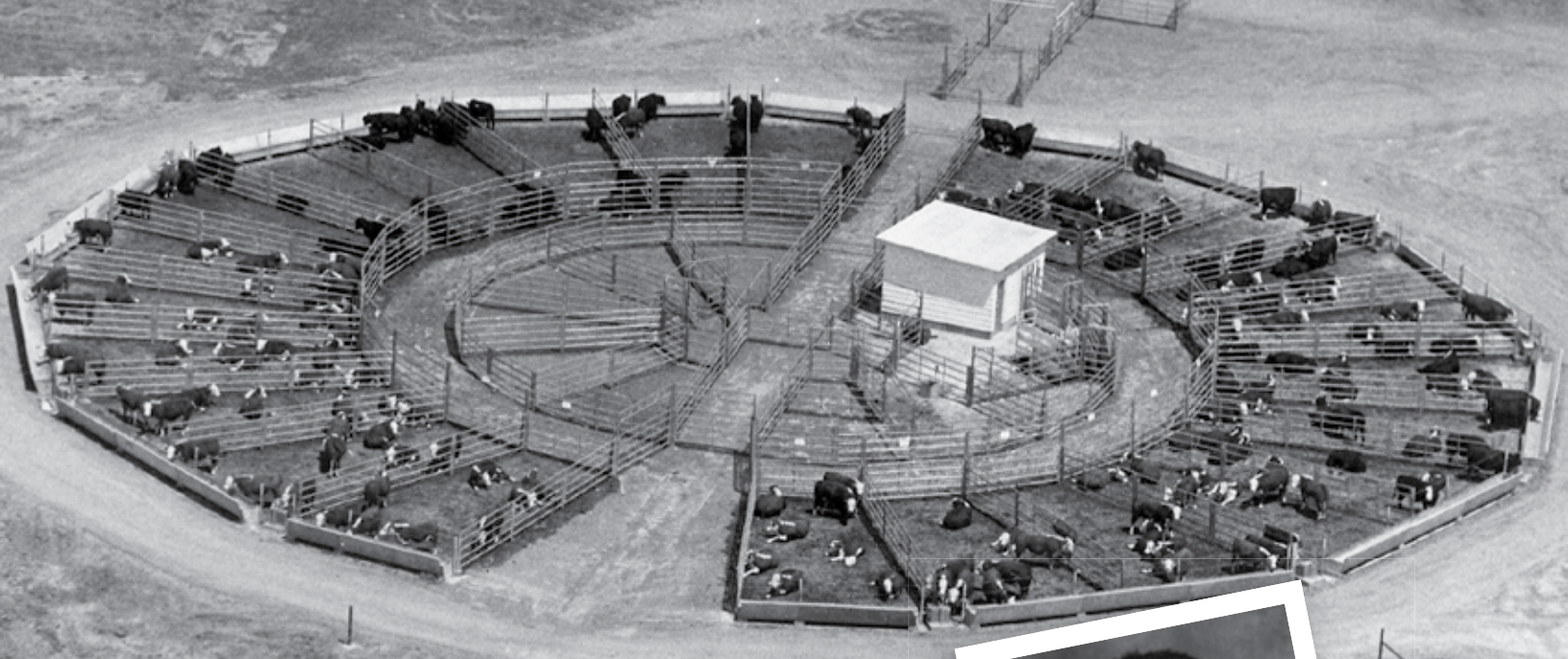
Until 1999, livestock research has been an integral part of the research center at Garden City. They provided valuable results for Kansas producers, as well as income for the experiment station.

In 1954, research on purebred **Duroc hogs** was discontinued to allow more emphasis on **dairy research**, which has had a long history at Garden City. It began with a small herd of grade Ayrshire cows in 1917. When these animals proved to be unproductive, they were replaced in 1922 with good quality, grade Holsteins. After the Brown Swiss breed became popular, the Holsteins were sold in the fall of 1940 and replaced with registered Brown Swiss. This high-quality herd was used to demonstrate the value of various irrigated pasture crops. The construction of a modern milking parlor was completed in 1963 (this building is currently utilized as a laboratory). The Brown Swiss herd grew from the original 11 head in 1940 to 145 animals, according to the 1966 annual report. However, the need for dairy research decreased, so the dairy was dispersed in the late 1960s and resources were redirected to feeding beef cattle.

Lamb feeding was an important enterprise in the Garden City area from the 1930s through the 1950s. Lambs were imported into the area to utilize crop residues from the sugar beet industry. Feeding experiments were initiated at the station in 1933 with the purchase of 250 feeder lambs. In subsequent years, approximately 600 lambs were purchased annually from Texas or New Mexico. Lamb feeding trials centered on efficient use of locally grown feedstuffs. Station researchers compared sorghum silage and other roughage sources, as well as methods of grain processing. Feed additives, including hormones, antibiotics, and even tranquilizers also were evaluated. After lamb numbers dropped in southwest Kansas, the lamb feeding trials at the experiment station were curtailed in the late 1960s.

Turkey feeding trials were conducted from 1947 through 1952, but the project was discontinued because of "lack of local interest."





Cattle feeding research has been a major venture at the research center for four decades. The 1962 Garden City Experiment Station annual report indicated the first cattle feeding trial was initiated in the fall of that year. The first four steer-feeding pens were located northwest of the present feedmill and held six head each.

In 1966, a landmark feeding study was designed to compare Colby, Garden City, Mound Valley, and Manhattan as cattle feeding locations. Calves were purchased from the Warner Hereford Ranch in Cimarron and were allotted to each of the four research stations. The cattle were fed identical rations in similar pens. Feedstuffs were grown in Garden City and shipped to each test site. This study was repeated four consecutive years. When all the data was analyzed, **feeding performance was best at the Garden City location.**

The tornado that inflicted major damage to the station on June 23, 1967, was an important catalyst in development of new cattle feeding facilities. Several of the older buildings were damaged or destroyed in the tornado, so they were replaced with updated cattle facilities. The centerpiece of the cattle feeding facilities was a **modern, state-of-the-art feedmill** with feed processing and mixing equipment together with grain and roughage storage facilities. A steam flaker was added later, which softened the grain by applying steam and then metered the grain between two large rolls to flatten the grain into “flakes.” Steam flaking was found to increase feeding performance. The feeding of steam-flaked grain is now common in today’s feedlots.

The “**circle pens**” were erected in 1969. These 24 pens were arranged in a circular pattern with the cattle weighing and processing facility located at the center of the circle. Feed bunks were arranged around the outside of the circle, allowing feed trucks easy access for delivery of feed. Several sets of feeding pens were constructed during the 1970s and 1980s, increasing the feeding capacity to approximately 1,000 head.



Circular cattle pens built in 1969.

Kelly Kreikemeier, Animal Scientist

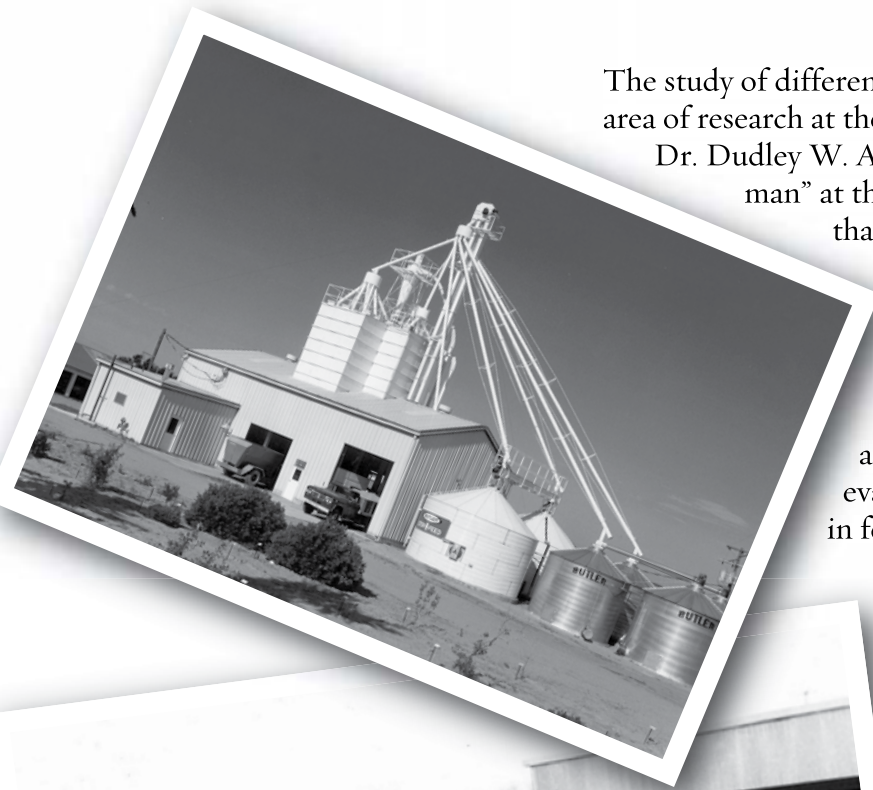
Steve Freeman, Animal Scientist

The study of different **feed processing methods** has been an important area of research at the Garden City Experiment Station. In 1969, Dr. Dudley W. Arnett was hired as the first “animal husbandry man” at the station. He started an extensive feeding trial that compared grain processed by several methods, including ground grain, dry-rolled grain, steam-flaked grain, extruded grain, high-moisture milo, reconstituted corn, and whole corn. Other beef cattle research included studies designed to look at different methods for care and feeding of newly received cattle. They also evaluated roughages, buffers, and fat and urea levels in feed rations, as well as the usefulness of several feed additives in the diets. Studies on the feeding value of high-moisture corn harvested at different moisture levels were used to develop guidelines for ensiling wet grain. Garden City researchers conducted the first practical application of ammonia to crop residues to improve its feed value in conventional feedlot growing rations.

Sprinkler-irrigated pasture research was initiated in 1970. A well, pump, and center pivot sprinkler were installed on 100 acres directly south of the current office. The irrigation equipment was purchased with \$40,000 donated from local businesses. Richard Henkle of Henkle Drilling spearheaded the fundraising project. Cattle were grazed on permanent pasture in early years. By the mid 1980s, a switch was made to wheat pasture. A number of studies evaluated the efficacy of supplementing the pasture grazing with hay, silage, or concentrates, as well as feed additives and implants.

A “**micro machine**” was installed in the feedmill in 1985. This device allowed the accurate delivery of very small amounts of nutrients or feed additives to the cattle rations. This allowed the scientist to easily compare antibiotics and other additives such as Ruminsen. A more energy efficient steam generator replaced the conventional boiler in the mid 1990s.

The last pen of cattle left the Southwest Research-Extension Center in December 1999. This ended 80 years of livestock research at Garden City. Resources were reallocated to initiate the Environmental Science project.



The new feedmill.



First steer feeding pens.

AGRONOMIC RESEARCH

Curtis Thompson

Agronomists at Garden City: *Crop improvement* – **Alvin E. Lowe** (1937-1958), **William (Bill) Stegmeier** (1958-1967), **William (Bill) Russell** (1968), **Merle Witt** (1969-2006); *Irrigation agronomists* – **Donald W. Grimes** (1956-1961), **Kenneth Snelling** (1961-1966), **Royal J. Swenson** (1966-1967), **Paul Penas** (1966-1967), **Mark Hooker** (1979-1987); *Soil fertility agronomists* – **George Herron** (1956-1990), **David Travis** (1964-1966), **David Newton** (1966-1967) and **Mark Hooker** (1979-1987); *Horticulture agronomists* – **Dean A. Hammond** (1958-1959), **John M. Nelson** (1962-1964), **Max E. Fogleman** (1964-1967), **Pyung Kyung Yu** (1967-1968) and **Jack H. Kyle** (1968-1977). *Tribune agronomist*: **Alan Schlegel** (1986-present)

Wheat, grain sorghum, and corn have perhaps the longest and most intensive research history of all crops researched at the experiment station during the last 50 years. Irrigated and dryland variety performance evaluations were conducted nearly every year during that period. The worst year for all crop research occurred in 1967 when two hail storms and a tornado destroyed the experiment station and its field research.

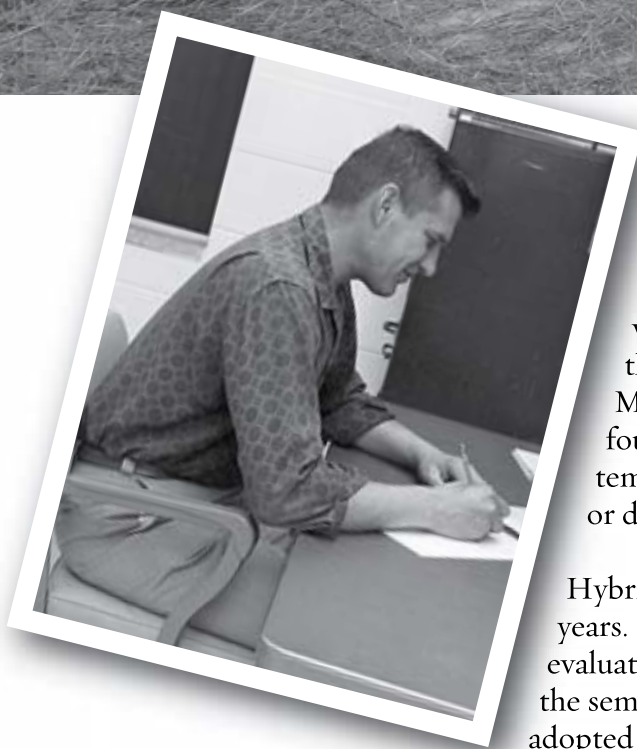
WHEAT

Irrigated wheat performance tests in the 1950s and 1960s often had top varieties yielding 55 to 60 bushels per acre (bu/a), provided hail or other natural disasters didn't destroy the experiment. Lodging and leaf and stem rust often harmed wheat plots. Over the next 50-year period, four experiments were abandoned, but the top yielding variety exceeded 60 bu/a in 27 of the years. The record irrigated wheat yield of 106 bu/a was achieved by T-81 in 2004. The 2004 trial averaged 91 bu/a, which was also a record average high.

Wheat dryland-fallow performance yields varied according to weather conditions. A record dryland wheat yield of 73 bu/a occurred in 1984. The 1984 experiment averaged 62 bu/a, which also was a record average high. In 22 of the years, the top variety yielded 40 bu/a over the 50-year average. Five dryland wheat performance tests were abandoned and an additional four trials had the top variety yielding less than 20 bu/a. This suggests that southwest Kansas experiences some adverse weather conditions for dryland wheat.

Merle Witt standing in alfalfa plots.





Monty Spangler examines seed placement by the newest plot implement—a no-till small plot planter.

Bill Stegmeier, Agronomist

Irrigated wheat fertility and nitrogen and phosphorus experiments were initiated in 1959 and continued on and off over the following decades. Wheat was not responsive to chloride fertilizers in experiments conducted during the mid-1980s. Leading edge work with irrigation management was conducted during 1957-1959. This work is still used in the Kansas wheat production handbook. Station agronomist Merle Witt evaluated the effect of temperatures on wheat. He found that during grain fill, yields were lower in plots exposed to temperatures 5°F above the ambient temperature during the night or day.

Hybrid wheat evaluation began in 1960 and continued for many years. The station evaluated a male sterile Scout in 1968 and began evaluating semi-dwarf wheat varieties that same year. Several years of the semi-dwarf wheat variety evaluations occurred before they were adopted as part of traditional wheat variety testing. A cooperative project with NASA and the National Oceanic and Atmospheric Administration (NOAA) using satellite imaging to evaluate crops was conducted from 1975 to 1978. Planting date and rate experiments were conducted off and on throughout the 50 years. Witt's evaluation of wheat planting dates throughout the winter has been especially valuable to producers who have delayed planting dates. Wheat planted November 1 has yielded 7 bu/a less than wheat planted October 1. Planting after November 1 results in declining wheat yields. Wheat planted February 1 or March 1 always vernalized, but delaying planting to April 1 resulted in wheat vernalizing only 50% of the time.

The Kansas Intrastate Nursery, Kansas Observational Nursery, and Southern Regional Performance Tests were used to evaluate experimental wheat lines prior to a variety release. Researchers at the experiment station were instrumental in wheat variety development over the entire 50 years. The Hybrid Regional Wheat Nursery was maintained several years to evaluate experimental hybrids, but such hybrids have never been widely adopted in Kansas.

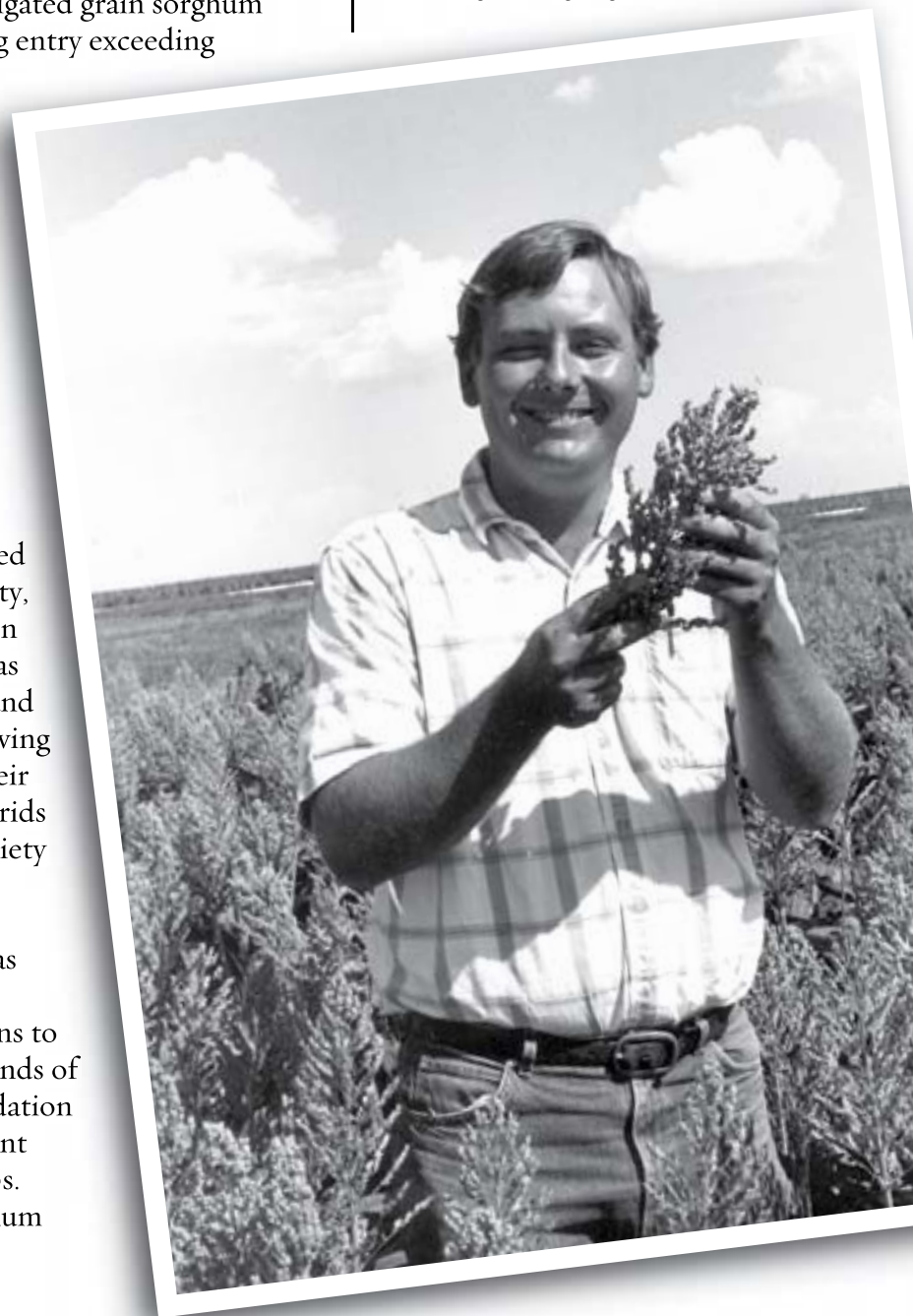
Wheat, triticale, and rye forage work was conducted intermittently throughout the 50-year period. Research involving livestock grazing on red and white wheat was conducted from 2002 to 2005.

SORGHUM

Sorghum varieties and hybrids were evaluated for grain and forage potential for most of the 50-year period. After the late 1980s, forage sorghum evaluation was more intermittent. Irrigated grain sorghum yields have been very high, with the top yielding entry exceeding 150 bu/a in 21 years and exceeding 120 bu/a in 45 years. The record irrigated grain sorghum yield was 178 bu/a in 2001; however, the highest average yield was 156 bu/a in 1993. Over the past 50 years, the irrigated grain sorghum performance test has been abandoned only four times. The dryland fallow sorghum test has been more erratic, with five years of abandonment and trial averages ranging from 20 bu/a in 1956 to 103 bu/a in 1996. The record high dryland fallow hybrid yielded 130 bu/a in 2001, apparently a great year for sorghum. As with wheat, many regional and intrastate nurseries were established at the experiment station, contributing to variety, inbred, and hybrid development. Although grain sorghum yield improvement has not increased as much as corn yield improvement, standability and stalk strength have been improved greatly, allowing sorghum growers to more efficiently harvest their sorghum crops. Waxy endosperm sorghum hybrids were evaluated during the 1960s. Tan plant variety evaluations began in 2001 and continue today.

A long-term nitrogen and phosphorus study was initiated in 1968 and conducted over a 10-year period. The experiment's final recommendations to maximize sorghum yield were to apply 120 pounds of nitrogen and 18 pounds of phosphorous. Foundation research on water use and irrigation management in sorghum was conducted during the late 1950s. That information remains in the K-State sorghum production handbook.

Alan Schlegel holding sorghum head.





Demonstration of the "hail machine" that was used to simulate hail damage to corn and other crops to evaluate yield losses due to hail damage.

CORN

From 1956 to 1981, a corn hybrid silage evaluation was conducted at the experiment station. Grain corn evaluation may be the greatest success story among all crops evaluated at the experiment station. In the irrigated corn performance tests, the first hybrid to exceed 100 bushel occurred in 1959, the first hybrid to exceed 200 bu/a occurred in 1969, the first hybrid to exceed 250 occurred in 1989. The record high for an irrigated corn hybrid was Pioneer 33P67, which yielded 303 bu/a in 2002. The 1988 trial was the first to average over 200 bu/a. From 1988

to 2006, 10 trials have had averages of 200 bu/a or more. The record trial average was 272 bu/a in 2003. The first year all hybrids yielded over 200 bu/a was in 1992. At least one hybrid has yielded 200 bu/a in 19 trials during this 50-year period. The only irrigated corn trial to be abandoned was the 1967 trial, which was lost to hail and tornado damage.

The corn performance test was hill-planted until 1979. Corn populations were increased as time passed: 17,400 plants per acre in the 1950s and 1960s to 30,000 plants after 1996. Short-season corn hybrids planted early were first evaluated in 1995 and were planted at 40,000 plants/a.

Foundation research on irrigated corn production and long-term nitrogen and phosphorus experiments also were conducted. This research had great value to the irrigated corn growers in Southwest Kansas. Evaluations found corn generally did not respond to boron, zinc, and sulfur fertilizers. However, corn did respond to zinc fertilizers at an off-station location in Haskell County where significant land leveling had occurred. Several planting date studies were conducted in the 1960s and 1970s. Generally, planting corn between May 1 and May 10 gave the highest grain yields. Corn silage yields tended to be higher with an early June planting date.

Cooperative research with National Crop Insurance that evaluated simulated hail damage in corn, wheat, and grain sorghum began in 1977 and continues today. This data has helped establish the current standards used by hail insurance adjusters across Kansas and possibly the United States.

SOYBEANS

Irrigated soybean research was initiated in 1959. The first variety performance experiment was planted twice and was still lost to jackrabbits. There have been 33 years with the top variety yielding 50 bu/a or more. The record setting irrigated soybean variety yielded 75 bu/a in 1990. The entire trial averaged 63 bu/a, which tied the record average yield set in 1986. Only six years of performance tests have had a variety yield 70 bu/a or more. These test years occurred in 1986 and in following years. In seven years the soybean test was abandoned due to rabbit damage, inadequate weed control, or high soil pH. In 2002, the first Roundup Ready soybean variety evaluation experiment was planted. The irrigated soybean variety tests have been exclusively Roundup-ready ever since. Experiments evaluating interactions of planting date, rate, and maturity group were conducted during the late '90s and beyond. This research found group III and IV varieties were best adapted for southwest Kansas.

ALFALFA

The first irrigated alfalfa variety evaluation was planted in the fall 1971. Since then, with a gap from 1978 to 1984, alfalfa variety evaluation has continued for a total of 28 years. Alfalfa yields were much higher after 1984. The record alfalfa yields occurred in 2000, with the trial averaging 13.8 ton/a. The first Roundup-ready alfalfa varieties were to be planted in the fall of 2007.

OTHER CROPS

Several other crops have been evaluated during the last 50 years at the research station. A castor bean variety trial was conducted from 1958 through 1968, and sugarbeet fertility, irrigation, and production practices were researched from 1956 to 1978. Crambe and winter and spring rape were evaluated in the 1960s, while canola evaluation began in the 1990s and continues. Winter survival of winter canola varieties has serious limited its adaptability in southwest Kansas.

Irrigated and dryland winter barley varieties were evaluated annually until the mid-1970s. Pinto bean/dry edible bean varieties were evaluated well into the '70s, and comfrey was evaluated during the '70s. Work with popcorn occurred through the mid-1970s, and safflower was evaluated in the early '70s and again in the late '90s. Oil and confectionary sunflower were evaluated for a six-year period during the mid-1980s and early '90s. Cotton was evaluated in the early '90s and was not successful because of herbicide drift.



Milkweed floss. Milkweed (top) and amaranth (bottom) were evaluated as crops for this area.

MISCELLANEOUS

An experiment to determine the value of crop residue to grain production and soil quality characteristics was initiated in 1969 and ended in 1994. The experiment was conducted with both wheat and sorghum residue. The residue treatments consisted of a burn and a physical removal of residue, resulting in surface residue being removed from two of the four treatments. A third treatment received additional residue from the treatment that had the residue physically removed, resulting in a doubling of the surface residue. The fourth treatment was a control that left the surface residue in place. All treatments were mechanically tilled and farmed. An article in *Agronomy Journal*, authored by Mark Hooker and others in 1986, suggested that yearly burning or physically removing the residue and had similar soil characteristics, including similar soil organic matter, as the treatment with double the amount of residue. This suggested that occasional burning or removal of residue had little impact on soil quality.

*Agronomists Curt Thompson and John Holman
evaluate winter survival of canola.*

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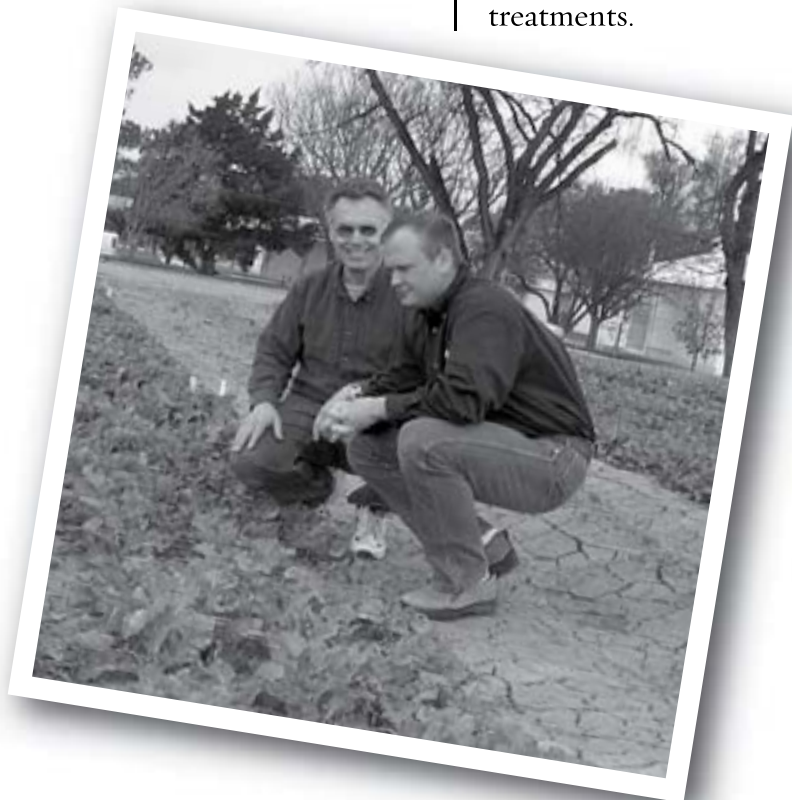
*Max Fogleman making a cross between two
muskmelon lines in the greenhouse.*

Effects of iron applications on sorghum.

*George Herron operates a soil testing instrument
(Atomic Absorption Spectrophotometer).*

Work on a wheat-sorghum-fallow rotation on dryland was first mentioned in 1963. This work was conducted under conventional tillage. Later research found that this system was more sustainable under no-till management.

Some unusual research conducted by faculty at the station included a nitrogen fertility experiment on irrigated corn using nitrogen rates as high as 1,600 lb/a. Corn yields were not increased with nitrogen rates above 120 lb/a. A second experiment conducted in Lane County evaluated the addition of night lights in an irrigated field to increase corn yields. Results suggested that the slight additional yield increase would not pay for the electricity used to implement the night-light treatments.



HORTICULTURE RESEARCH

Curtis Thompson

D. A. Hammond evaluated several vegetable crop varieties for their production potential in the area in 1958. In 1959 and afterward, other horticulturists continued to evaluate varieties of onions, strawberries, watermelon, squash, cucumber, muskmelon, sweet corn, tomatoes, sweet potatoes, and Irish potatoes. Additional crops evaluated included broccoli, snapbeans, spinach, radishes, cabbage, chives, peas, lettuce, red beets, turnips, and rutabaga.

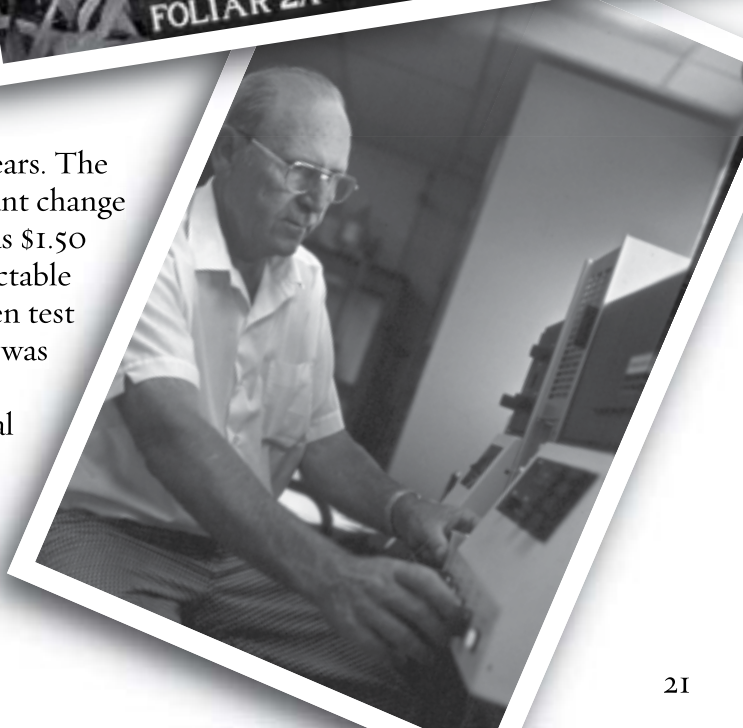
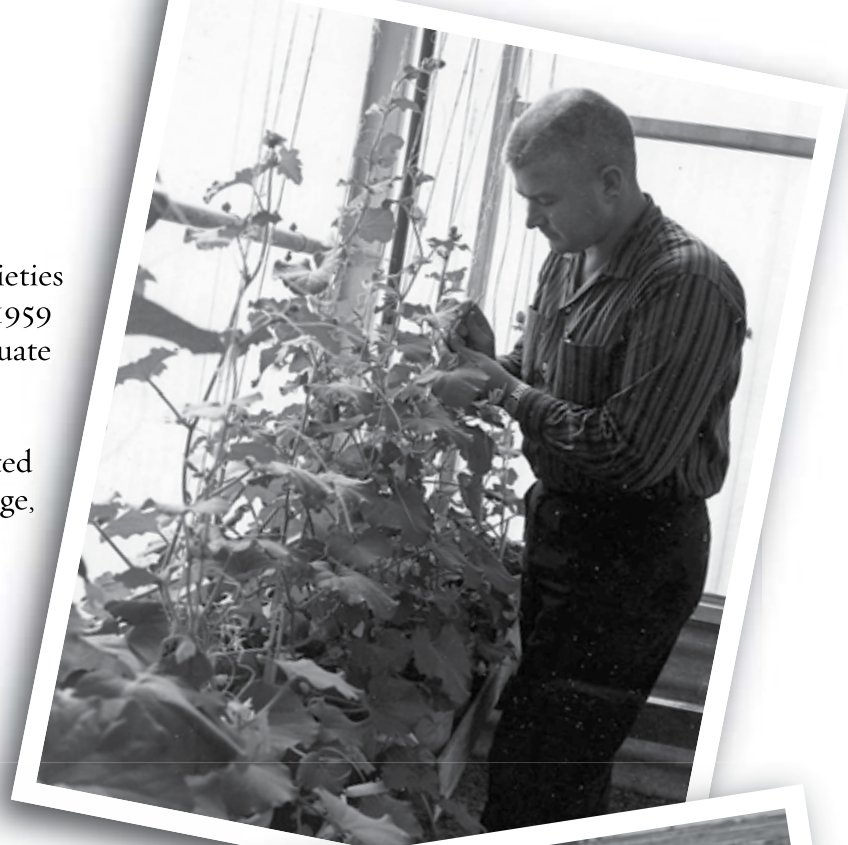
Evaluation of many of these crops focused on commercial field production. Cucumbers were evaluated for their potential in the pickling industry. Tomatoes were evaluated with suggested evidence of crosses being made for early mechanical picking of tomatoes for processing. Excessive heat tended to reduce tomato set, which continues to be a problem today. Sweet corn was evaluated for the canning industry, and dry edible bean evaluation was conducted by the horticulturists; **Jack Kyle** initiated a dry edible bean breeding program in 1969, and it continued until 1975.

There was only one report of peach and pear evaluation – adverse environmental conditions had destroyed the crop.

SOILS RESEARCH

Curtis Thompson

The soil testing lab at the research center was initiated in 1948 to analyze soils for local farmers at low cost. **George Herron** was hired in 1956, and he ran the soils lab for many years. The 1969 annual report contained an apology for the first significant change in fees for soil testing since 1949; a general fertility test fee was \$1.50 per sample, which included pH, Bray 1 phosphorus, and extractable potassium. Organic matter was an additional \$0.50. A nitrogen test to 2 feet was \$2, a zinc test was \$3, and a lawn and garden test was \$2. The public soil testing services were discontinued in 1982, when demand for the service had declined because commercial providers were available and George moved on to become station head. Research soil sample analysis continued into 1990.



DRYLAND CROPPING SYSTEMS RESEARCH

John Holman and Charles Norwood

Dryland Soil & Cropping Systems Agronomists at Garden City: **Roy B. Herring** (1951-1958), **Homer Brady** (1958-1960), **Norman Nossaman** (1960-1965), **Donald Robinson** (1966-1967), **Edward Deibert** (1968-1972), **Charles Norwood** (1972-2000), **John Holman** (2006-present).

The Garden City Experiment Station has performed dryland research since the station was started in 1907. It was one of 22 experiment stations established from Canada to the Gulf of Mexico to do dryland agronomic research in the early 1900s. Emphasis has always been placed on crop rotation, proper variety selection, fertility, and efficient water use. Interest in irrigated crop production for southwest Kansas began in the late 1800s, yet many people believed the future of the region lay in dryland farming. Increasing energy costs for irrigation and declining water tables shows those early pioneers were likely correct..

When settlers arrived from the eastern states, they prepared the seedbed as they had previously done, using a moldboard plow to turn the soil over 5 to 6 inches deep. Early station research demonstrated that improper tillage increased soil erosion and a topsoil loss. Early tillage systems resulted in a loss of an estimated 500 tons of top soil per acre over an 11 year study period. This loss represents enough nutrients to produce 25 bushels of sorghum annually for 48 years.

Early researchers at the station were able to show that crop rotation would increase the odds of making a crop. The fallow year was used to save up moisture and nutrients to be used during the cropping year. However, researchers soon realized how inefficient the fallow period was in terms of storing water. In 1914, Sewell stated that the amount of water stored by summer tillage is about 15% of the rainfall received during the tillage period.

TILLAGE SYSTEMS AND CROP ROTATION RESEARCH

The **sweep plow**, also known as the Noble blade or the undercutter, is used to undercut roots of weeds and crop stubble while leaving the plant and stubble more or less intact on the surface. This tillage is also known as stubble mulching because the stubble remains on the surface to reduce water evaporation and to protect the soil from wind and water erosion. Research was done at the station to compare crop yields for plots tilled with the sweep plow, moldboard plow, or the widely used one-way plow. The moldboard plow inverts the soil and buries nearly all crop residue. The one-way plow leaves most of the residue on the surface, but in a horizontal position

Close up of Austrian winter peas.

Agronomists Curt Thompson and John Holman look at Austrian winter peas to evaluate its winter survival.



where it degrades rapidly in contact with the soil. The sweep plow leaves the stubble more or less erect where it does not degrade as rapidly. This study ended in 1965 and led to the conclusion that plots prepared with the sweep plow yielded 2 bushels per acre more than plots prepared with the one-way. Plots prepared with the one-way yielded 1-2 bushels per acre more than plots prepared with the moldboard plow. This research demonstrated the value of the sweep plow to local producers and encouraged them to adopt the technology. The sweep plow has since become the dominant tillage tool for dryland systems in this area. The one-way can be considered the replacement for the moldboard, and the sweep plow the replacement for the one-way.

Chiseling is another tillage operation that is performed to break up the “plow pan” and perhaps increase water infiltration, which should lead to increased crop yield. This research was done in the 1950s and resulted in little useful data. The conclusion was that chiseling was not needed on western Kansas soils.

Deep tillage was evaluated on sandy soils in the far southwestern counties of Kansas. The soils of this area have a sandy surface with an underlying layer of finer soils, usually not exceeding 15% clay. A disk plow was operated at a depth of about 2 feet and pulled by a crawler tractor. The sandy layer was inverted and mixed with the layer below. The objective was to reduce wind erosion of the soil. The tillage was successful in converting the texture from sand to loamy sand or from loamy sand to sandy loam in the top 4 inches of the soil profile. Theoretically this should reduce soil wind erosion; however, plowing still left the soil in an erodible condition, although somewhat less than before. Plowing did increase yields and probably reduced soil erosion, but the effects were not long-lasting enough for widespread use. In addition, the technology for mulch tillage was becoming available and was much more effective in reducing soil erosion.

Paper and chemical mulch studies were conducted in the 1950s and 1960s on grain sorghum and wheat. The objective was to conserve soil water and increase yield by covering the soil area portion between the crop rows with a mulch. However, the results were not usually statistically significant, and it was not practical to obtain favorable results on a farm scale because of the high expense of applying the mulch. Later in the 1960s, even asphalt was tried as a mulch, but a suitable application method could not be found.

Reduced and no-till cropping systems research began in the late 1960s and early 1970s. The introduction of effective herbicides made it feasible to manage weeds without tillage. This research continues today. This also led to the development of the wheat-sorghum-fallow cropping system by Bill Phillips, the weed scientist at Hays in the mid- to late-1960s. This cropping system proved to be superior to the wheat-fallow system in southwest Kansas. This system also worked well in the wheat



Charles Norwood showing sunflowers in the cropping systems plots.

and sorghum growing areas of the Texas and Oklahoma panhandles, as well as western Nebraska. This system allows two crops to be planted in three years, compared to one crop in two with the complete fallow systems. It is also well adapted to reduced tillage or no-till systems, particularly in the sorghum phase. Reducing tillage often resulted in increased moisture available to plants, which allowed the cropping system to be intensified. Corn could be grown instead of sorghum in the three-year rotation. Corn has a higher yield potential than grain sorghum when moisture is not limiting, but corn also has a higher water requirement and is more subject to drought stress than is sorghum. If corn is in the rotation, research has shown that the corn must be no-tilled. Grain sorghum will give positive yield responses to no-till in most years, but in the 1991-2000 period, corn responded positively to no-till every year of the test. No-tilling corn can make the difference between a decent yield and crop failure. Corn almost always out-yielded sorghum in the 1990s. However, it must be pointed out that the 1991-2000 period had above average rainfall. In moderate to severe drought, corn will not compete favorably with sorghum. Wheat, at least at the Garden City location, has not consistently responded positively to reduced and no-till systems. However, less tillage reduces the chance of wind erosion in the growing wheat crop. Research at Tribune has shown that the yield advantage of no-till systems increases over time. Research at Garden City has shown that it might take several years of continuous no-till before wheat yields become significantly higher than minimum or conventional tillage systems. From the 1970s through approximately 1990, the dryland project also was involved in the testing of several herbicides that the chemical companies were trying to register. Such herbicides included Bladex, Glean, Ally, Paraquat, Igran, and Command and Roundup. These herbicides and others were compared with each other and then integrated into reduced and no-till cropping systems.

Sorghum growing in wheat stubble (top) and sorghum stubble (bottom).



Fallow and continuous cropping studies were conducted in one form or another from the 1950s until the present. Generally, fallow cropping will yield more than continuous cropping –sometimes twice as much. However, fallow (wheat-fallow-wheat or sorghum-fallow-sorghum) is a very ineffective method of storing moisture and today has been largely superseded by rotations such as wheat-sorghum-fallow. Annual forage crops require less moisture than grain crops, and by including a forage and a grain crop in rotation, the cropping system might successfully be intensified. Current research is evaluating annual legumes and legume/grass forage combinations in rotation with winter wheat. These systems are being compared to continuous winter wheat and winter wheat-fallow for water use efficiency and profitability. Another crop currently being studied in southwest Kansas is winter canola. Winter canola would be an excellent rotation crop with winter wheat, but winter canola has had a history of winter-kill in the region. Current research is evaluating new cultivars for improved winter hardiness.

FERTILITY RESEARCH

Studies of the effects of nitrogen, phosphorous, and potassium on wheat and grain sorghum have been performed about as long as university research has been conducted. Southwest Kansas is no exception.

Traditionally, since most land was fallowed, the two major dryland crops, wheat and grain sorghum, did not respond very often to nitrogen and phosphorus because these two nutrients were released into the soil solution (mineralized) during the fallow period. Exceptions occurred when precipitation was well above average. A small response to fertilizer could also be found on sandy soils, which are commonly low in fertility. Research has also been conducted on timing of fertilizer applications to determine if application timing in the growing season can improve response. Deep placement of nitrogen was tried in the late 1960s and early 1970s. In general, neither timing nor placement had much effect because precipitation, not fertility, was the limiting factor in dryland production in southwest Kansas. However, in the 1970s, 1980s, and 1990s, the yields of these crops gradually increased, and it was found that along with the higher yield potentials came the need for more fertilizer. Currently, the recommendation is about 30 to 40 lbs/a of nitrogen and also phosphorous if need is indicated by a soil test. However, crops cannot be expected to respond every year, because of the normally dry conditions.

PLANTING RESEARCH

Plant population, row spacing and hybrid studies. In the 1960s and 1970s, various grain sorghum studies were conducted with different combinations of plant population, row spacing, and hybrids. The early studies compared hybrids in 20- and 40-inch rows at various row spacings. The most important result of these studies was that 20-inch spacing almost always gave better yields than 40-inch spacing. The 40-inch spacing was likely traditional; when farmers used mules and horses, the animal could walk between such rows. With tractors, the wide row spacing is no longer necessary. However, 20-inch rows are typically too narrow to cultivate with modern machinery, so for the most part, farmers in this area use 30-inch rows. The yield with 30-inch rows may or may not be less than that of 20-inch rows, but it will almost always be higher than the yield from 40-inch rows. However, Carlyle Thompson, agronomist at Hays, developed a planting system for sorghum that included narrow rows (10-15 inch spacing) planted in late June or early July and relied on nearly complete sorghum canopy for weed control. By the time many weeds had germinated, they did not impact yield. Weed control could also be obtained by careful selection of herbicides. Thompson's system was tried in the late 1970s at Garden City with limited success. Generally, early maturing hybrids performed best in narrow rows while later maturing hybrids performed best in wide rows. The optimum plant population in all the above studies depended on available rainfall; higher populations were slightly better in wet years while lower populations were better in dry years.

John Holman standing in his 2007 limited irrigation winter canola crop.

Charles Norwood explaining results from cropping systems research plots.



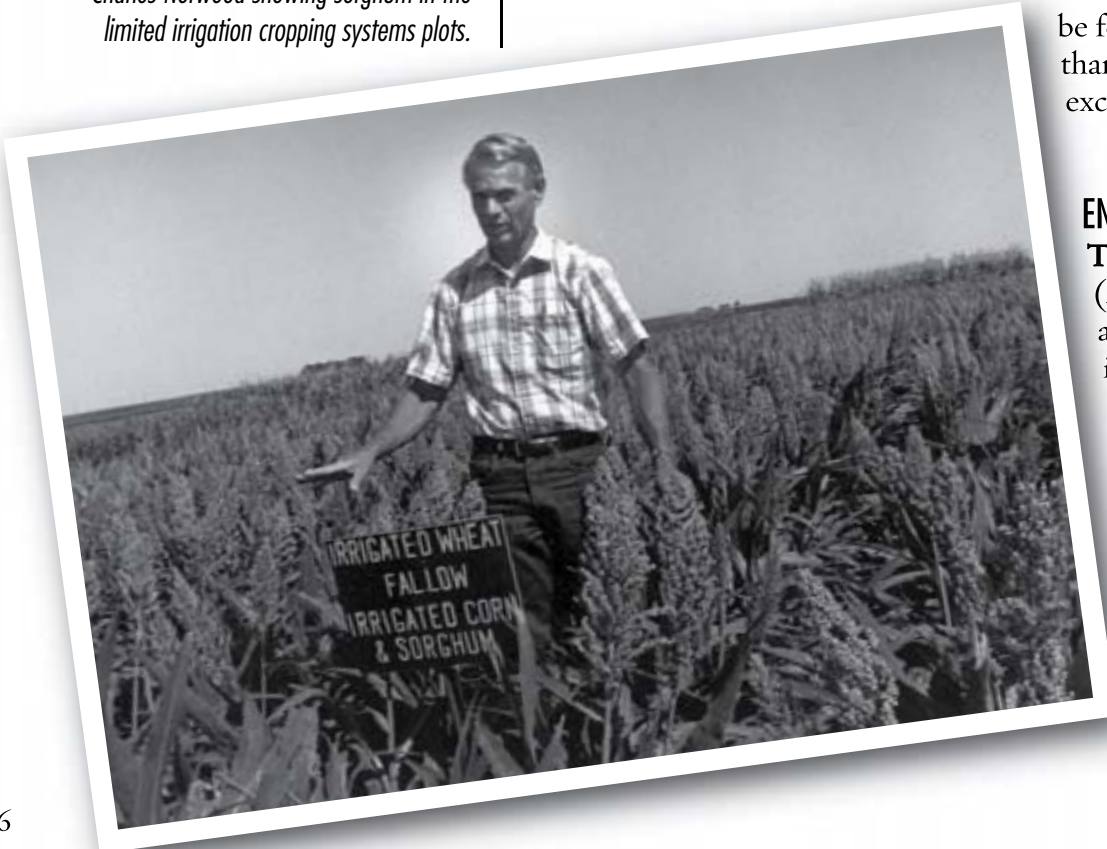
When preliminary studies with corn indicated it could compete with grain sorghum in dryland cropping systems, a study was initiated looking at combinations of planting date, plant population, and corn hybrid. Due to above-average rainfall in the 1990s, higher populations and later hybrids usually produced the highest yields. The recommended population from this study is 18,000 plants/acre. Contrary to popular belief, planting dates of May 1-May 15 produced higher yields than mid-April plantings. Under more normal rainfall, however, mid-season hybrids and lower plant populations are projected to be superior. Very early season hybrids will not do well regardless of rainfall because of low yield potential.

LIMITED IRRIGATION RESEARCH

Irrigated-dryland transition. With a decrease in the water table and increasing costs of irrigating, an interest has developed since the 1990s in cropping systems that are not fully irrigated and perhaps only irrigate once or twice in a growing season. A study was designed to determine if one, two, or three irrigations would result in an adequate corn yield as compared to a total dryland system. The rotation used was wheat-corn-fallow, with only the corn being irrigated. Both conventional (sweep plow) and no-till systems were tested. Corn either received a single irrigation at tassel stage, two irrigations at tassel stage and grain fill stages, or three irrigations at vegetative, tassel, and grain fill stages. Of course, the more water, the more yield, but irrigating at the grain-fill stage usually produced the least response. However, a single irrigation at tassel gave an average 29% yield increase over the dryland system. This meant that limited irrigation was feasible and competitive with dryland systems. As with dryland corn, no-till cropping usually produced higher yields. Also, the data indicated that at the energy prices in effect in

2000, it would probably not be feasible to irrigate more than once unless the corn price exceeded \$2.50/bu.

Charles Norwood showing sorghum in the limited irrigation cropping systems plots.



ENVIRONMENTAL SCIENCE

Thomas C. Willson

(2000-2005) conducted a project that included integrating feedlot manure and irrigation water management in grain and forage production. Willson worked on water quality projects, such as identifying sources of fecal coliform contamination in the Upper Arkansas River.

ENTOMOLOGY RESEARCH

Larry Buschman

Entomologists at Garden City: **Roy F. Fritz** (Dept. of Entomology, 1939-1941), **Elvin W. Tilton** (Dept. Entomol., 1951-1954), **C. F. Henderson** (USDA, 1951-1954), **Lester J. DePew** (Dept. Entomol. 1954-1989), **Jay D. Stone** (Dept. Entomol., 1973-1976), **Donald E. Mock** (SW Area Office, 1973-1980), **Gerald L. Greene** (SWREC 1976-1996), **Marshall W. Johnson** (Dept. Entomol., 1979-1981), **Lawrent (Larry) L. Buschman** (Dept. Entomol., 1981-present), **Phillip E. Sloderbeck** (SW Area Office, 1981-present), **Gary L. Dick** (Dept. Entomol., 1989-1992).

GRASSHOPPER PROJECT (1939 TO 1941)

Grasshoppers were major pests in the western Great Plains starting in the mid 19th century. In the early 20th century, there were area-wide grasshopper control programs supervised by county agents using bran and molasses baits containing arsenic or Paris green as toxins. The Department of Entomology assigned a graduate student, **Roy F. Fritz**, to the Garden City station to conduct studies on the grasshopper problem in western Kansas from 1939 to 1941. He worked on the biology of grasshoppers in the region, including the relationship between soil conservation practices and grasshopper problems. Fritz also observed that grasshopper baits needed to go out when temperatures were above 70 degrees, when the grasshoppers began feeding. Subsequently, there were several active grasshopper projects in Manhattan. In 1979 and 1981, the Garden City station's Donald Mock, Marshall Johnson, and Lester DePew published additional work on the efficacy of grasshopper insecticides.

SMALL GRAIN INSECT PROJECT (1951 TO 1989)

In the late 1940s and 1950s, arid conditions in western Kansas enhanced the build-up of **brown wheat mites** and producers clamored for help. The K-State Department of Entomology assigned Elvin W. Tilton (1951-1954) and then Lester DePew (1954-1989) to work on this problem in western Kansas, and the U.S. Department of Agriculture assigned C.F. Henderson (1951-1954) to collaborate on these problems. The group conducted a number of biological and chemical control studies on the brown wheat mites and the greenbug, and they developed some management strategies for these insects. When more normal rainfall returned, the brown wheat mite problem subsided. Consequently, the USDA entomologist was reassigned and DePew did further studies on management of the **greenbug, wheat curl mite, and pale western cutworm**. DePew was able to identify insecticides that were effective on these pests. He also demonstrated the host plant resistance of new wheat varieties to the greenbug and determined the economic threshold for the pale western cutworm on wheat.



Les DePew presenting results from greenbug trials in sorghum.

In 1967, a new greenbug biotype (biotype C) appeared as a major pest of sorghum. When new resistant sorghum hybrids were developed, DePew established that while new resistant hybrids provided good control of the greenbug, the hybrids benefited from insecticide applications when under heavy pressure. He also identified several insecticide treatments that were effective against the greenbug. In the late 1980s, DePew and Phil Sloderbeck also documented a Lorsban-resistant strain of greenbug that threatened wheat and sorghum production.

DePew also worked on a variety of other insect pests in the region. In the 1960s he conducted management studies for the **spotted alfalfa aphid** and the **alfalfa weevil**. In the 1980s he conducted research on the oviposition habits, chemical control, and alternate hosts of the **sunflower moth**. DePew also did some early efficacy work on ground application of insecticides for corn rootworm control.

CORN INSECT PROJECT

In the late 1960s, corn production began to increase in south central and western Kansas with the expansion of irrigation. The southwestern corn borer expanded its range northward into southern Kansas during the 1960s, while the European corn borer spread across Kansas from the east during the 1970s. The southwestern corn borer is devastating to corn production because it cuts the plant off before harvest in the fall, causing enormous yield losses. This insect must be managed for corn production to be successful in this region. In addition to corn borers, spider mites often were found to be a pest of corn in the arid climate of the High Plains. In the 1970s, producers in the region clamored for help in the management of these pests, resulting in the Kansas Legislature funding new entomology faculty positions to work on these pests.

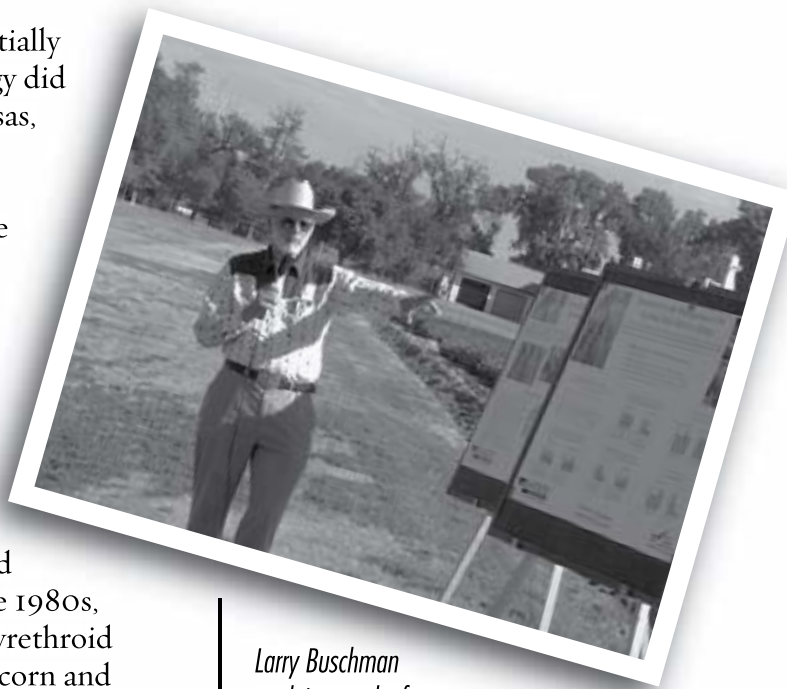
In the late 1970s, Fred L. Poston and Steve Welch of the entomology department and their graduate students conducted studies from Manhattan on the **southwestern and European corn borer**. Much of the field work on the southwestern corn borer was done at the St. John's Research Field, but the information applies well to southwestern Kansas. They were able to identify the time windows when the corn borers were hatching and vulnerable to insecticide treatments and identified several insecticides that were effective against both corn borers. During the 1980s and 1990s, Larry Buschman and Phillip Sloderbeck conducted efficacy trials of corn borer insecticides for both the European and southwestern corn borer in Garden City, including studying insecticide chemigation (applying insecticides through sprinkler irrigation systems). During the 1980s, Randall Higgins, Poston and Welch developed computer models to help predict the timing for this window and the economic threshold for making treatment decisions for the European and southwestern corn borers. These models were used extensively in southwestern Kansas. Also in the 1980s, Buschman and Lester DePew demonstrated that spider mite populations tended to increase after insecticides were used to manage other pests, such as corn borers in corn or greenbugs in sorghum.



Corn ears from experimental Bt and non-Bt corn hybrids showing a remarkable reduction in corn earworm damage to the kernels.

Research addressing the **corn spider mite** problem was initially conducted from Manhattan. John C. Boling of entomology did some initial miticide efficacy testing in southwestern Kansas, while Gerry Wilde and a graduate student did some early greenhouse work on the **Banks grass mite**. When Boling left, the entomology department decided it would be more effective to station an entomologist at the Garden City station to work on spider mites. Jay Stone, Don Cress, Marshal Johnson, and Larry Buschman were Department of Entomology faculty members assigned to work on the corn spider mites in Garden City. Each of these entomologists evaluated the efficacy of various miticides available for use against corn spider mites. In the 1970s, a number of organophosphate miticides were effective, but these products lost their effectiveness or were removed from the market by the EPA during the 1980s. During the 1980s, Buschman and Sloderbeck helped demonstrate that the pyrethroid bifenthrin was effective in managing Banks grass mites in corn and helped to get it registered under the trade name of Capture. This miticide gained full registration in 1990. It became the most widely used product for managing both corn borers and spider mites during the 1990s and early 2000s. During the late 1990s, Buschman and a student found no resistance to Capture in Kansas populations of Banks grass mite. However, resistance to Capture was documented in Texas in the 2000s, and its efficacy in Kansas appears to be declining. Buschman and Sloderbeck have demonstrated the efficacy of two new miticides that may be useful in managing the corn spider mite over the next decade.

Buschman and Sloderbeck also studied the biology and ecology of spider mites on corn. During the 1980s, they documented that the **Banks grass mite** predominated in early-season populations, but that the **twospotted spider mite** could predominate later, during reproductive growth stages of corn. This appeared to happen when insecticides or miticides were used, because they seemed to reduce Banks grass mite populations without affecting twospotted spider mite populations. Buschman and Depew also documented that insecticide treatments targeting other insect pests caused mite populations to increase. Buschman and a graduate student documented a number of alternate winter hosts for spider mites and demonstrated the importance of these hosts in forming a green alternate host bridge on which the mites could survive the winter. These alternate hosts also had a major impact on the early-season populations of spider mites available to infest corn in spring. The twospotted spider mite did not survive the winter as well as did the Banks grass mites, so there were more Banks grass mites than twospotted spider mites invading the corn in spring. This explained why spider mite populations started out as predominantly Banks grass mites. Buschman and his students also documented the important role of the pathogenic fungus *Neozygites* and the predator mite *Neoseiulus fallacis* on population dynamics of spider mites in corn. Both tend to be more effective on Banks grass mites and contribute to predominance of twospotted spider mite populations late in the season.



*Larry Buschman
explains results from corn
borer and spider mite trials in field corn.*

The **western corn rootworm** is also a major pest of corn in western Kansas, but because it is also a pest throughout the rest of the corn belt, most of the work on this pest was conducted in Manhattan by Gerald Wilde and his graduate students. In Garden City, Buschman, Sloderbeck and DePew did several evaluations of the efficacy of soil insecticides against the western corn rootworm. In 1995 and 1996 Buschman also evaluated the efficacy of aerial treatments of a beetle bait formulation in managing western corn rootworm beetles.

In the mid-1990s Buschman and Sloderbeck, in cooperation with Higgins in Manhattan were among the first to evaluate the new types of **Bt corn** against the southwestern corn borer. They were able to document that some of the early types of Bt-corn were not effective against second generation corn borers in western Kansas. However, they also demonstrated that several other types of Bt corn had excellent efficacy against both the southwestern and European corn borers. They were able to document up to a 74 bu/acre yield advantage for Bt hybrids under heavy southwestern corn borer pressure.

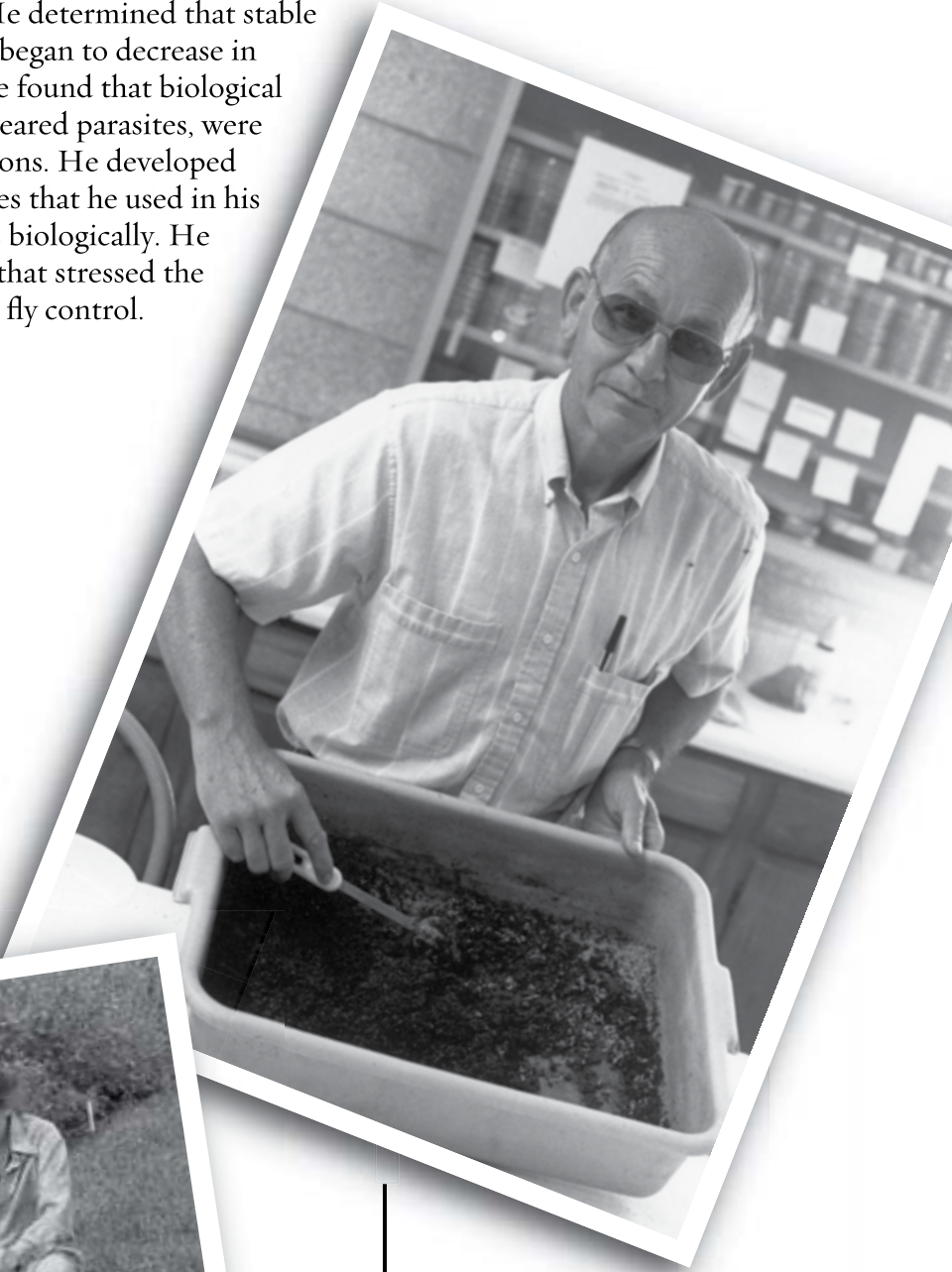
SOYBEAN STEM BORER PROJECT

The **soybean stem borer**, *Dectes texanus*, came to the attention of Kansas soybean producers in 1985, when the Kansas Department of Agriculture reported noticeable damage to soybeans in five counties in south-central and southwestern Kansas. The problem has grown to include many of the counties in the western two-thirds of the state. This problem may be related to increasing acreage of soybeans planted in the state and to the increasing use of no-till farming practices. In the mid 1990s, Sloderbeck and Buschman approached the Kansas Soybean Commission about sponsoring research to learn more about this pest. Using large plots (one-fourth of a center pivot irrigation system), they demonstrated that stem borers could be managed using two aerial applications of a pyrethroid targeting beetles before they laid their eggs. The researchers also demonstrated that one of the systemic insecticides can be used as a foliar treatment, a lay-by treatment, or a seed treatment to control these insects. The two are now working to get this insecticide labeled for use in soybeans. Buschman and a graduate student are also working to develop host-plant resistance to this pest. In addition, Buschman is working on better sampling methods to help determine if and when treatments are needed for this pest.

Corn stalks from Bt and non-Bt corn hybrids showing sharply reduced southwestern corn borer damage in the stalks.

FEEDLOT INSECT PROJECT

In 1982, Gerald Greene stepped down as head of the Garden City Experiment Station and began a livestock entomology project. There are millions of cattle in feedlots throughout southwest Kansas, and **stable fly** losses are estimated at 0.2 pounds per head per day when fly populations are heavy. Greene began his work by surveying local feedlots to identify stable-fly breeding sites and to document the degree of natural biological control that was present. He determined that stable fly populations peaked in June and normally began to decrease in July as temperatures exceeded 95 degrees. He found that biological control practices, which released laboratory reared parasites, were not effective for managing stable fly populations. He developed rearing procedures for a native parasite species that he used in his research on controlling stable fly populations biologically. He also did a pilot stable-fly management study that stressed the need for sanitation as the first step in feedlot fly control.



Gerald Greene showing fly larvae that served as food for a parasite that was released in southwest Kansas feedlots to reduce stable fly populations.



Two entomology graduate students, Teru Niida and Holly Davis, dissect soybean plants to evaluate soybean stem borer infestation.

IRRIGATION RESEARCH

Norman Klocke and Dennis Tomsicek

Irrigation Engineers at Garden City: **J. W. Longstreth** (USDA, 1911-1912), **Geo. S. Knapp** (USDA, 1914-1916), **W. R. Meyer** (USDA, 1949-1955), **Jack T. Musick** (USDA, 1956-1959), **Francis Ohmes** (1971-1982), **William (Bill) E. Spurgeon** (1988-1994), **Todd P. Trooien** (1996-2000), **Norman Klocke** (2001-present).

A.W. Stubbs, editor of the *Irrigation Champion*, wrote in 1895, "It is facts and not theories that the people want in reference to the subject of irrigation." This parallels the founding philosophy for the establishment in 1907 of the Southwest Research-Extension Center.

In 1911, interest in irrigation was high, and the Garden City Industrial Club and city commissioners raised \$6,200 to drill a **deep well for irrigation**. A 97,500 cubic foot reservoir was also built that year. The stage was set for irrigation studies to begin in 1914. A new irrigation plant was installed in 1929 to help meet the expanding irrigation needs of the station. It consisted of six small, shallow wells connected to a large pump. The original deep well was abandoned in 1931. A new deep well, capable of pumping 1,500 gallons per minute, was drilled in 1950. Irrigation research expanded in 1948, when the Garden City Company made 80 acres of land available near Holcomb. This area, made up of Ulysses and Richfield silt soils, came to be called the Irrigation Project.

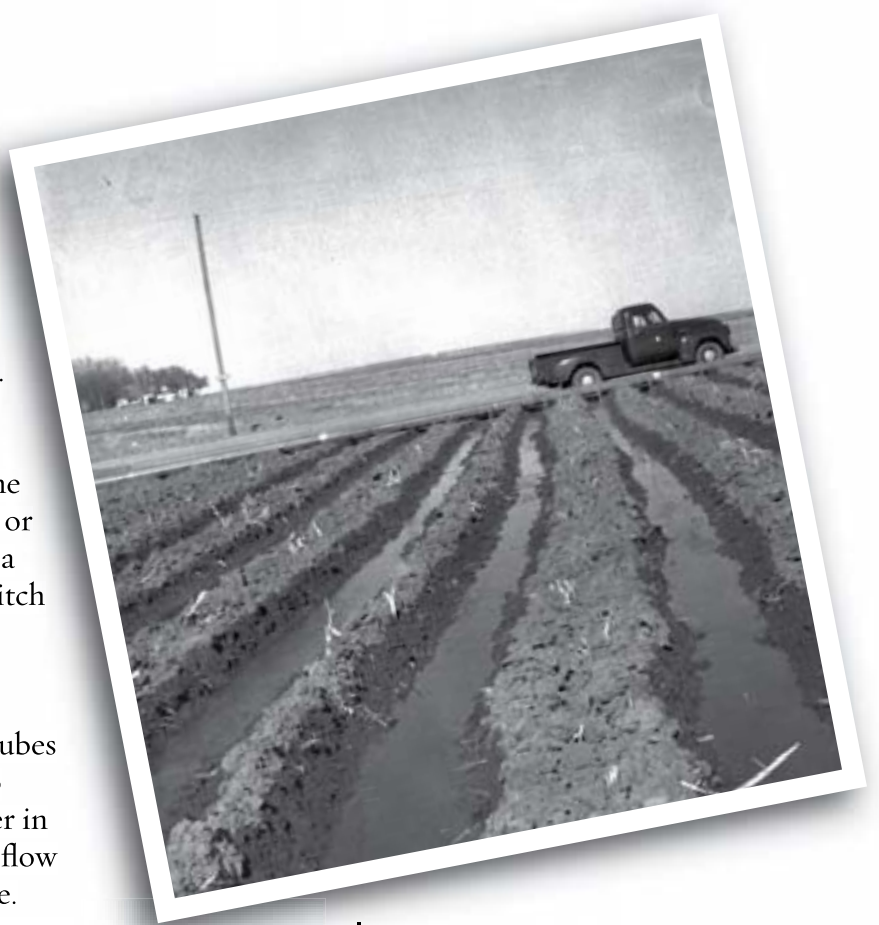
*Moving irrigation pipe during the 1950s
and 1960s.*



Adoption of new irrigation systems in southwestern Kansas followed the pattern seen for the Great Plains and elsewhere in the West. Early settlers dug **diversion canals** around rivers to deliver water to nearby fields. Lateral ditches brought water to fields and head ditches along the high side of the field and delivered water to furrowed rows or basins. Art and experience were required to irrigate. The head gate needed to be set to allow inflow to the head ditch. The irrigator had to match the inflow with the water turned out into each row or basin. Originally, the turnouts were made with a shovel by digging a mini-ditch from the head ditch to each furrow.

Advancements to **surface irrigation** came with **siphon tubes** and **gated pipe**. First, the siphon tubes carried water over the edge of the head ditch to the irrigated furrow. At a constant level of water in the head ditch, the siphon delivered a constant flow of water to the furrow for each diameter of tube. Setting siphon tubes eliminated the manual turnouts with the shovel, but the irrigator still needed to match inflow to the head ditch with outflow through the siphon tubes. The gated pipe replaced the head ditch when the water source was a pump. Water carried with pressure to gated pipe brought irrigation to the uplands. Fields were graded to carry water more uniformly from the high end of the field to the low end. Gated aluminum pipe had one opening slot per crop row and each opening had a sliding gate that could be adjusted to control outflow. The irrigator needed to open and close gates for each irrigation set and adjust the opening for flow to match the pump's delivery. Gated pipe irrigation is still practiced in southwest Kansas, but acreage has shifted from nearly 100% of irrigation to approximately 20%. The center pivot had become the predominant form of irrigation by the mid 2000s.

Surface irrigation with furrows or borders may seem as simple as turning water into a field, but it is a complex process. SWREC researchers worked for several decades to develop more uniform irrigation from these techniques. The soil in surface irrigation provides the conduit to advance the water and the medium to infiltrate water. The goal is to infiltrate the same amount of water into the root zone from the top to the bottom of the field. Field slope, soil type, furrow size, flow rate, and field length all influence irrigation uniformity. SWREC researchers worked with all these variables, both at the main center and the irrigation site near Holcomb, which was provided by the Garden City Company. During the 1980s, researchers also studied the use of surge valves to help manage the distribution of water across the field.



Pre-season furrow irrigation in the 1950s. This practice fills the soil profile with moisture, so it can be used by the plant during the growing season.

Center pivots came to southwest Kansas in the early 1970s. The SWREC installed a water drive Valley system in the field south of the office building, and 84 acres became available for sprinkler irrigation research. The Valley water drive center pivot was replaced with a Zimmatic electric drive around 1985. A Valley linear-move irrigation system was installed on the Finnup Foundation property north of the main center during 2002. This system was modified with 36 valves so that test plots could be irrigated in a random fashion. In 2005, a half circle Zimmatic center pivot was installed west of the main center, replacing furrow irrigation of plots.

Center pivots provided many advantages over surface irrigation. The systems can be installed on sloping land, can deliver water to every part of the field uniformly with proper design, and can reduce labor requirements dramatically. The initial system designs had sprinkler heads that required 70 psi operating pressure and shot water into the air at 23° above horizontal. This caused excessive evaporation losses. New sprinkler designs in the early 1980s had lower sprinkler angles, lower operating pressures, and reduced evaporation by distributing the water within the canopy.

Researchers in Texas developed the **Low Energy Precision Application** system for delivering water through the canopy and directly to the soil at ultra low pressures. Researchers at SWREC predicted challenges with this system in fields with rolling topography. Water distributed within the canopy had a smaller wetting diameter that caused more intense application rates than could be handled by the soil infiltration rates. The result was water running from the higher areas to the lower areas. Studies at SWREC proposed that small basins be created between the crop rows to capture the water where it was applied. On sloping topography, this practice could fail when there was silting of the basins and reduced holding capacity.

During the early 1990s, **subsurface drip irrigation** was introduced to the area through research at SWREC and similar research at Colby. The first one-acre system was installed at SWREC. Another 10-acre system was installed at the Holcomb irrigation research site. Installation techniques, lateral location, lateral pipe size, lateral length, irrigation frequency, operating pressure, and emitter size all had to be evaluated to determine the best recommendations for Kansas conditions. Subsurface irrigation can place water in the plant root zone and avoid evaporation losses. In addition, it was a big improvement in application uniformity compared to surface or sprinkler systems.

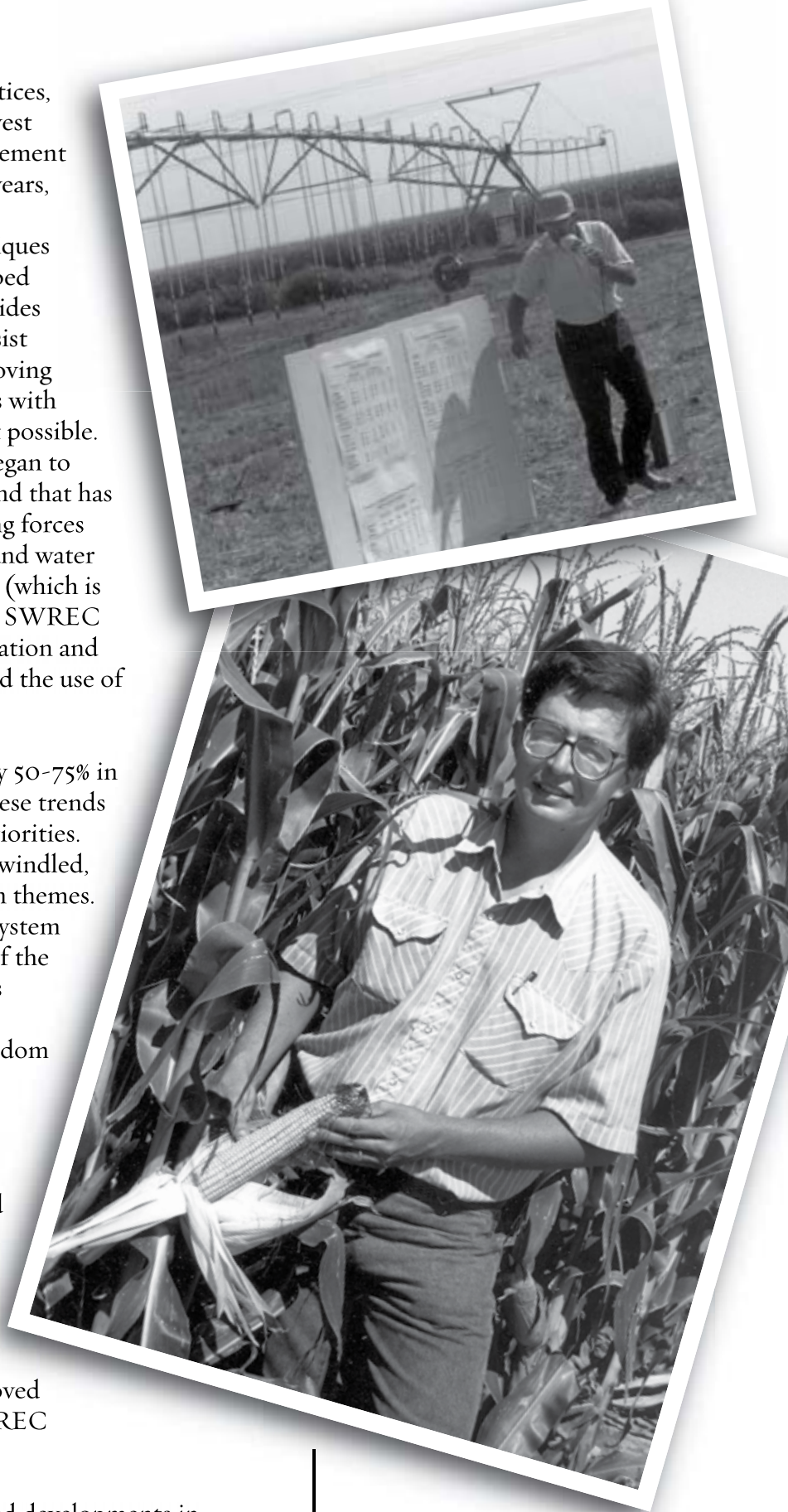
Norman Klocke explaining operation of the new linear-move sprinkler system installed in 2002 to conduct precise irrigation application rate experiments.



Through all of the advances in irrigation practices, **cropping management** was adapted to southwest Kansas by SWREC researchers. Many management research topics seem to be repeated over the years, but as irrigation systems developed, cropping approaches changed. The management techniques developed for the area were originally developed for full tillage systems because modern herbicides were not available. Tillage-based systems persist in furrow irrigation because keeping water moving through a furrow requires clean tilled surfaces with little crop stubble. No-till management is not possible. During the early 1990s, sprinkler irrigators began to reduce the number of tillage operations, a trend that has accelerated in the early 2000s. The motivating forces for these changes were less energy for tillage and water saved through reduced soil water evaporation (which is suppressed by **crop residue** as documented by SWREC researchers). Reduced water supplies for irrigation and strongly escalating energy costs have prompted the use of reduced tillage systems.

Groundwater resources have been depleted by 50-75% in western Kansas from the 1970s to 2000s. These trends have strongly influenced SWREC research priorities. As water supplies from the Ogallala aquifer dwindled, irrigation research turned to limited irrigation themes. In 2002, a four-span linear-move irrigation system was installed on the Finnup property, north of the SWREC headquarters. The linear system was equipped with extra valves to enable watering plots with different amounts of water in a random manner. From the beginning, irrigators have wanted to know how much crop yield can be anticipated from different amounts of water. With this knowledge they can plan crop selections, allocation of land to each crop, and the amount of water to give each crop based on economic decisions. Originally these decisions were made with pencil, paper, and multiplication tables. Then they were made with a hand-held calculators. In 2003, the decision-making process was improved by the **crop water allocator** developed by SWREC and K-State researchers.

Through the years, irrigation research followed developments in irrigation system design. The constant research themes involved making irrigation systems work in southwestern Kansas conditions and adapting crop management strategies for profitable production with these systems.



Dennis Tomsicek (top) and Bill Spurgeon (bottom) explain effects of low placement in the corn canopy of sprinkler nozzles on water runoff and grain yield.

OTHER IRRIGATION MANAGEMENT TOPICS INCLUDED:

1. Critical plant-growth stages for irrigation and amounts to apply
2. Crop adaptability to irrigation systems
3. Economical quantities of water to apply
4. Loss of water from reservoirs by evaporation and seepage
5. Grain sorghum and corn irrigation and plant population
6. Leaching of saline-alkali soils
7. Soil moisture management
8. Consumptive water use, water timing, and efficiency for wheat, corn, and sorghum
9. Sugar beet production under different irrigation levels
10. Plant transpiration and soil water evaporation
11. Sprinkler-irrigated pasture grazing and runoff research
12. Terrace research and tillage comparison for corn and grain sorghum under sprinkler irrigation
13. Fertility responses to surface-irrigated corn, grain sorghum, and wheat
14. Surge irrigation using different cycle times
15. In-canopy corn irrigation using different amounts and frequencies
16. Subsurface drip irrigation for corn using different drip-line spacings and plant population
17. Irrigation with different spray mode and tillage combinations
20. Frequency and amount study
21. End-of-season completion dates for corn
22. Full and limited irrigation of grain sorghum and full/short season corn at different planting dates
23. Narrow corn rows concentrated over wide spaced drip lines
24. Corn, sorghum, wheat, sunflower, and soybean water requirements

No-till planter used to plant in heavy corn residue. The residue acts as insulation to reduce moisture evaporation from the soil.

A water-drive center pivot sprinkler system in operation on the experiment station during the 1960s and 1970s.



WEED SCIENCE RESEARCH

Randall Currie

Weed scientists at Garden City: **Jerry Condray** (1968-78), **Vernon Langston** (1984-1985), **Don Morishita** (1986-1990) **Margaret (Peg) Steward** (1988-1991) and **Randall Currie** (1991-present).

Living things follow a cycle, beginning with conception and then infancy, adolescence, maturity, followed by a decline in fitness with age, and ultimately by death. A good weed control practice has a life cycle that develops in much the same pattern: beginning with discovery or birth, continuing with adoption, and ending in decline and often death as nature or the culture it occurs in adapts to overcome the practice. The life cycles of a succession of weed control practices is presented here. The role of weed control research at SWREC has often been the nurturing of a weed control practice during its birthing and adoption by growers. The center's research also has extended the useful life of weed control practices as they began to decline late in their life cycles.

It could be argued that the first weed control in Finney County was practiced by the Native Americans prior to the influx of the Europeans. They used fire to induce plant species changes that improved hunting. This section is a brief description of weed control from 1907 till 1957 to set the stage for a more detailed account of the period from 1957 to present.

Prior to 1945, herbicides for weed control were sparse and not very selective. Salts such as sodium chloride and sodium chlorate were commonly used to killed all vegetation for an extend period. Kansas State University was involved in the research on the use of sodium chlorate to slow the spread of field bindweed from 1907 to the early 1920s. From the 1920s until the early 1940s it actively promoted this practice. Most selective weed control in the post-World War II period relied on deep tillage prior to planting, followed by multiple inter-row cultivations. These tillage practices consumed huge inputs of labor and energy. They also reduced yield because they depleted soil moisture – already limited in western Kansas compared to eastern Kansas. The first researchers at the station tried to transplant the practice of deep fall tillage and found it led to crop failures in this more arid region. For many decades, producers in the region repeated this failed practice. Furthermore, the practice removed surface crop residue, exposing the fragile soil to the erosive power of wind and water. This precipitated the ecologically devastating dust storms of the 1930s, which deposited soil from this region as far away as our nation's capital.



Randy Currie, Weed Scientist

During the 1950s, the Garden City Experiment Station recorded a drought period that was similar to that of the 1930s. The number and intensity of dust storms fell modestly due to reduced use of deep tillage and increased use of herbicides. In 2002, the Garden City Experiment Station recorded another drought with intensity equal to those of the 1930s or 1950s. No dust storms were recorded due in large part to extensive adoption of reduced- and no-tillage practices, which rely on herbicides to manage weeds.

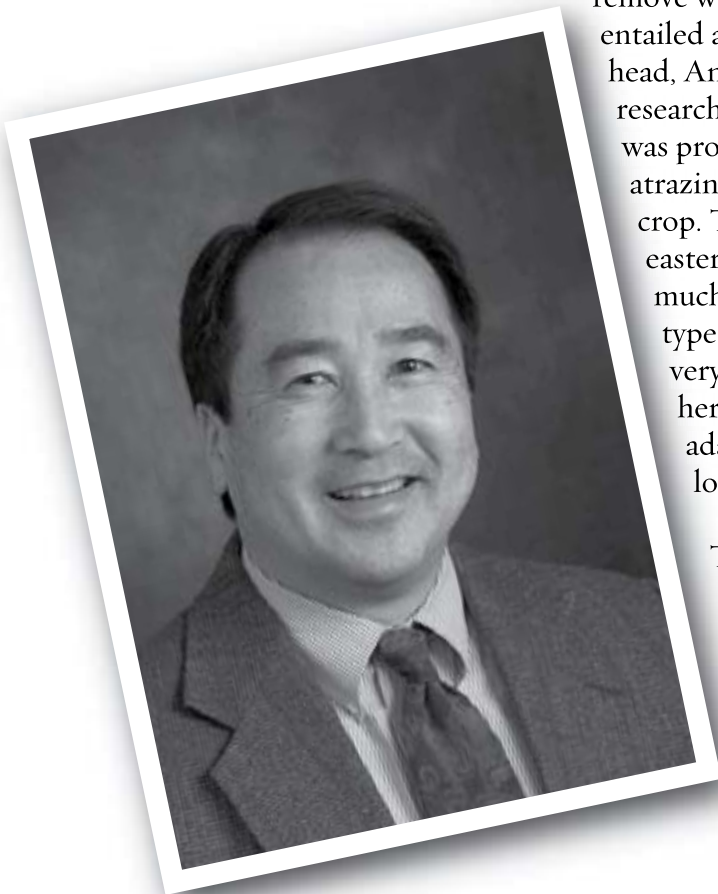
In the late 1940s, there was widespread adoption of the herbicide 2, 4-D. This product controlled a broad array of broad-leaf plants and could be used safely in many grass crops with a good bit of selectivity. Progressively more effective herbicides have been developed since then. Nature and economics have gradually conspired to defeat or severely compromise many of these compounds. The irony is that many of the compounds that followed 2,4-D are in the later stages of decline or are already gone, but 2, 4-D remains a viable herbicide, as it has been more difficult for nature to defeat. This herbicide is now an elder statesman among herbicides, albeit not as effective as in its youth. It requires a good bit of assistance from younger compounds, but is still a widely used herbicide.

The 1950s were dominated by photosynthetic inhibitor herbicides, such as diuron, simazine, and atrazine. This period saw the birth of the acid analide grass-control herbicides alachlor and propachlor. During this period, each individual research project at the experiment station had to develop its own weed management procedures to

remove weeds as a factor in their experiments. This frequently entailed at least two cultivations plus hand weeding. The station head, Andy Erhart, banned most herbicide use in Garden City research plots until they were better understood. This policy was prompted by simazine injury to landscape plantings and atrazine injury to wheat from its use in the proceeding corn crop. The soils of this region are very different from those in eastern Kansas. They have a much higher PH and require a much different herbicide rate structures for these triazine type herbicides. This reinforces the lesson learned from the very first experiments at the station: transplanting tillage and herbicide management practices from other regions without adaptation to local conditions can cause significant crop losses.

The 1960s saw the rise of research on herbicides requiring intense tillage for incorporation, including the carbamate herbicides EPTC and butylate or dinitroanilines such as trifluralin. The 1960s also saw the emergence of compounds like the growth regulator herbicide dicamba and the triazine herbicide metribuzin.

Don Morishita, Weed Scientist





Jerry Condray was the first researcher at Garden City to devote a full-time effort to statistically analyzed weed control research. In 1973, prior to easy access to computers, he wrote “A calculator was purchased this year. It will be shared among the projects. This should make statistical analysis much easier.” Even with the advent of this tool, most complex statistical analysis had to be done on “main frame” computers in Manhattan with paper cards laboriously coded with perforations.

The 1970s saw the rise of research on cyanazine, glyphosate, metolachlor, and sethoxydim. Weed control in this period still relied on herbicides, such as the triazines and acid analides that were applied at one- to six-pounds per acre. Although effective, they required inter-row cultivation to achieve complete weed control. These compounds killed the “easy weeds.” They introduced a selection pressure that shifted weed populations to more difficult-to-control weeds such as Johnsongrass and shatter cane.

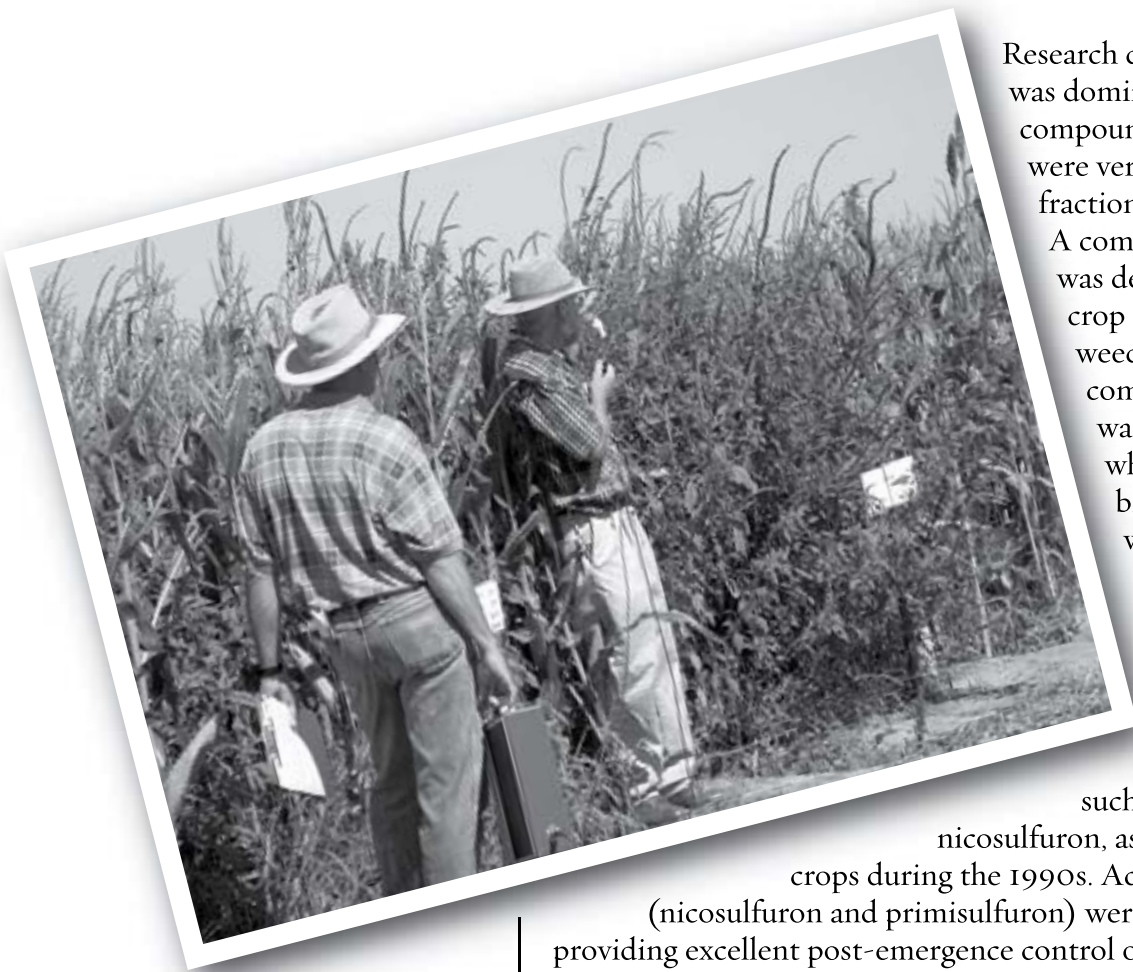
The 1980s saw the birth of the ALS herbicides such as chlorsulfuron, imazethapyr, and metsulfuron, as well as glufosinate, quinclorac, and acetochlor. Although acetochlor was discovered during this period, it did not reach farmers until it was off-patent more than 17 years later.

Vernon Langston (1984-85) was the second weed scientist at Garden city. He evaluated emerging chemistries and compared them to existing standards. Being a son of the southeastern United States, he took a job with a crop protection company in Louisiana after one winter in Garden City.



A greenhouse study that demonstrates herbicide tolerance in shatter cane.

Peg Steward, Research Associate



Randy Currie showing corn plots with excellent pigweed pressure. A good herbicide trial needs to have good weed pressure in the control plots and few weeds in the treated plots.

Research during the 1980s and 1990s was dominated by the ALS inhibitor compounds. These compounds were very active, often using fractions of an ounce per acre. A compound of this chemistry was developed for almost every crop and provided very selective weed control. The first major compound from this family was Glean (chlorsulfuron), which provided excellent broad leaf control in winter wheat.

Don Morishita and Peg Steward (1988-1991)

laid a foundation for the further expansion of other ALS herbicides,

such as primisulfuron and

nicosulfuron, as well as ALS resistant

crops during the 1990s. Accent and Beacon

(nicosulfuron and primisulfuron) were milestone discoveries

providing excellent post-emergence control of Johnsongrass and shatter in corn. The ALS compounds were victims of their own success; in less than a decade of intense use, a broad array of weeds quickly developed resistance to them. Although independent incidences of ALS-resistant shatter cane have occurred in southwestern Kansas, as well as other parts of the world, this resistance has not been widespread enough to limit nicosulfuron or primisulfuron. ALS herbicides are still widely used, but they often require tank-mixing with other compounds that have different modes of action to shore up their weakness brought on by resistance.

Aggressive use of ALS chemistries together with crop rotation has caused a local eradication of the once-widespread shatter cane at the Garden City Experiment Station. No shatter cane has been observed here since 1995. Shatter cane control research presently is conducted with the forage sorghum "Rox orange," which simulates shatter cane. Rox orange does not have the weedy traits of seed dormancy and shattering found in shatter cane. Although Johnsongrass populations have been greatly reduced by using these technologies, it has been much more persistent and is also continually reintroduced from surrounding areas.

The foundation work for crops breed for resistance to glufosinate, sethoxydim, and glyphosate was also being laid during the 1990s. The first two-pound sack of glyphosate-resistant corn in Finney County had to be to spread over far too large an area to do a proper test, much to the consternation of the excited weed research team. It was a rare pleasure in this period to still have sethoxydim-resistant corn; sethoxydim has no activity on broadleaf weeds and kills nearly all grassy weeds. This allowed the measurement of the effects of broadleaf weeds with out the interference of grassy weeds.

During the late 1990s and mid 2000s, glyphosate-resistant crops have held center stage. Glufosinate- and sethoxydim-resistant crops are gone or in rapid decline in this region. The HPPD-inhibiting herbicides, such as isoxaflutole, mesotrione, tembotrione, and topramezone, are beginning their expansion.

Beginning in the late 1990s, the use of glyphosate-resistant crops increased competition among all herbicide companies. This forced the decrease in price and the increase in the quality in all new weed control practices. As a result, inter-row cultivation for weed control is now almost unnecessary and rare. Glyphosate's place as the foundation of many weed control programs in this region may be in jeopardy, at least in the longer term. A number of weeds in North America, outside Kansas, are developing resistance to glyphosate, such as Palmer amaranth, water hemp, marestalk, Italian ryegrass, and common ragweed. Outside North America, glyphosate resistance has been found in goosegrass, buckhorn plaitain, hairy fleabane and Johnsongrass. We can only hope that practices learned while managing ALS resistance, such as crop rotation and tank mixing herbicides with different modes of action, can be applied to slow the spread of resistance to glyphosate and thus preserve it as an effective weed control tool for many years to come.

Randy Currie showing the plot with excellent bur ragweed control.



EXTENSION PROGRAM

The Kansas State University Cooperative Extension Service extends to all citizens research-based information that helps them improve their standard of living and quality of life. Its job is two-fold. The first is to extend current, science-based information from the university through educational programming on subjects of agriculture, natural resources, family and consumer sciences, 4-H youth development, community development, and energy to the people of Kansas. The second is to bring back to the university problems that can be solved by careful study and research within these program areas. The extension service is a partnership of the United States Department of Agriculture, the land-grant university system, Kansas State University, and the local, elected extension council or governing body representing local citizens. Much of its effectiveness can be credited to the part played by Kansas in planning extension educational programs, making it a true local, state, and federal partnership.

In 1969, the **Southwest Area Extension Office** was established with **Ray Mann** as the director (1969-1991). This was the first area extension office established off-campus to provide administrative and subject matter support to county extension faculty and citizens on a regional basis. This integrated network of local, regional, and campus-based faculty and expertise is important to the quality and relevance of applied research and timely information delivery. Initially, area extension faculty and farm management fieldmen were housed at the experiment station, but in 1972 they moved to 1501 Fulton Terrace in Garden City for improved office space. Upon Mann's retirement in 1991, **Paul Hartman** became the area extension director and continues in that position.

In June 1996, the Southwest Area Extension Office moved from Fulton Terrace to the Forrest Park Building at 2510 John Street, but the Farm Management office remained at the Fulton Terrace location. Then in 2000 the area extension office moved back to the experiment station, now called the Southwest Research-Extension Center (SWREC), when the new office building was completed. In 2006, the Farm Management Association established a satellite office at the SWREC. The Southwest Farm Management Association main office is now located in Dodge City.

The purpose of the Southwest Area Extension Office is to provide leadership and assistance in planning, conducting, and coordinating educational programs for southwestern Kansas in cooperation with other area and state extension specialists and research faculty. The specialists assist county extension faculty in the area with educational programs and serve as resource and support personnel to address local needs and issues. Also, specialists serve as liaisons with state and federal agencies, agri-business, commodity organizations, consulting groups, and local farmers. Area extension specialists convey the concerns of western Kansas agricultural producers, homeowners, family and youth to personnel at SWREC and appropriate departments at K-State that cooperate on various research and educational projects.



Rita Dome, Office Professional

Eva Rosas, Office Professional



The counties included in the southwest area have fluctuated over the years. When the university established area extension offices in 1969, the state was divided into five areas, with 22 counties in the southwest area. Currently there are four administrative extension areas in Kansas and there are 24 counties under the administrative leadership of the southwest area extension director and 26 counties being served by the area's extension specialists.

The following is a listing of the area extension faculty and office professionals, with examples of educational programming and activities in the area.

SOUTHWEST AREA EXTENSION DIRECTOR

Extension Directors: Ray H. Mann (1969-91), Paul D. Hartman (1991-present)

The extension director is administratively responsible to the dean of agriculture and director of extension. The role is to provide administrative leadership in the area. Major responsibilities include:

- Providing administrative leadership, direction, and support in matters pertaining to personnel hiring, supervision, and evaluation of faculty
- Cooperating with county commissioners and 24 county extension executive boards
- Budget formulation, negotiation, and management under Kansas Extension Council and extension district law
- Educational program planning, delivery, and evaluation
- County extension council and executive board organization and maintenance
- Supporting professional development activities of faculty and support staff;
- Administration of area office budget, area and county faculty and staff
- Serves as a liaison between the county, area, and state extension operations
- Public relations with county commissioners, legislators, and other civic and community leaders

Ramona Hinde, Office Professional

SW Area Extension Directors Paul Hartman and Ray Mann



EXTENSION PROJECTS

4-H YOUTH DEVELOPMENT

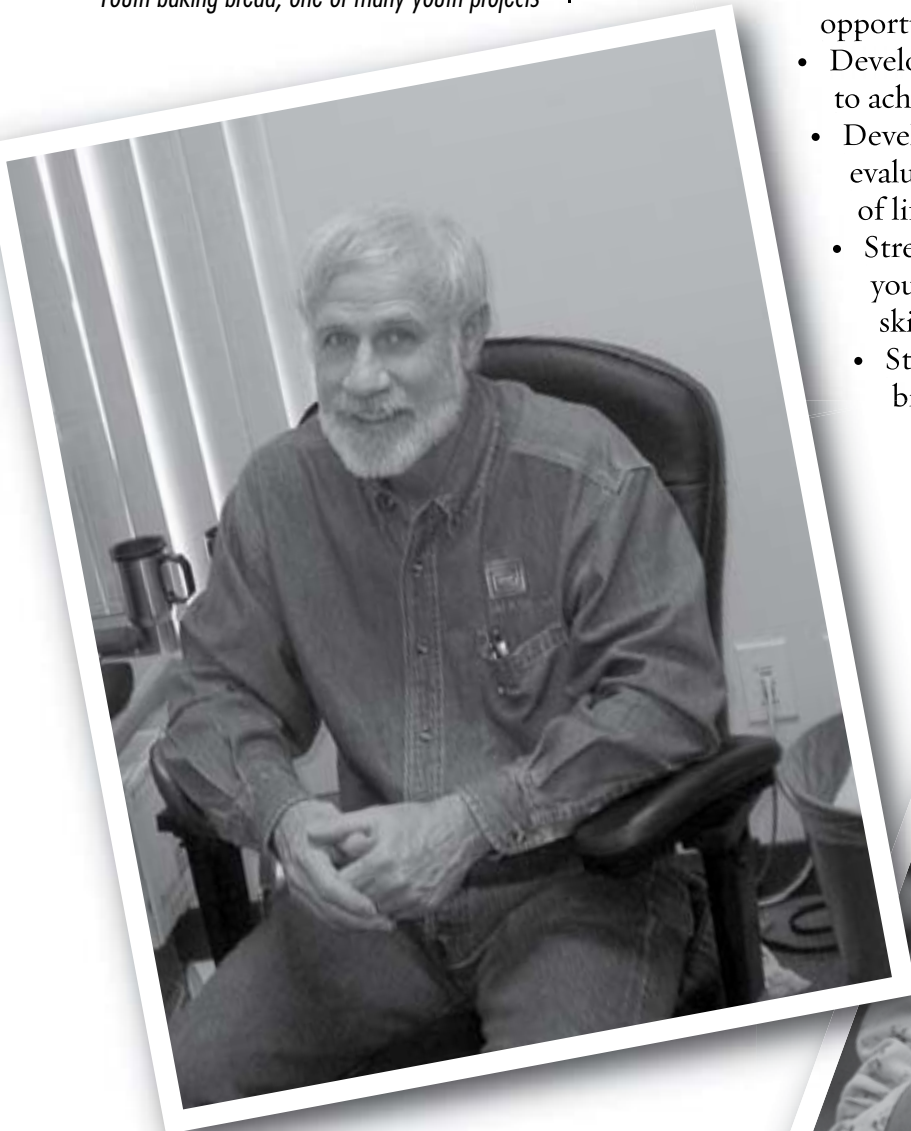
Extension Specialist, 4-H Youth Development: Loren E. Whipps (1972-76), **Fredrick R. Rohs** (1976-1982), **Christy Ladd** (1982-1984), **Errol Burns** (1984-1988), **Conall E. Addison** (1995-2003), **Rodney Buchele** (2003-present).

Responsibilities:

- Develop, strengthen, and support youth development competencies of extension professionals
- Develop, strengthen, and support youth development competencies of adult and youth volunteers
- Strengthen the relationship between research and practice using the curriculum resources of land-grant and other research-based systems
- Provide imaginative, motivational, and experiential learning experiences to help youth build competencies and master life skills
- Practice an ethic of access, inclusion, and opportunity for all youth
- Develop strategic collaboration and partnerships to achieve the 4-H mission
- Develop training and methods for program evaluation of elements of delivery and mastery of life skills
- Strengthen internal communication of 4-H youth development principles as related to life skills development
- Strengthen external promotion of the 4-H brand name to all audiences

Rod Buchele, 4-H Youth Development Specialist

Youth baking bread, one of many youth projects



CROPS AND SOILS

Extension Specialist, Crops and Soils: Dale H. Edelblute (1955-80), James A. Schaffer (1980-83), Edward G. Gatliff (1983-84), Dwight G. Mosier (1986-91), Curtis R. Thompson (1993-present)

Extension agronomist Dale Edelblute utilized county agricultural agents and county extension meetings to bring crop production research results to producers in southwestern Kansas. After his 25 years of service, Edelblute's legacy of excellent extension education remains today in the farming community. He was instrumental in development of and producer education for the county soil survey books. The area agronomist position evolved around county programming, including applied field research, agronomy field demonstrations, and county meetings. Previous agronomists James Schaffer, Ed Gatliff, and Dwight Mosier, as well as current agronomist Curtis Thompson, have continued cooperating with county agricultural agents, research faculty, and other area faculty to extend production knowledge to growers in the area and beyond. Additional responsibilities have evolved over the years, with involvement in statewide agronomic training, the agronomy department, extension publication writing, and active participation in regional and national professional societies as well as other professional agronomic groups.

AGRICULTURAL ECONOMICS

Extension Specialist, Agricultural Economics: Loren Whipps (1969-transferred to 4-H in 1972), T. Roy Bogle (1973-transferred to the Agricultural Economics Department in 1975), Randall B. Baden (1976-78), Mark A. Krause (1983-86), Kevin C. Dhuyvetter (1986-89, reappointed 1990, transferred to the Northeast Area Office in 1994), James D. Sartwelle, III (1995-97), Troy J. Dumler (1998-present)

The extension agricultural economist is responsible for directing extension economics education programs in southwestern Kansas in cooperation with county agents and state/area specialists in the Department of Agricultural Economics. Specifically, the economist conducts research to deliver educational programs on the profitability and risk associated with crop and livestock production systems in western Kansas. Recent research has primarily focused on cropping systems – both irrigated and non-irrigated. That work includes selection of crop rotations and tillage systems, and economically optimal uses of yield-increasing crop inputs such as fertilizers and irrigation water. The economist works on determination of equitable cropland rental arrangements, management of machinery costs, and analysis of agricultural policy alternatives. Additional responsibilities of the area economist include conducting applied research in conjunction with specialists and research faculty of related disciplines when it supports the area economics education programs. The applied research conducted individually and in cooperation with other disciplines is then disseminated to Kansas agricultural clientele and interested parties worldwide through public meetings, publications, media releases, newsletters, individual consultation, and electronic sources.



Dwight Mosier (right), Agronomy Specialist

Curt Thompson, Agronomy Specialist

Jim Schaffer, Agronomy Specialist



LIVESTOCK PRODUCTION

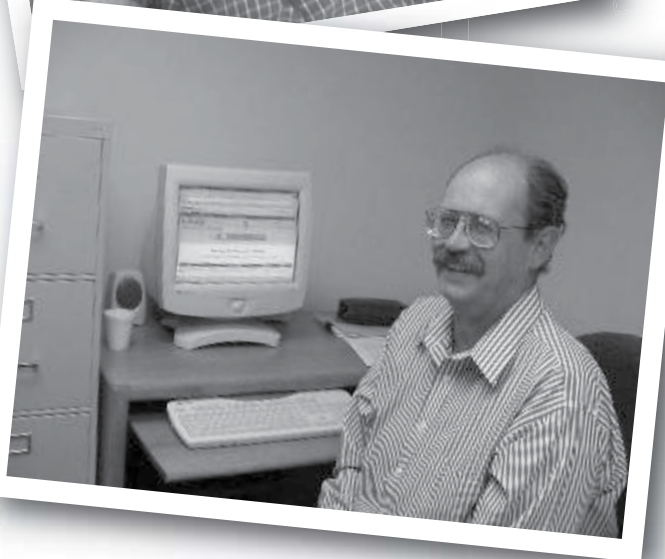
Extension Specialist, Livestock Production: Eugene N. Francis (1969-1980), Scott B. Laudert (1981-88), Kelly K. Kreikemeier (1989-90), Thomas P. Eck (1992-94), Twig T. Marston (1995-1997), G. Lance Huck (1998-2000), Ron Hale (2001-present)

The primary focus of the animal science program is to provide support to livestock producers. That includes leadership in planning, coordinating, and conducting educational programs in animal science for 26 southwestern Kansas counties, including meetings, tours, and field visits. Field and classroom training is provided to agricultural extension agents to enhance their animal production knowledge. The specialist assists agents in planning and developing animal science programs in the counties and serves as a resource for agents faced with challenging questions from producers and the public. The specialist works with other extension specialists and research faculty in animal science, agronomy, agricultural economics, veterinary medicine, and grain science to provide experience-based information and cutting-edge research in addressing the needs of the livestock industry. Major educational programs have included but are not limited to:

- Livestock nutrition requirements
- Feeding and feeding management
- Weaning and receiving management
- Beef quality assurance
- Proper user of commercial livestock products
- Biosecurity
- Nutritionally related health problems
- Irrigated forages and crop residues
- Animal identification



The livestock extension specialist is a member of the Beef Empire Days board of directors and assists with overall annual event planning. Eugene Francis, former area livestock specialist (1969-1980), and Al Maddox, former Finney County agent (1965-1971), provided leadership and organized Beef Empire Days, the beef industry's celebration event for southwestern Kansas. In recent years, this specialist served as the co-chairman of the Live and Carcass Show and was involved with all aspects of planning and managing the show, including data collection, analysis of carcass rankings, and the carcass show. Other events this position works with are the Feedlot Special, the Most Profitable Animal, the B.E.S.T. Steer Trial Contests, and the Grandstand Judging Contest. The position is responsible for data collection, analysis and awards. Involvement with Beef Empire Days allows this specialist to build working relationships with a number of feedyard management personnel.



Kevin Dhuyvetter, Agricultural Economics Specialist

Troy Dumler, Agricultural Economics Specialist

Ron Hale, Livestock Production Specialist

CROPPING SYSTEMS

Extension Specialist, Cropping Systems: John D. Holman (2006-present)

The nature and purpose of the position responsibilities are to plan, implement, and direct a research (70%) and extension (30%) program in cropping systems focused on traditional and nontraditional crop production systems for southwestern Kansas, a semi-arid climate that encompasses full-to-limited irrigation and strictly rain-fed operations. Creating more profit potential for water-limited cropping systems is a high priority. Emphasis will be on developing a mechanistic understanding of physiological relationships for predicting crop response to environment and cultural practices. Cropping systems research will be conducted with a team of scientists at SWREC and other Kansas State University units. Other responsibilities include providing leadership for cropping systems research and collaboration in related areas; publication of results in the peer-reviewed literature in a timely manner; partnering with colleagues on joint publications; and pursuit of extramural funds.

ENTOMOLOGY

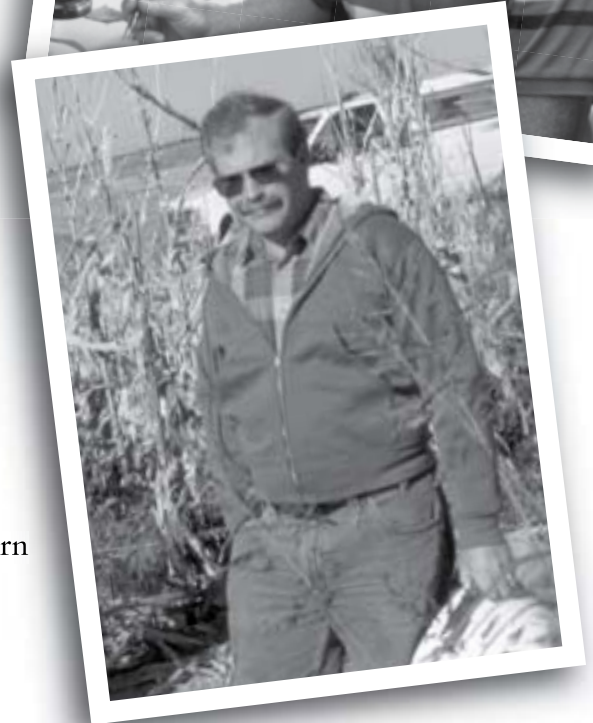
Extension Specialist, Entomology: Donald E. Mock (1973-1980) and **Phillip E. Sloderbeck** (1981-present),

In 1973, Don Mock, was appointed area extension specialist at the Southwest Area Extension Office. He developed a grain sorghum **field scouting program** in three southwest Kansas counties. This was part of a USDA/Kansas Pest Management Project. This project quickly expanded to include corn and soybeans. The program was considered a success, and many of the early field scouts in that program set up private consulting businesses by 1976, including Servi-Tech and Scientific Crop Services.

During the early 1980s, Steve Welch and Fred Poston of the entomology department in Manhattan developed a calculator model to predict when the southwestern corn borer would begin laying eggs. Phil Sloderbeck, area extension entomologist, used the model to assist growers in timing their scouting for corn borer egg masses. In the summer of 1982, an extension program was established to train farmers and consultants how to use the model. That year, 28 predictions were made based on larval samples taken by cooperators and personnel from the State Board of Agriculture and K-State. This led to the publication of the Southwest Kansas Entomology Update Newsletter that was mailed to county agents, aerial applicators, crop consultants, and other agricultural industry representatives for the next 20 years. The development of these models continued into the 1990s with addition of the European corn borer model. Eventually, the addition of computerized economic decision models that calculated economic thresholds based on crop potential as well as treatment costs were developed.

Phil Sloderbeck, Entomology Specialist

Phil Sloderbeck collecting corn borer data in corn plots.

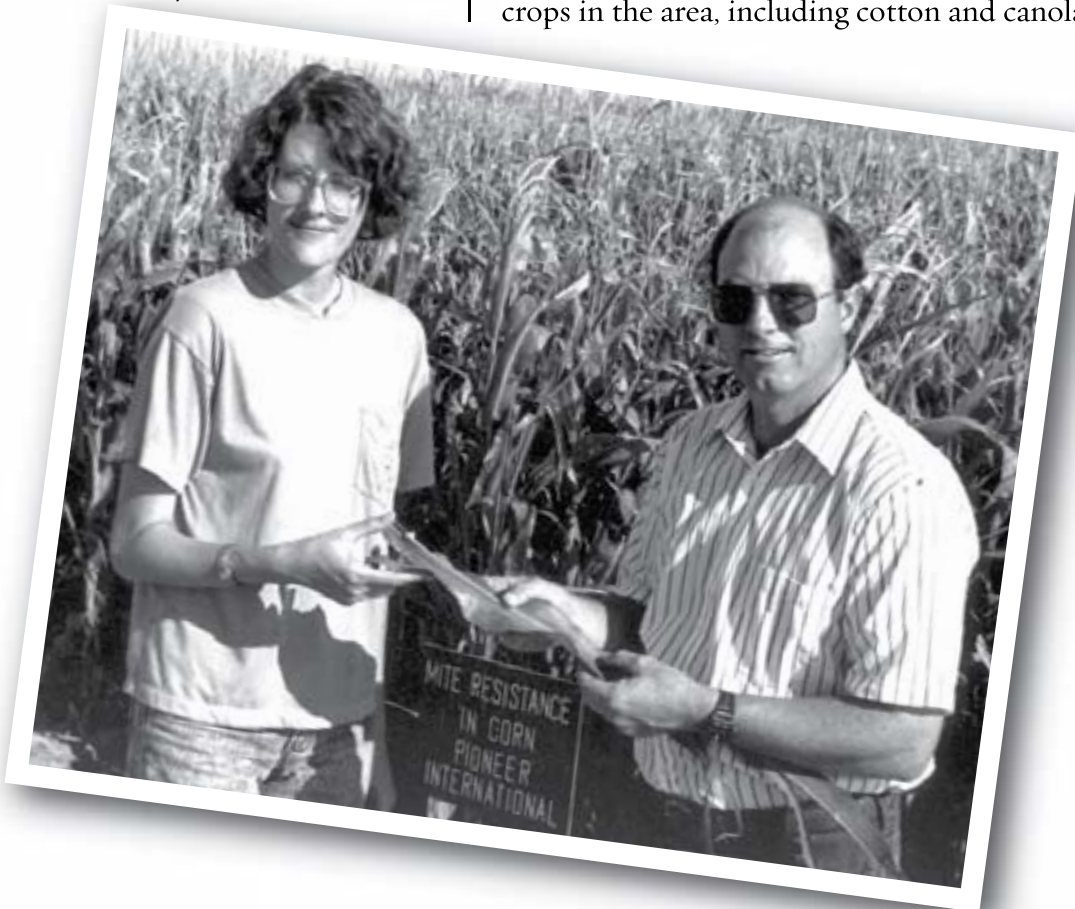


In the late 1980s, there were reports that greenbugs in sorghum could not be controlled with chlorpyrifos (Lorsban) and parathion. Sloderbeck and cooperators were the first to document that these greenbugs were resistant to these organophosphate insecticides and that this resistance was based on elevated esterase levels. They developed a gel-electrophoresis technique to test for resistance. For several years, greenbug surveys were conducted to follow pesticide-resistant greenbug populations and help producers choose appropriate treatment options.

In March 1986, the **Russian wheat aphid** was first detected on wheat in Texas. An official announcement was made on April 1. News of this new insect pest was the topic of a radio interview for KBUF in Garden City on April 3. Within hours, a call was received from a Colorado county agent who was seeing damage similar to that described in the radio interview. Samples of those aphids were collected on April 4, and by April 5, the Russian wheat aphid was found in Stanton County. During April and May several newsletter articles were sent to county agents, crop consultants, and aerial applicators in the area describing the potential problem, updating them on the spread of the aphids and treatment options. This quick response undoubtedly helped many producers manage this new pest. Fortunately, this insect has not become the pest problem in western Kansas that was initially feared. It continues to be a problem in eastern Colorado and is an occasional pest in the western tier of Kansas counties along the Colorado state line.

From the 1990s through the present, extension entomology efforts focused on providing information on advancements in the Bt corn technology and on providing insect management information for new crops in the area, including cotton and canola.

Lisa Wildman and Gary Dick (below) worked with Larry Buschman and Phil Sloderbeck on spider mite resistance in corn.



FAMILY AND CONSUMER SCIENCES

Extension Specialist, Family and Consumer Sciences: Dorothy Neufeld (1969-1982), Carol H. Young (1982-2003), Debra J. Bolton (2005-present)

The purpose of this position is to:

Provide visionary leadership to county extension agents, extension boards, local program development committees, and community leaders in analyzing situations, identifying needs, obtaining extramural funding, and in developing educational programs for children, youth, adults, families, and communities

- Provide leadership in expanding long-term, outcome-based extension programming in family and consumer sciences (FCS) in general, and in a specific area of family studies, community development, and human nutrition
- Establish and/or maintain collaborative relationships with other area organizations and groups to help further the K-State Research and Extension mission
- Act as liaison between the extension agents and extension specialists with FCS responsibilities to promote effective and efficient interaction
- Provide training opportunities for extension agents, including:
 - » Evaluation of local FCS program effectiveness
 - » Leadership development
 - » New agent orientation and training
 - » Developing collaborations including resource development
 - » Supporting extension agents in developing and carrying out personal professional improvement plans; and
 - » Proactively ensure that potential clientele have equal access to programs without regard to race, color, religion, sex, national origin, age or disability
- Actively participate in personal professional development growth opportunities
- Foster diversity and teamwork

Carol Young was one of the architects of the Five-State Multicultural Conference held in Garden City. The conference was important for the region because it trained professionals from education, social services, health providers, and community leaders on diversity awareness, multicultural competence, family advocacy, and leadership. For 13 years, the conference attracted various human resource professionals from Nebraska, Colorado, Iowa, Missouri, and Kansas. Debra Bolton continues the work in diversity for the area, having been one of the founders of the Coalition of Hispanic Organizations and Professionals and serving on various civic committees and nonprofit boards in the area.



Debra Bolton, Family and Consumer Sciences Specialist

Carol Young, Family and Consumer Sciences Specialist

FARM MANAGEMENT

Extension Specialist, Farm Management Fieldmen: John Smerchek (1969-1970), Danny Trayer (1969-1974), Jon Herod (1969-1994), Ralph N. Germann (1969-1993), Milt McMinimy (1970-1973; re-appointed 1979-1982), Parman Green (1974-1977), Harry Lobmeyer (1977-1983), Bob Lisec (1981-1989), Don Gronau (1980-1992), Jon R. Janssen (1973-1981), Jim Sturdevant (1983-1991), Douglas Eck (1990-1992), Douglas D. Stucky (1992-present), Anthony Tarrant (1992-1995), Leslie Krehbiel (1995-1997), James Dawson (1992-2005), Roy Aycock (1994-1997), Dave Rogers (1997-2000), Gary Snyder (1998-present)

The Kansas Farm Management Association (KFMA) is a cooperative program between K-State Research and Extension and six local farm management associations. A team of dedicated farm management economists throughout the state consult with members during on-farm visits.

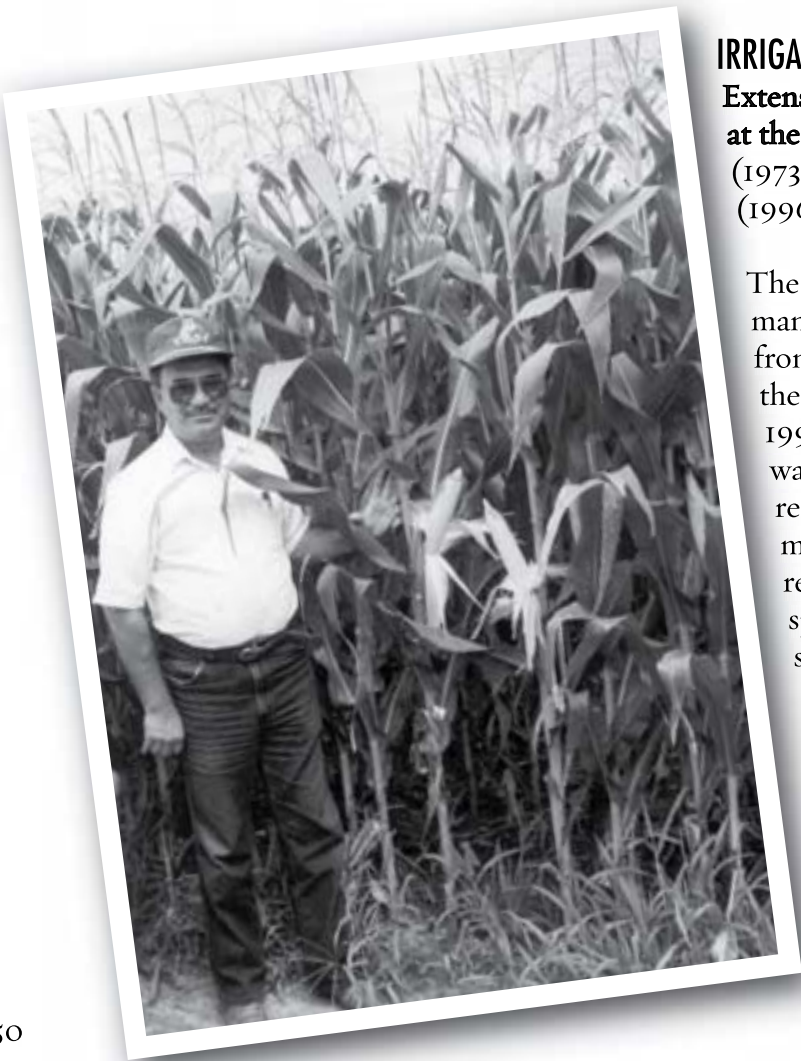
The KFMA program provides each member with financial and economic information that can be used to improve farm business organization, farm business decisions, and farm profitability. KFMA economists are supported by a team of economists and staff in the Department of Agricultural Economics at Kansas State University to provide leading-edge information and analysis.

Mahbub Alam evaluating corn yield under different irrigation treatments.

IRRIGATION AND WATER MANAGEMENT

Extension Specialist, Irrigation and Water Management at the Southwest Area Extension Office: David Pope (1973-1976), James G. Thomas (1976-83), Mahbub Alam (1996-present).

The position of extension specialist, irrigation and water management was held by Pope and Thomas for 10 years, from 1973-1983. When James G. Thomas left in 1983, the position fell vacant and remained so for 13 years. In 1993, the Irrigation/Water Management Committee was formed with the charge of developing a statewide research and extension irrigation and water management plan for Kansas. The committee strongly recommended filling the position of extension specialist, irrigation and water management for the southwest area. Alam was recruited from Colorado State University in 1996.

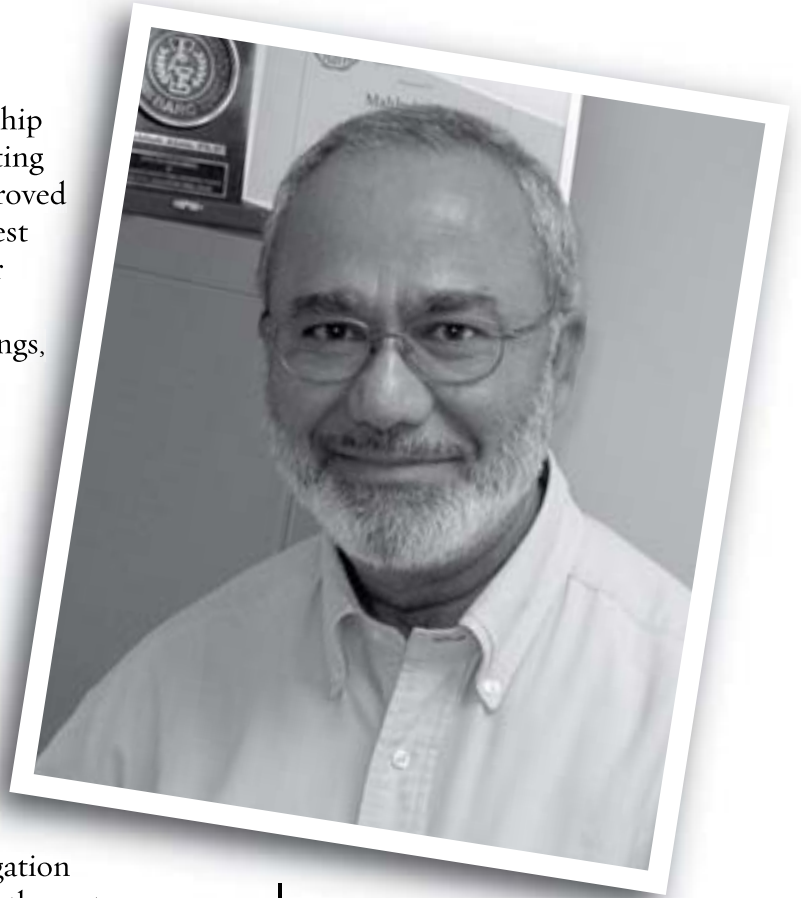


Alam developed an educational program to improve irrigation and water management according to the guidelines of the committee. He provided the leadership and assistance in planning, coordinating, and conducting educational programs in irrigation management; improved water management technology; demonstrated the latest irrigation methods, waste water utilization, and water quality in cooperation with state and area extension specialists. The educational programs included meetings, demonstrations, tours, consultations, and field visits. Irrigation updates for classroom trainings and field demonstrations for practical know-how are provided for the benefit of enhancing the knowledge of county agents, crop consultants, the irrigation industry, and others.

Irrigation scheduling and water management demonstrations initially were set up in 12 counties with the help of Kansas Corn Commission funding support. Data collected from these fields provided support to research-based recommendations and hands-on training. Computer spreadsheets were developed to track soil water balance by entering irrigation and rainfall events. These spreadsheets eventually led the water management team to develop an independently operable computer software program, KanSched, for irrigation scheduling. This is a user-friendly program capable of developing visual charts to guide the producer. In 2002, Alam was asked to expand his program to include the northwest area of Kansas.

The educational program was further enhanced with the development of the Mobile Irrigation Lab (MIL) with partial funding support from the Kansas Water Authority through the Kansas Water Office, Kansas Corn Commission, and the Ogallala Aquifer Program of the USDA. The MIL program also supports center pivot testing and analysis and in turn helps producers minimize waste of water and improve system efficiency. Kent Shaw was appointed in 2005 as MIL coordinator and provides additional support to this program.

Demonstration on the use of subsurface drip irrigation (SDI) was initiated when K-State research found the technology viable for field crops in western Kansas. SDI may help conserve water. The research findings of both the Northwest Research-Extension Center in Colby and the Southwest Research-Extension Center at Holcomb provided research-based information in implementing the technology. At present, SDI has been installed in about 20,000 acres in Kansas. This technology was also tested to see if animal wastewater from feedlot lagoons could be applied below the soil surface to avoid environmental concerns. This application was found to be suitable with proper design, operation, and maintenance. Demonstrations were also conducted to use hog wastewater through sprinkler irrigation system.



Mahbub Alam, Irrigation and Water Management Specialist



Mahbub Alam explaining sprinkler characteristics during a field demonstration program.

Activities of the extension specialist, irrigation and water management may be summarized as:

- Assist county agents with planning and developing irrigation demonstrations, applied field research, and system evaluation for efficiency in their counties and serve as a resource person for the agent when faced with challenging questions or concerns from producers, industry, or the public
- Help to implement the K-State Mobile Irrigation Lab program and planning of field activities that provide irrigation scheduling training to county agents, farmers, farm consultants, and agency staff engaged in farm programs
- Conduct tests to evaluate center-pivot sprinkler irrigation systems for water distribution uniformity, fuel efficiency, and other factors for profitable irrigated cropping systems. Perform field testing of the computer software KanSched and provides feedback for further improvements.
- Conduct applied research in cooperation with county agents and state and area extension specialists. The results are used to support recommendations and provide additional hands-on credibility to the educational programs.
- Serve as a liaison between research and extension faculty to provide timely and relevant information to the public.
- Maintain Web site for relevant information and dissemination of evapotranspiration (ET) information for irrigation scheduling and conservation of water.
- Develop written materials for the publication of water management extension bulletins, news releases, and journal articles.

WATER QUALITY

Extension Specialist, Upper Arkansas Watershed: Robert Frisbie
(2000-present)

K-State Research and Extension watershed specialists provide leadership in the development and implementation of science-based information and educational programs that reflect local conditions and input. They guide activities aimed at reducing non-point source pollution and improving water quality in high-priority watersheds. The overall goal of this program is abatement of non-point sources of fecal coliform contamination and improved water quality through adoption of best management practices by farmers, homeowners, and other landowners in targeted watersheds in Kansas.

General responsibilities are to:

- Develop professional leadership based on technical competence within the multicounty area.
- Work with landowners and farmers within the watershed, industry representatives, and agency collaborators to develop action plans that serve the industry and their communities, improve production and profitability, and contribute to environmentally sound operations to maintain and improve the watershed (networking).
- Develop educational programs based on local watershed priorities and coordinate watershed extension programming with and through extension agricultural agents and respective industry and agency representative. Coordinate efforts with members of the watershed team (or other watershed multicounty specialists and K-State Research and Extension faculty) and agents representing other areas of expertise in assigned multicounty area.
- Be actively involved in multicounty/state networking involving K-State faculty/staff and all public and private interests in watershed management. Assess clientele/industry needs for new technology and research. Work as a member of the watershed team to develop and implement statewide program efforts coordinated through the watershed extension programming team.
- Identify and cooperate with relevant organizations, agencies, and institutions that deliver educational information pertinent to watershed management.
- Maintain a flow of current research-based information to the local farm and community interests with the watershed.
- Facilitate applied research and on-farm demonstrations pertinent to management for improving water quality in cooperation with K-State researchers and extension specialists utilizing available resources.
- Work with extension specialists and agents to develop and implement project proposals in high-priority areas to help bridge any gaps between research and implementations



Bob Frisbie, Water Quality Specialist

Kent Shaw and Coulter (Bucky) Heinz testing a producer center pivot sprinkler system as part of the Mobile Irrigation Lab Project.

DISCONTINUED EXTENSION PROJECTS

COMMUNITY DEVELOPMENT

Extension Specialist, Community Development at the Southwest Area

Extension Office: Larry D. Hendrix (1974-1986), Duane Williams (1986-1988), Kirk A. Zoellner (1989-1992)

ENVIRONMENTAL QUALITY

Extension Specialist, Environmental Quality: Thomas Willson (2000-2006)

FORESTRY

Extension Specialist, Forestry: Melvin J. Baughman (1971- 1975), Raymond G. Aslin (1975- 1978), Dale A. Starkey (1978), Jon P. Skinner (1994-1996).

HORTICULTURE

Extension Specialist, Horticulture: Milan T. Jones (1969-1973).

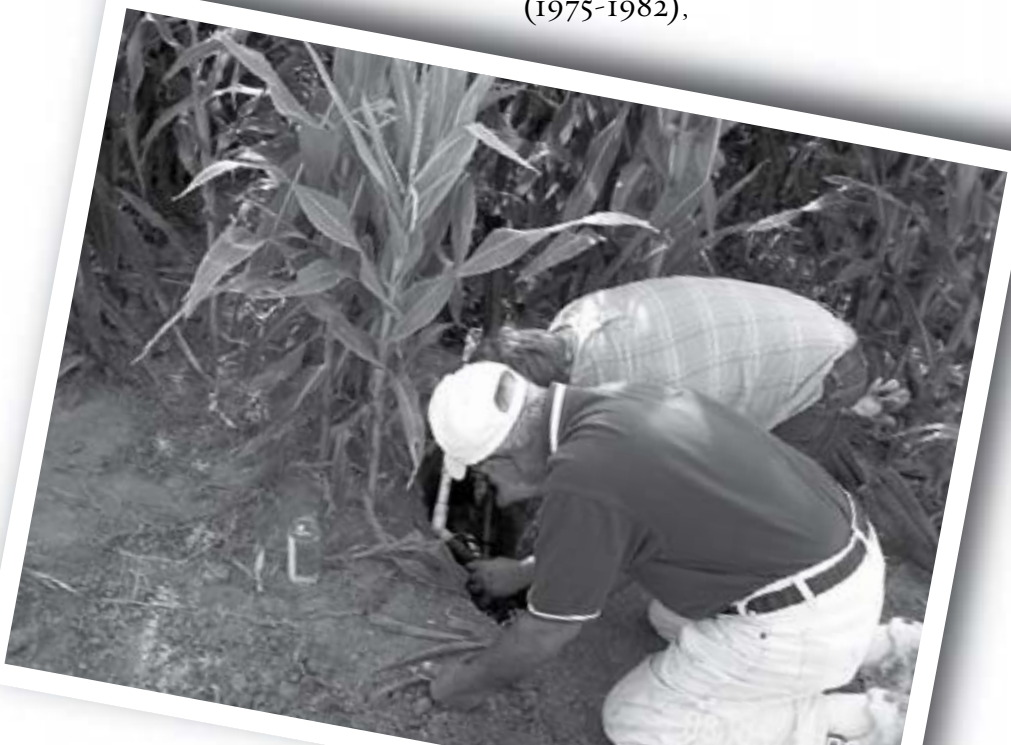
PLANT PATHOLOGY

Extension Specialist, Plant Pathology: Venance H. Lengkeek (1978-1981)

WILDLIFE DAMAGE CONTROL

Extension Specialist, Wildlife Damage Control: Edward K. Boggess (1975-1982),

Mahbub Alam and Danny Rogers (Department of Agricultural and Biological Engineering) conducting field evaluation of Eldon Schmidt's subsurface drip irrigation system.



WEATHER OBSERVATIONS

Jeff Elliott and John Holman

The weather, or climate, determines the type of crops and vegetation that will be successful in a specific area. Our southwest Kansas climate can be described as “continental,” with large daily and annual extremes in temperature and a summer precipitation pattern. We seldom have years with “average” weather, and this variability is an important aspect of our climate.

The following tables and charts attempt to summarize nearly 100 years of weather observations at the Southwest Research-Extension Center. **Andy Erhart, Charles Norwood, Jeff Elliott,** and others have been weather recorders over the past 50 years.

PRECIPITATION

Moisture is a limiting factor in crop production in the central Great Plains. Our average annual precipitation over the last 98 years has been 18.30", but this has ranged from a low of 5.68" in 1956 to a high of 36.19" in 1923 (Figure 1). The monthly total precipitation is also variable (Figure 2). Most of the precipitation (77%) falls during the April-September growing season. Measured precipitation includes both rain and snowfall (snow is melted to determine the moisture content). The National Weather Service's standard time period for averaging climate data is 30 years. The running 30-year average annual precipitation also shows the variability of our 30-year average (Figure 3). In recent years there has been a slight uptrend in precipitation. The 18 largest single daily precipitation amounts recorded at the Southwest Research-Extension Center range from 2.50 to 4.55 in/day (Table 1, page 58). Monthly snowfall averages ranged from 0.0 to 4.71 in/month, while the highest snowfall in one month was 21.0 inches in 1970 (Table 2).

AIR TEMPERATURE

Because Garden City is located north of the equator, the angle of the sun above the horizon varies in a pronounced annual cycle: higher during the summer and lower during the winter. As the angle of the sun rises, there is more energy to heat the surface and the air temperature increases. There is a slight lag in temperature relative to the sun's position. The coldest part of the year generally falls during the second week in January and the warmest in the third week of July (Figure 4, Table 3). There is a relatively large difference between daily maximum and minimum air temperatures. It is interesting to note that this daily variation of approximately 28 degrees is consistent throughout the year. This diurnal variation makes our summers more comfortable. Many residents comment that although our summer daytime temperatures may be hot, “at least it cools off at night.” The lowest temperature ever recorded at the center was -22°F on January 19, 1984. The highest temperature was 111°F on July 13, 1913, and again on July 13, 1934.



Corn field damaged by hail on July 3, 1967.

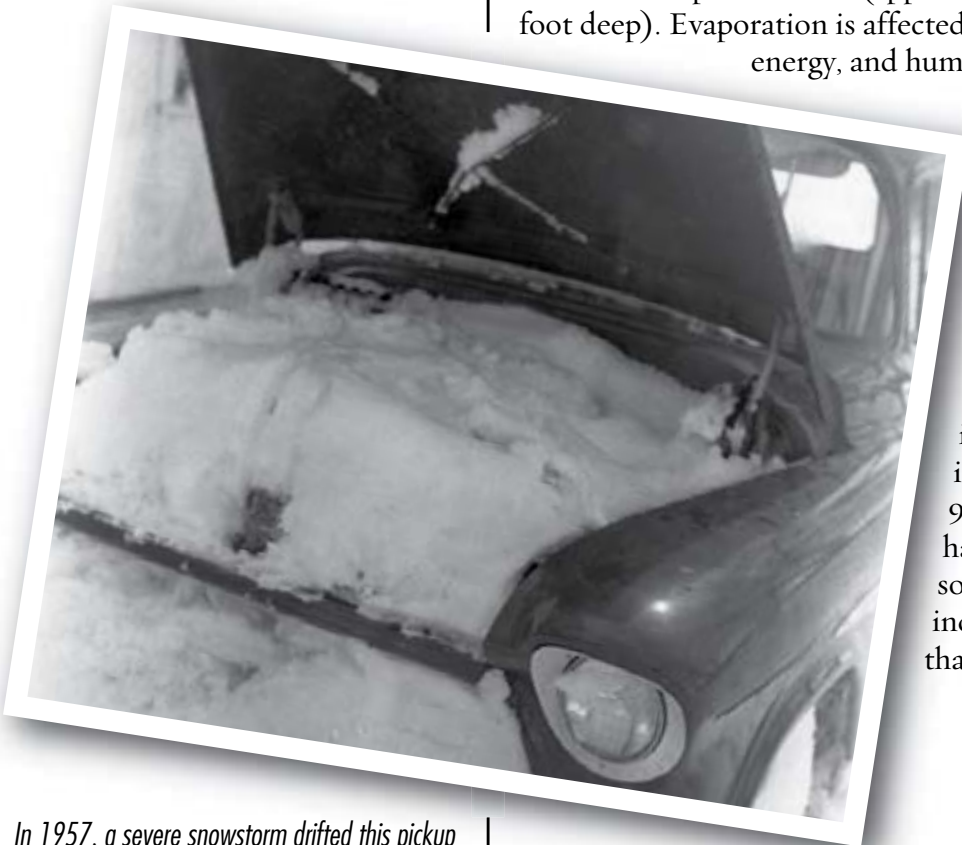
Dates of the last freeze in spring and first freeze in fall are important for determining the length of the growing season. The date of the last freeze (32°F) in the spring defines the start of the growing season. The average last freeze falls on April 28 with the earliest being April 2 in 1930, and the latest on May 26, 1950 (Figure 5). The average date of the first fall freeze (32°F) occurs on October 13, with the earliest on September 20, 1934, and the latest on November 2, 1950 (Figure 6). The period between the last and first freeze of the growing season is known as the “frost free period” (Figure 7). Note the variability in the length of the growing season. Although the average frost-free period is 168 days, it can be as short as 126 days and as long as 204 days.

OTHER CLIMATE PARAMETERS

Average wind run or the accumulated wind measured over a 24-hour period has been recorded at SWREC and is shown in Figure #8. The wind tends to be the highest in March and April, averaging almost 7 miles per hour, and lowest during the fall and winter months, when it averages less than 5 mph. Our anemometer is located approximately 18 inches above the ground. Since wind speed increases dramatically as elevation increases, this means that 5 mph at 18 inches will measure approximately 13 mph at 6 feet above the ground surface. This makes us one of the windiest locations in the nation.

Open pan evaporation is the amount of water that evaporates from a standardized pan of water (approximately four feet in diameter and one foot deep). Evaporation is affected by temperature, wind speed, solar energy, and humidity. A measured amount of water is

added daily to replenish that which has evaporated. These amounts are measured during the warm season (April-October) when there is little danger of the water freezing in the pan. The 50-year average open pan evaporation at the center is 72 inches, with the lowest being 60 inches of evaporation in 1997 and the highest being 92 inches of evaporation in 1964 (Figure 9). This explains why we tend to have little soil surface moisture in southwestern Kansas; we have only 18.3 inches of annual precipitation, but more than 72 inches evaporate each year.



In 1957, a severe snowstorm drifted this pickup engine compartment full of snow.

CONCLUSIONS

The climate of the central Great Plains is comparatively uniform across the region. Our climate features low relative humidity; abundant sunshine; moderate to low amounts of precipitation, with most precipitation received during the growing season; moderate to high wind movement; high temperatures during the growing season; and a large daily range in temperature. These climate characteristics, along with the high variability in these characteristics, have shaped the agriculture of our region. Since the dust bowl years, fallow (not planting a crop for a season) has been used to store soil moisture and reduce the risk of low crop yields. Early cropping systems that used tillage extensively and had a long fallow period, such as a wheat-fallow rotation, stored about 15% of the precipitation received during the fallow period (15% fallow efficiency). Research showed that reducing tillage and increasing surface residue can reduce soil water evaporation and increase water infiltration. That increases the efficiency of the fallow period (storing more soil moisture) and allows for intensifying the cropping system (growing crops more frequently). Increasing fallow efficiency allows producers to change from a wheat-fallow rotation (one crop in two years) to a wheat-summer crop-fallow rotation (two crops in three years). Current production systems that use little to no tillage and have shorter fallow periods, such as a wheat-summer crop-fallow rotation, have increased fallow efficiencies of about 40%. Because the amount of precipitation can vary greatly from year to year and throughout the season, the risk of crop failure can also be reduced by planting both winter and summer crops. Through research we might be able to increase fallow efficiency further by designing crop rotations that are better suited to our climatic conditions and by working to improve varieties for use in our production region.

The official weather station for the experiment station. The manually operated instruments, which have recorded weather since 1908, are in the background and the automated instruments are in the foreground.





Dust storm photographed in 1957.

Table 1. The heaviest daily precipitation events recorded at the SWREC over the past 98 years.

Heaviest Daily Precipitation - Garden City	
Precipitation (in)	Date
4.55	July 4, 1913
4.20	August 8, 1915
3.68	September 16, 1923
3.58	August 27, 1979
3.40	July 22, 1953
3.33	August 9, 1967
3.27	April 12, 1977
2.92	May 26, 1944
2.80	June 8, 2001
2.76	May 14, 1947
2.70	May 8, 1965
2.68	April 8, 1943
2.65	October 4, 1930
2.64	June 7, 1943
2.63	June 25, 1982
2.58	August 19, 1985
2.51	October 15, 1969
2.50	June 15, 1955

Table 2. The average accumulation of snow recorded at SWREC over the last 50 years, with lowest and highest monthly amounts.

Monthly Snowfall SWREC 1956-2006			
	Average (in)	Least	Most
January	4.33	0.00 (2003)	14.75 (1990)
February	3.63	0.00 (2006)	19.50 (1960)
March	4.71	0.00 (2005)	21.00 (1970)
April	0.80	0.00 (2006)	7.50 (1994)
May	0.00	0.00	0.00
June	0.00	0.00	0.00
July	0.00	0.00	0.00
August	0.00	0.00	0.00
September	0.03	0.00 (2006)	1.00 (1995)
October	0.43	0.00 (2006)	11.00 (1997)
November	1.95	0.00 (2003)	14.50 (1992)
December	3.17	0.00 (1999)	11.50 (1992)
SEASONAL TOTAL	19.28	4.00 (1967-1967)	59.75(1992-1993)

Table 3. Monthly precipitation, temperature, wind speed, and evaporation recordings at SWREC.

	Precip (in) 1908-2006	Snowfall (in) 1956-2006	Maximum Temperature 1956-2006	Minimum Temperature 1956-2006	Mean Temperature 1956-2006	Wind Speed (mph) 1956-2006	Evaporation (in) 1956-2006
January	0.37	4.33	42.7°F	15.0°F	28.9°F	4.73	-
February	0.57	3.63	47.4°F	19.2°F	33.3°F	5.51	-
March	1.03	4.71	55.5°F	27.2°F	41.4°F	6.75	-
April	1.65	0.80	66.9°F	38.0°F	52.4°F	6.86	8.53
May	2.96	-	76.2°F	49.2°F	62.7°F	6.24	10.54
June	2.99	-	86.3°F	59.0°F	72.7°F	5.93	12.69
July	2.56	-	91.9°F	64.0°F	78.0°F	5.12	13.91
August	2.37	-	89.4°F	62.3°F	75.9°F	4.63	11.83
September	1.54	0.03	81.2°F	52.8°F	66.9°F	5.08	9.26
October	1.18	0.43	70.5°F	39.8°F	55.2°F	5.01	6.69
November	0.68	1.95	54.9°F	26.7°F	40.8°F	4.85	-
December	0.41	3.17	45.4°F	18.0°F	31.7°F	4.56	-
ANNUAL	18.31	19.05	67.4°F	39.3°F	53.3°F	5.44	73.45

Figure 1.

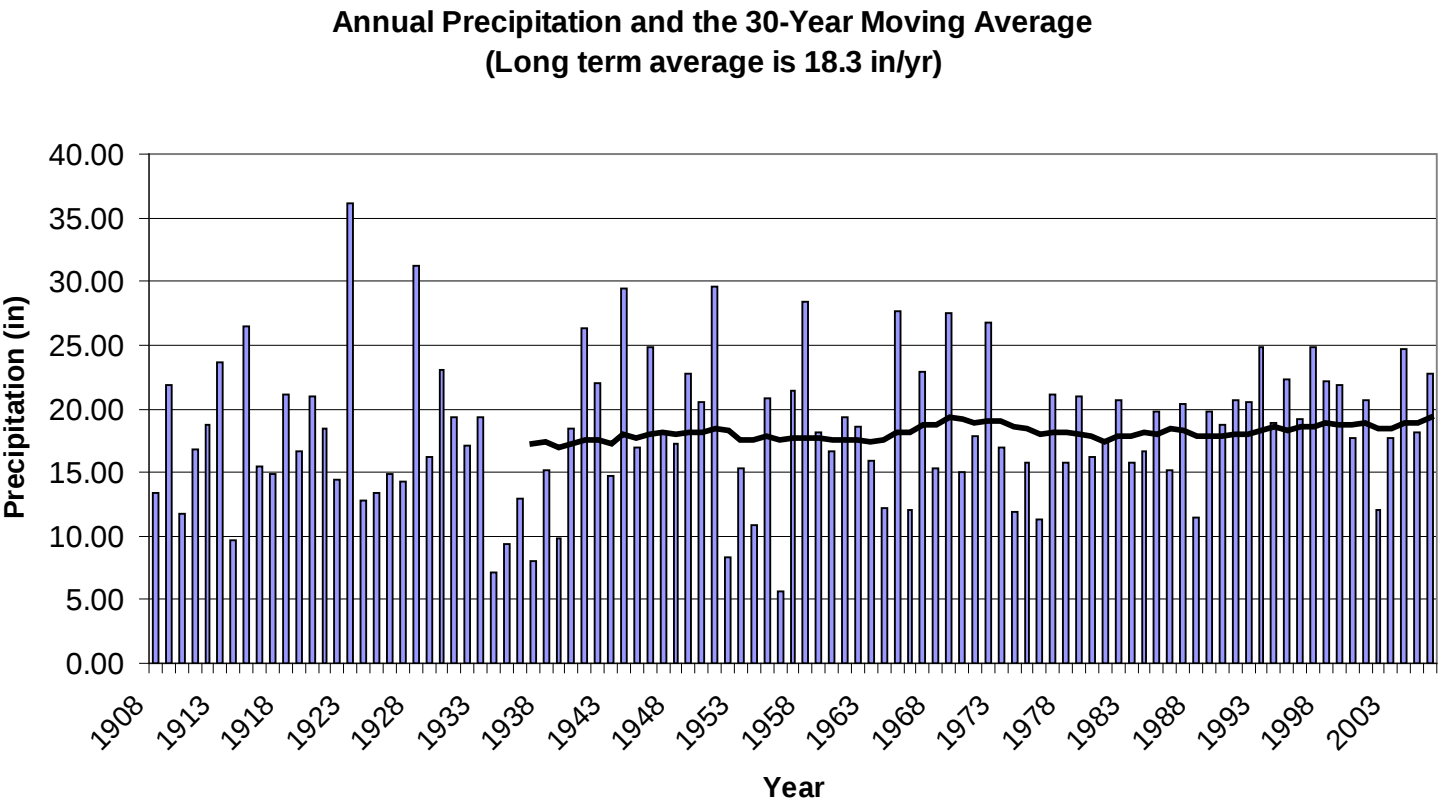


Figure 2.

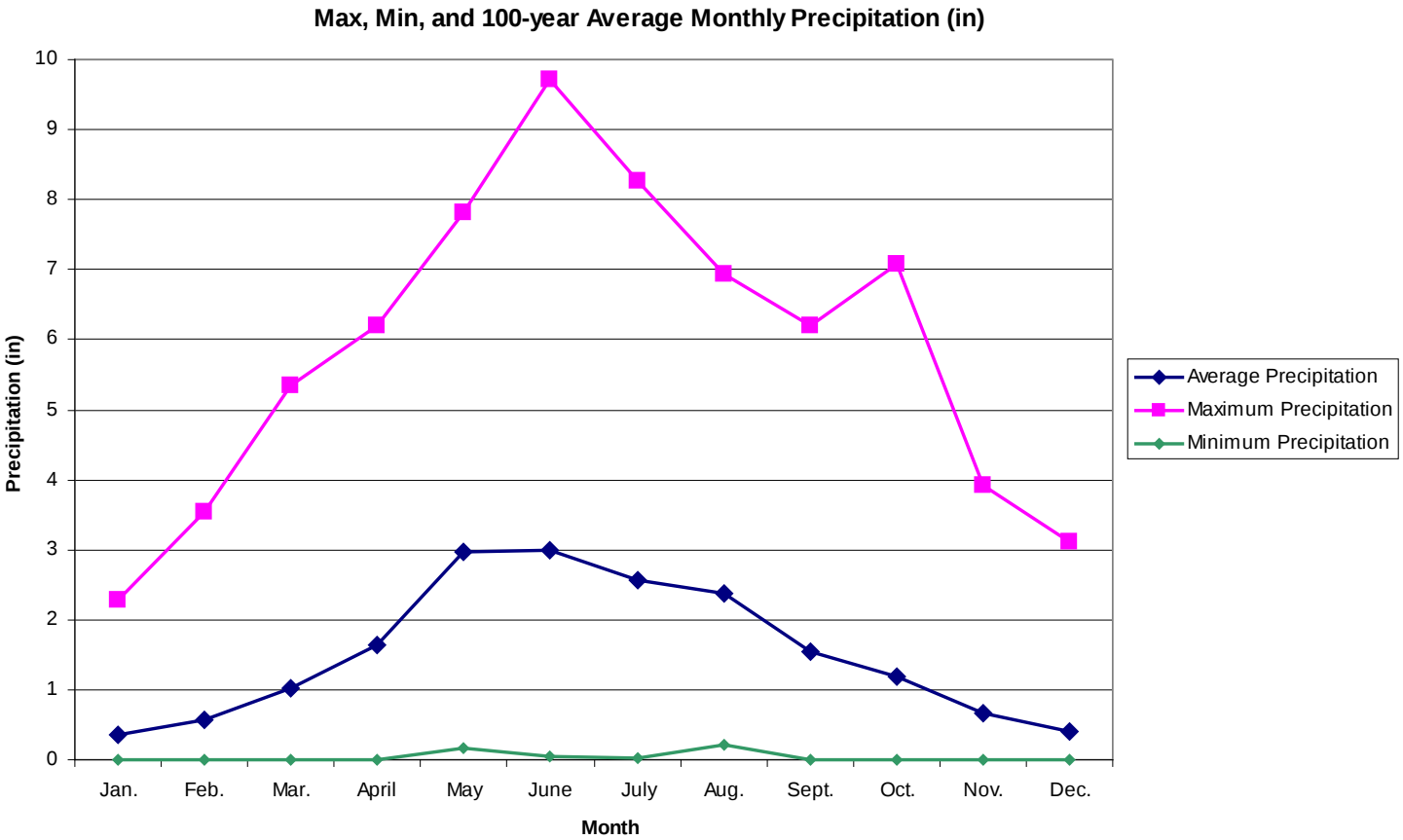


Figure 3.

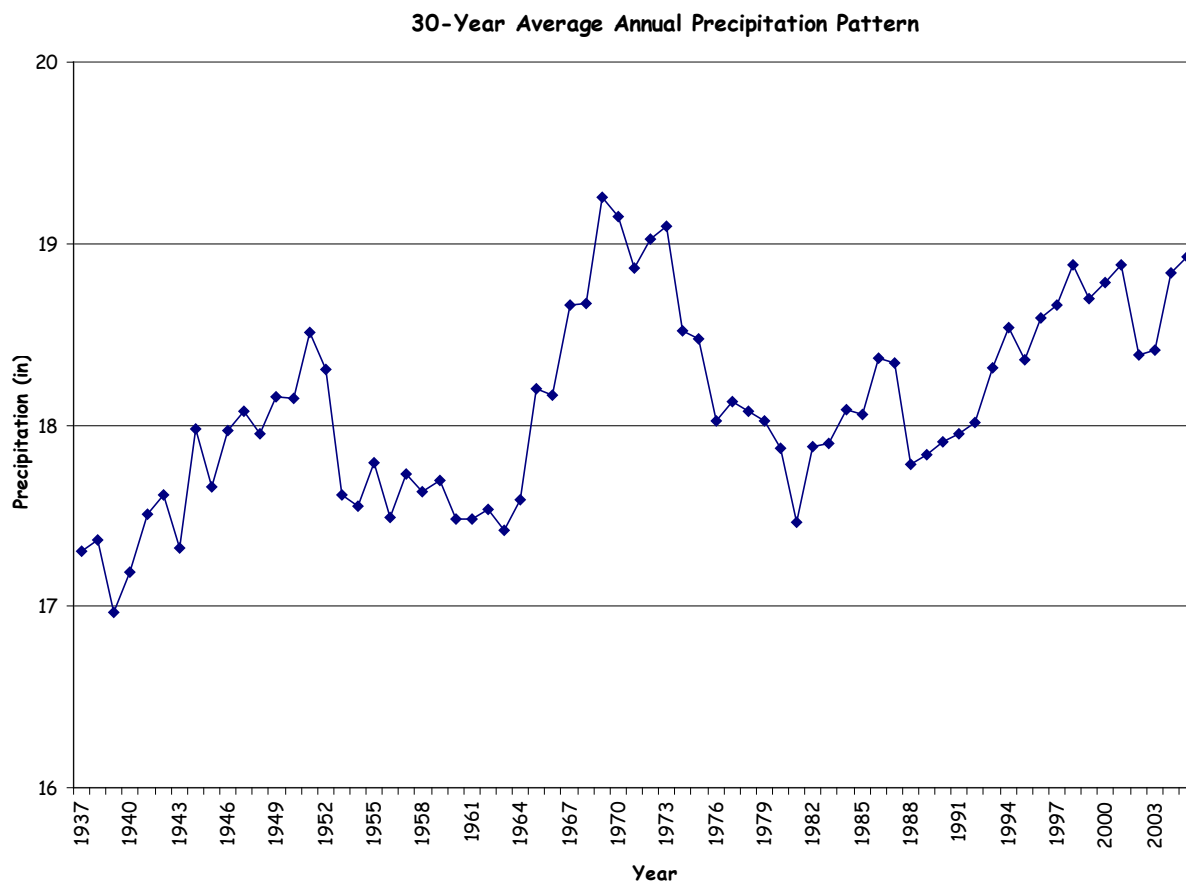


Figure 4.

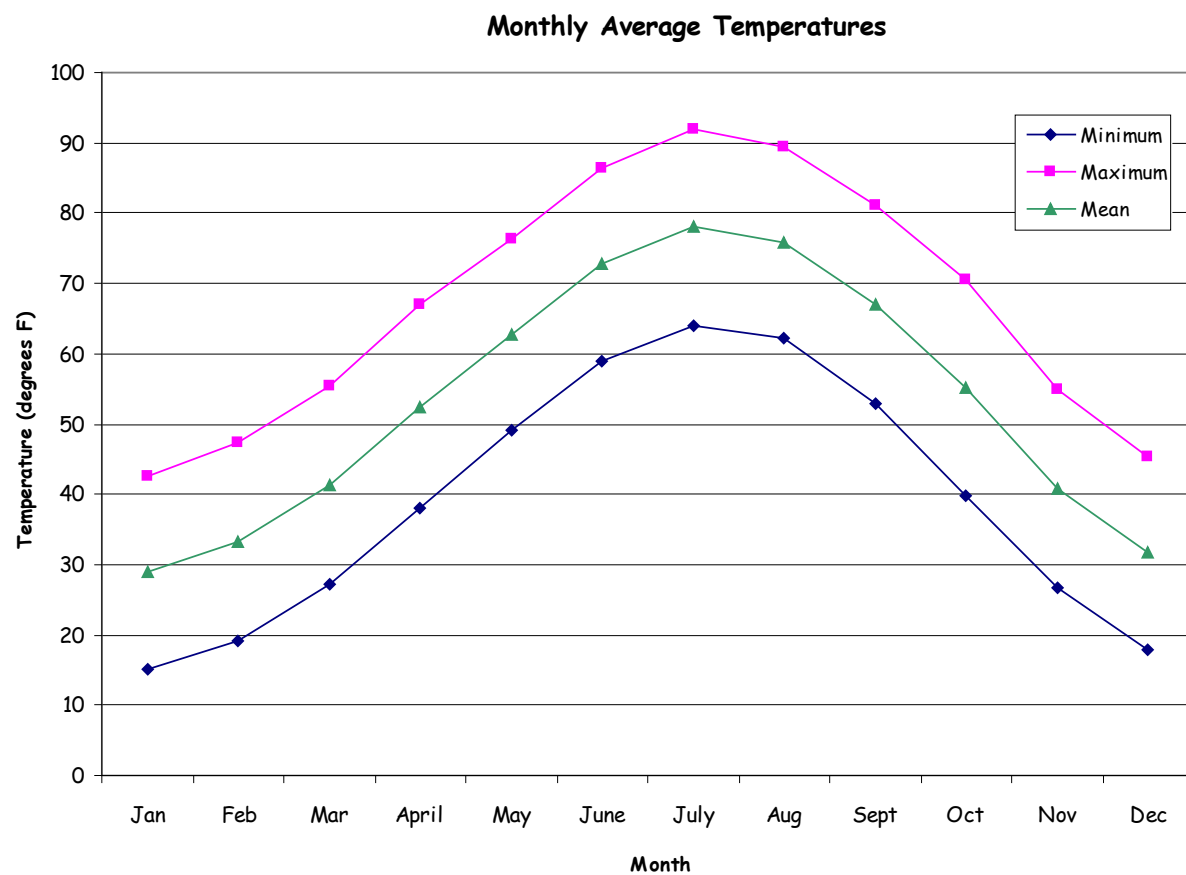


Figure 5.

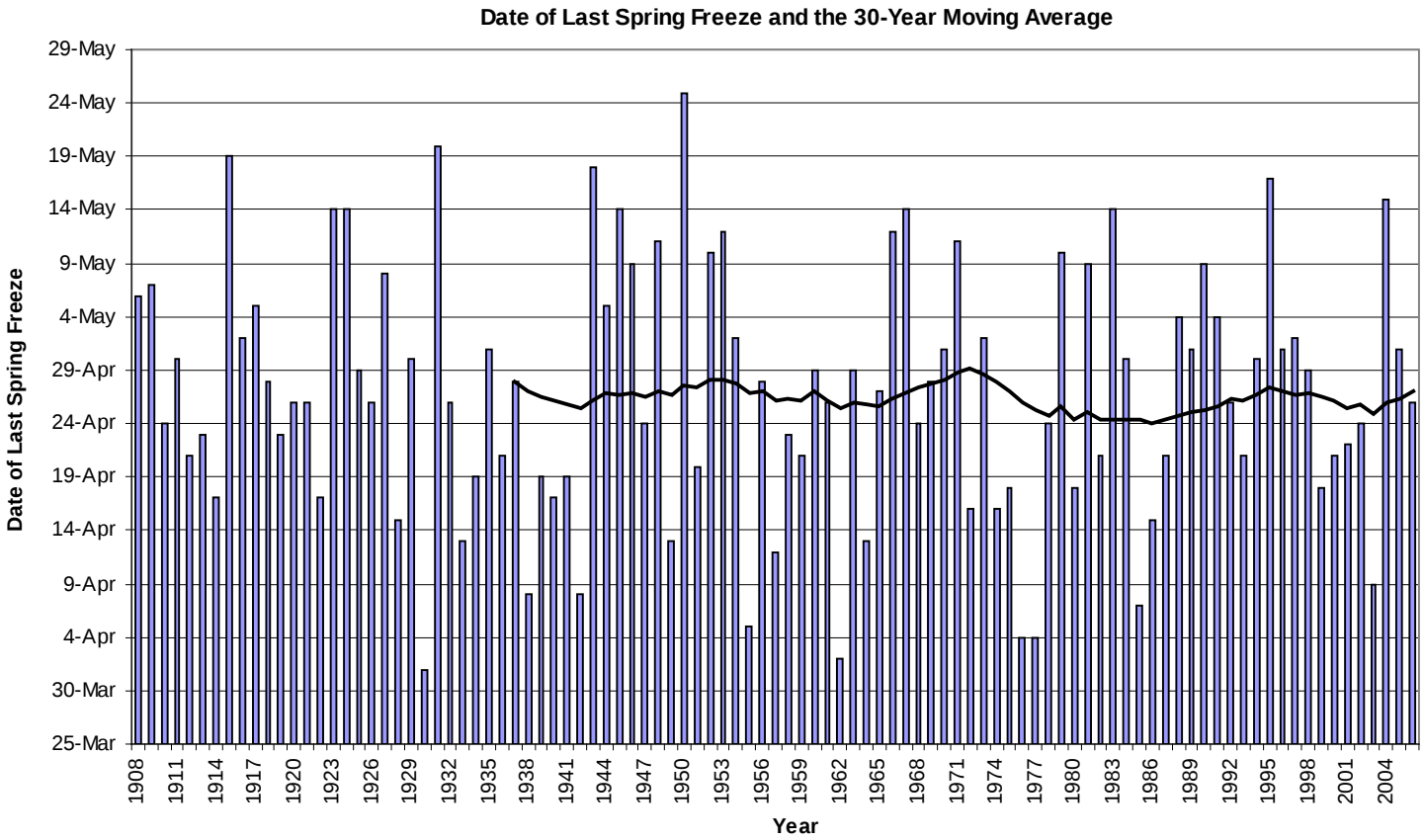


Figure 6.

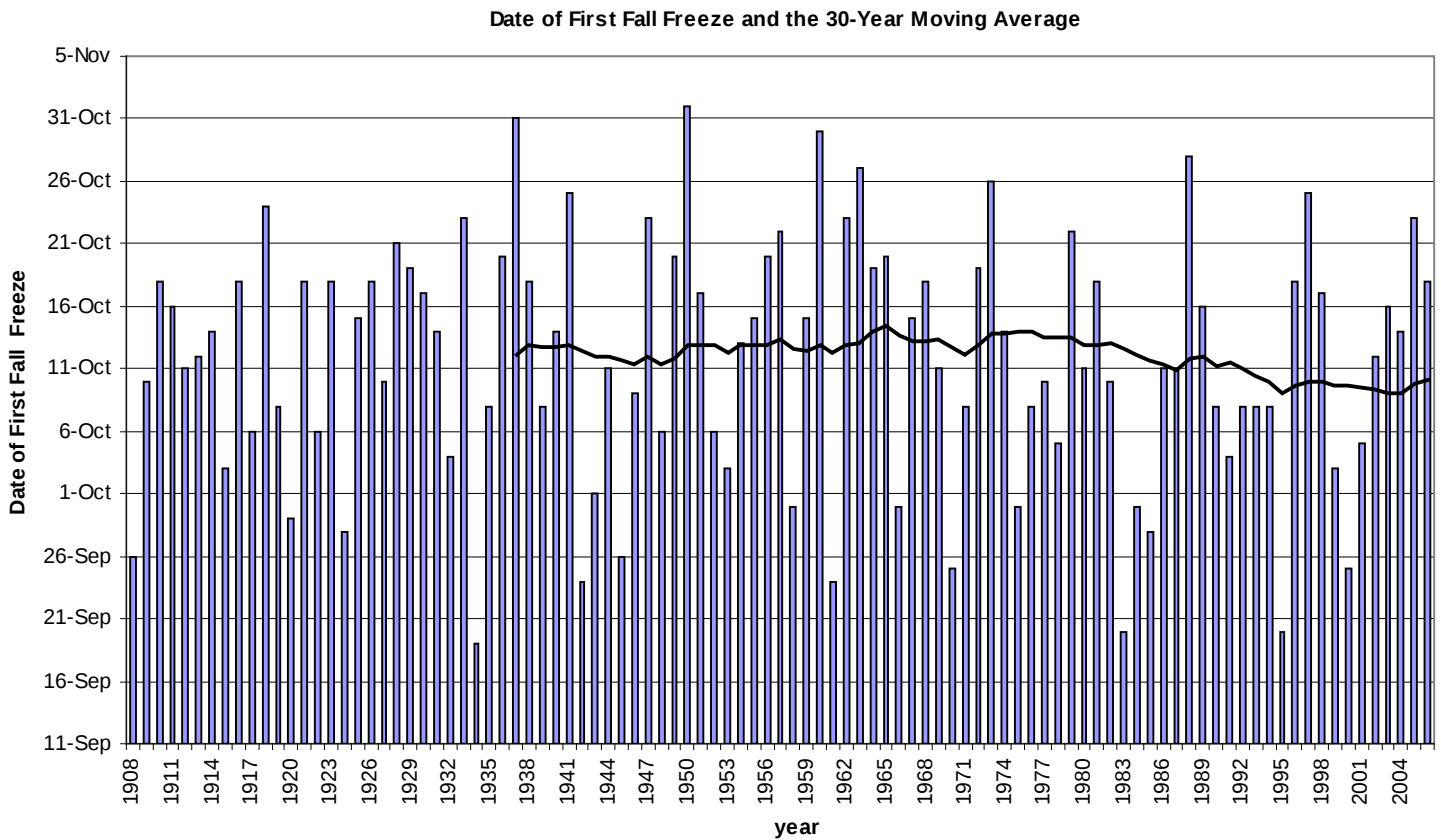


Figure 7.

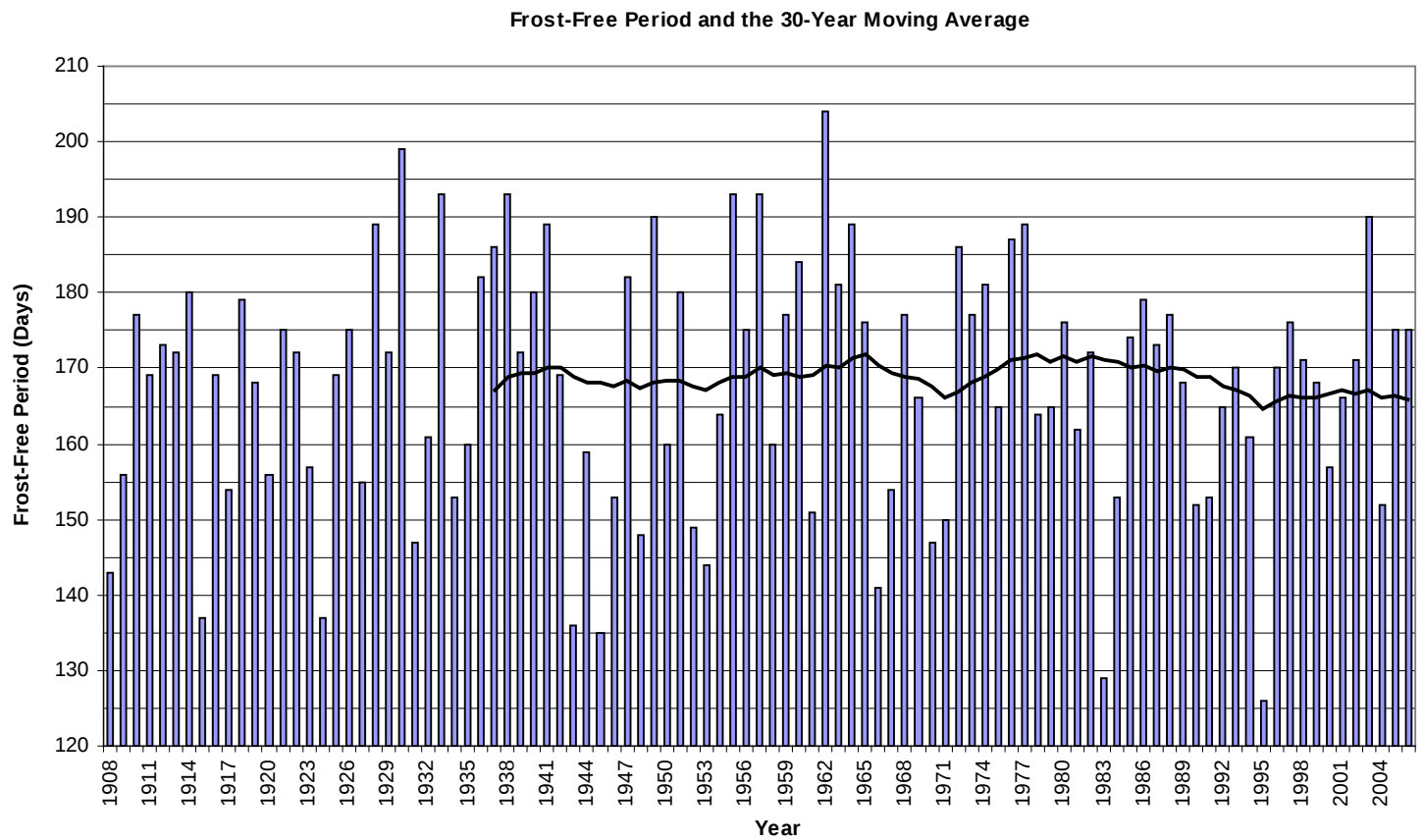
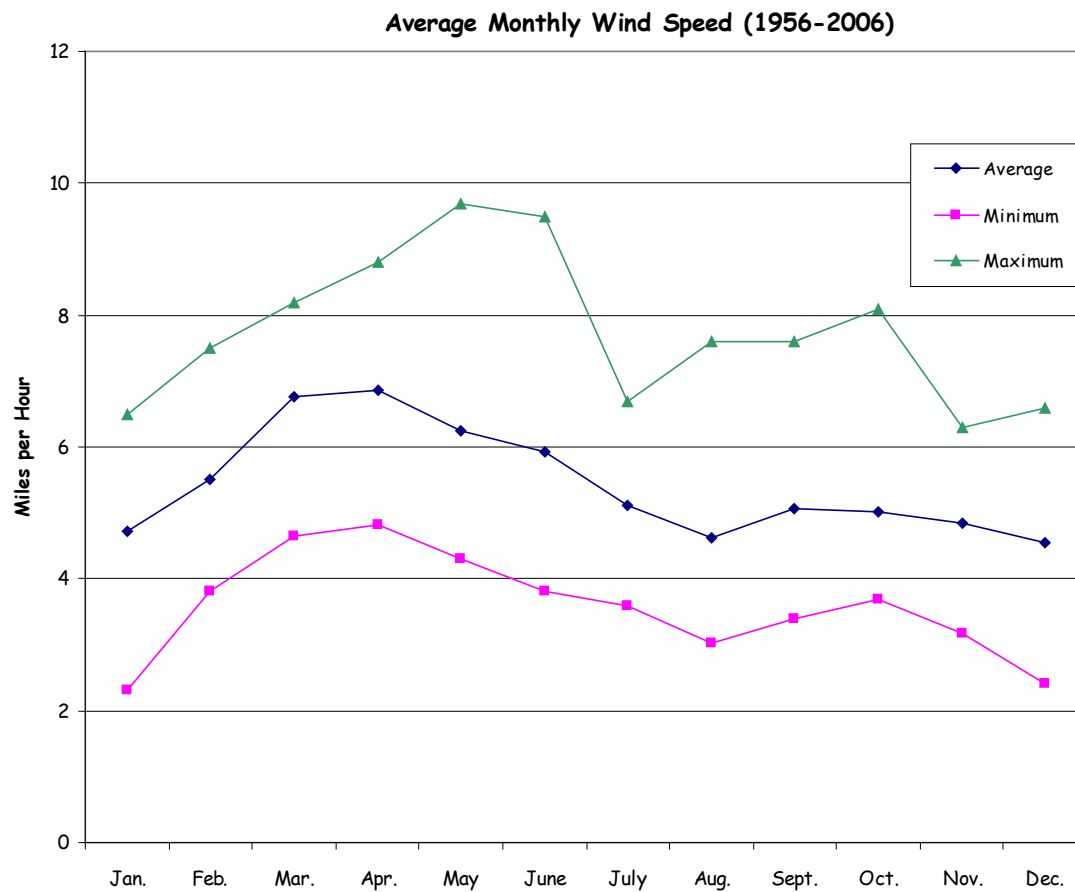


Figure 8.



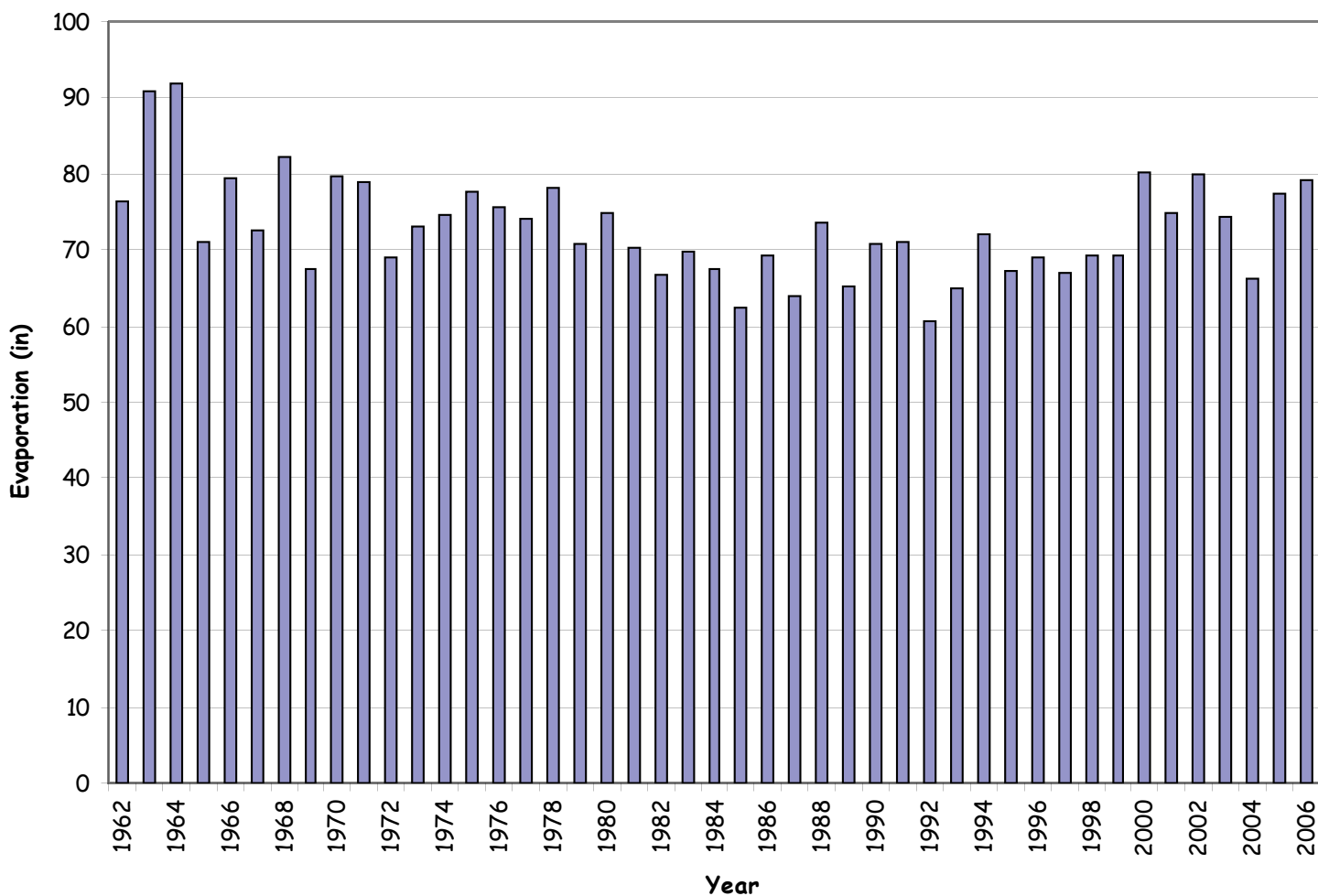
Former K-State Associate Director of Research,
George Ham, speaking to Melvin Neufeld at
a Garden City field day.

Then Kansas Secretary of Agriculture,
Sam Brownback, visited the SWREC to
present an award.



Figure 9.

Open Pan Evaporation (April-October)



ROSTER OF RESEARCH EMPLOYEES

1907 - 2007

Abdullahi, Adamu N.
 Abrigo, Marjorie W.
 Ackley, Billy R.
 Adams, Cathy Small
 Adams, Kimberly J.
 Adams, Krista
 Albers, Brent J.
 Aleman, Javier A.
 Allen, Suzanne L.
 Alley, Bruce L.
 Allmon, A. Roscoe
 Allsbury, Chad
 Anderson, Cory L.
 Anderson, Edgar M.
 Anderson, Scott J.
 Angel, Shannon W.
 Archer, Daniel T.
 Armantrout, George
 Arnett, Dudley W.
 Arnold, James E.
 Arnold, Patricia
 Aronson, Andy
 Atkinson, Cory C.
 Avalon, Earl
 Avila, Fred
 Avila, Roberto

Belland, Mary A.
 Bennett, Charle E.
 Bentrop, Gary
 Bergersen, Michael A.

Gary Miller and Henry Melgosa

Kevin Butler

Jeff Elliott



Baier, Ann
 Baier, Janet S.
 Baier, Jeffrey A.
 Baier, John
 Baier, Jovita Doll
 Bailey, Dustin R.
 Baker, Joyce A.
 Baldwin, Kalen H.
 Banning, Anne
 Banning, David T.
 Banning, Michael John
 Barlow, Robin L.
 Barry, Gary L.
 Battin, Helen B.
 Baumgartner, Jolene
 Bayles, John J.
 Beason, Eddie J.
 Becker, Coy E.
 Becker, Jill A.
 Belding, Billy J.

Mary Embree

Andy Erhart, in later years.

Bill Irsik and David Romero, Jr.

Bergersen, Robert A.
Bergner, Thom W.
Bernasky, Jeffrey J.
Bilberry, Jason T.
Billinger, Lynn A.
Binns, Porter D.
Birdsong, Gene Allen
Bitter, Gregg A.
Bitter, Jason
Black, Gerry L.
Black, Jr, John S.

Blackburn, Jord A.
Blair, Frank S.
Blocksome, Carolyn E.
Bloedorn, Danny L.
Boatman, Darin C.
Bobel, Marjorie H.
Bogard, Michael L.
Bohannon, David R.
Bond, H. Dewayne
Boone, Brenda B.
Bowen, George
Boyd, Carl H.
Brack, Peter N.
Bradfield, Brian
Bradstreet, Jack L.
Brady, Homer A.
Brandl, Connie J.
Brandt, Jr, Robert T.
Branstine, Bryan N.
Bremer, Dale J.
Bretton, Charles L.
Brewer, Jimmie A.
Briceno, Alfredo E.
Bridges, Lana K.
Brown, C. B.

Brown, Lindsey
Brown, Tim L.
Browning, Derek A.
Bruneau, Rusty J.
Brungardt, Kyle T.
Brungardt, Sherri
Brunswig, Johnathan W.
Bui, Vu Duy
Bullock, Deneen R.
Bullock, Walter A.
Bunning, Shawn A.
Burch, Jimmy D.
Burgardt, John
Burke, Daniel Z.
Burrows, William

Burson, Pamela S.
Buschman, David A.
Buschman, Larry L.
Bustamante, Bridgette
Butler, Candis
Butler, Ernest L.
Butler, Richard Kevin
Byers, Robert L.
Byrd, Clayton R.

Caldwell, Doug
Callen, Jeff
Campbell, Claude
Campbell, John F.
Campbell, Mary Stuart
Canning, Tricia J.
Carlson, Carl W.
Carnahan, Howard
Carrica, Joseph M.
Carroll, Chris
Carter, Bradna R.
Carter, Darla D.
Carter, Lori A.
Cavenee, Stacy L.
Cessna, Aric B.
Chamberlain, Victoria J.
Chen, Hongyin
Chilcott, E. F.
Childers, Donald D.
Chowdhury, Manjur A.
Cilek, James E.
Cipra, Kevin K.
Clark, Albert A.
Clay, Robin
Clemmer, H. J.
Click, Harold E.
Coates, Casey M.
Coen, James A.
Coen, Leslie F.
Coker, Vera
Cole, Chistiane R.
Coleman, Shari D.
Coles, E. H.
Collins, R. Ed
Collins, Richard J.
Compton, Dina L.
Condray, Jared E.
Condray, Jerry L.
Conrad, William A.
Cooper, Frank E.
Cooper, Casey A.



Cordova, Nina
 Corley, Shannon D.
 Covey, Jr., Harold
 Cox, A. Kenneth
 Coyne, Patrick I.
 Cozad, Eugene M.
 Craig, Dailey E.
 Crampton, Stefani
 Cress, Donald C.
 Croft, Jr., James W.
 Cronin, Jr., Marvin D.
 Cronin, Matthew
 Crottinger, Scot A.
 Crough, Timothy
 Crump, Kelly D.
 Cruz, Frank B.
 Culbertson, Clifford
 Currie, Randall S.
 Custer, Raymond

Dah, Susan K.
 Dailing, Dail R.
 Daugherty, William D.
 Davis, Holly
 Davis, Jr., George V.
 Davis, Mark, G.
 Dawson, Margaret J.
 Dawson, Will
 Day, Ralph
 Deibert, Edward J.
 DeBusk, Amanda L. Feldt
 DePew, Lester J.
 Detty, Steven B.
 Dick, Gary L.
 Diehl, Kevin A.
 Diehl, Larry H.
 Diller, Gary
 Dimit, David, E.
 Dobyns, Shasta, M.
 Douglas, Tim
 Dover, Keele
 Drussel, Ryan
 Dudding, Mark M.
 Dunlap, Craig H.
 Dunlap, Mark E.
 Duvall, George R.
 Dye, Vicki A.

Earnest, Ivan
 Eck, Thomas, P.
 Edelblute, Dale

Edwards, Ralph
 Eggers, I. L.
 Eller, Ellen M.
 Elliott, Florence E.
 Elliott, Jeffrey K.
 Ellis, David A.
 Elmy, Ronald J.
 Embree, Mary L.
 Engel, Matthew M.
 Enriquez, Jose Anselmo
 Enriquez, Jose Jaime
 Epp, Meagan E.
 Erhart, Andrew B.
 Erskine, Rachel L.
 Espinosa, Rudy

Fairbanks, Rocky A.
 Fairchild, Mark A.
 Farrar, Francis W.
 Farris, Lonnie D.
 Fernandez, Anastacio
 Figgs, Robin R.
 Fillmore, Patricia L.
 Fillmore, Paula J.
 Fine, Keith E.
 Finkenbinger, Neal
 Fischer, William A.
 Fitzpatrick, Erin E.
 Fitzpatrick, Michael J.
 Flack, Patricia E.
 Fleming, John L.
 Flook, Clarence
 Fogleman, Max E.
 Foos, Ryan M.
 Foreman, Charlres H.
 Foth, Diane L.
 Francis, Eugene N.
 Frazee, William C.
 Frazier, Leonard Leon
 Freeman, Arthur S.
 Frey, Andrew
 Frickel, David L.
 Frickel, James L.
 Fritz, Roy F.
 Frownfelter, T. O.
 Fulton, Keith S.

Gallegos, Carlos
 Galloway, Earl C.
 Galyean, Curran R.
 Garcia, Daniel D.



Dallas Hensley

Carl Waner in later years.

Ruby Long splits a corn stalk looking for corn borers.

Marilyn Vass

Daniel Grice

Dennis Tomsicek



Garcia, Harry
Garcia, M. Cathy
Garcia, Manuel
Garcia, Marcus C.
Gardner, Douglas S.
Gates, Arlen
Geier, Nathan
George, Janet L.
Gerber, Bruce J.
Gerdes, Don G.
Germann, Ralph N.
Gillan, Frances Dean Finley
Gillan, Stephen
Gillen, Robert L.
Goebel, Rodney G.
Goering, Jon E.
Gomez, Gregory D.
Gonzalez, Joseph M.
Good, Mark
Goodwin, Joe
Govert, Amy J.
Gramling, Susan D.
Green, Gay McDonald
Greene, Gerald L.
Grice, Daniel D.
Griffin, Alan J.
Griffis, Gary D.
Grimes, Donald W.
Grover, Ben L.
Gu, Xu
Guillen, Becky
Gunderson, Joshua M.
Guo, Yu-jie
Guzman, Jose G.
Guzman, Omar R.
Gwin, Roy E.



Haas, Howard J.
Haas, Melvin L.
Hacker, Donna
Hactor, Marilyn
Hadley, Susan
Haflinger, Fred R.
Hall, Bennie A.
Hall, Wesley G.
Hamill, David A.
Hamilton, Marie M.
Hamit Lawrence K.
Hammond, Dean
Hammond, Travis L.
Hands, Ricky W.
Hanna, Michael E.
Hannagan, Mark H.
Hanson, Debra
Harbaugh, Dorothy Jean
Hare, Nelson
Harms, John
Harris, Heather
Harris, Marsha R.
Harris, R. Dean
Hartman, Paul D.
Harvey, Joseph L.
Hatfield, Al D.
Hayes, W. Mike
Hays, Kelly
Hays, S. Kelly
Hays, Stephen K.
Head, Charlie H.
Head, Jeffrey A.
Hebrlee, Craig A.
Hector, Marilyn E.
Heili, Edward M.
Heine, Paul C.
Heinz, Coulter J.
Heinz, Skyler P.
Heit, Tiffany L.
Hendershot, Tim
Henderson, Charles F.
Henderson, Michael I.
Hendricks, Michael G.
Hendrix, Mike R.
Hensley, Dallas D.
Hergert, Blane L.
Herl, Gerald
Herman, Richard
Herman, William R.
Hernandez, Carlos
Hernandez, Kathleen L.

Hernandez, Martin
 Herod, Jon G.
 Herring, Roy B.
 Herron, George M.
 Hicks, Matthew S.
 Hisey, Charles A.
 Hitz, Kara E.
 Hoagland, Clifford R.
 Hoffman, Theodore C.
 Hofmeister, Stephanie J.
 Holm, Jeremy B.
 Holman, Johnathon D.
 Holt, Thada Sharpe
 Homer, George E.
 Homer, Linda L.
 Hooker, Mark L.
 Hoopes, Roger
 Hoover, Annette L.
 Hoover, Roger
 Hopkins, Grant
 Houghton, Waldo
 Howard, William Rocky
 Huang, Zaiming
 Huddleston, Catherine E.
 Huddleston, Roberta L.
 Huelskamp, Clinton A.
 Hughbanks, Scott
 Huilt, Geo.
 Hummer, Jewell
 Hunt, Harold
 Huschka, Bernard
 Huschka, Gerald F.
 Hutcheson, Shaun P.

Ibarra, Ricardo
 Ibarra, Roy
 Ibarra, Wanda
 Ibarra, Yanelly L.
 Ighofose, Patricia E.
 Inyeinengi, Edith
 Irsik, Jon
 Irsik, William G.
 Isaac, Harold

Jackson, Cathy L.
 Jacob, Donald J.
 Jacobs, Carole J.
 James, Jr., Claude
 Jameson, Patricia E.
 Jameson, Susan A.
 Johnson, Arthur

Johnson, Elizabeth K.
 Johnson, Marshall
 Johnson, Teisha D.
 Jones, Candace S.
 Jones, Jeffrey
 Jones, Kevin L.
 Jones, Leslie J.
 Jones, Thomas E.
 Jost, Larry K.

Kail, Cherie D.
 Kauffman, Hadley L.
 Keating, F. E.
 Keeling, Joyce Mason
 Kehn, Sam
 Keller, Ruth Helen
 Kendrick, Patrick
 Kerbs, Leonard C.
 Kern, Dorothea
 Kester, William R.
 Kile, Albert F.
 King, Gary
 Kinyon, Rebecca S.
 Kirchoff, Jack
 Kirchoff, Jerry W.
 Kirkham, Philip
 Klima, Rickie L.
 Klocke, Norman L.
 Klozenbucher, Kim J.
 Knapp, Geo. S.
 Knoche, Craig L.
 Knoll, Donald
 Koehn, Dennis
 Koehn, Galen L.
 Koehn, Jaylen W.
 Koehn, Rodney J.
 Koehn, Verlin R.
 Koehn, Virgil
 Koksall, Frank L.
 Kolbeck, Aaron
 Kraft, Glenda S.
 Kraft, Robert A.
 Krause, John B.
 Kreegar, Jennifer A.
 Kreikemeier, Kelly K.
 Kuhlman, Dennis K.
 Kyle, Jack H.
 Kyle, Paul J.

Ladd, Christy L.
 LaGessee, John H.



*Jennifer Wright between the Teetzen twins,
 Danelle and Micala.*

Gary Miller and Manuel Garcia

Ramon Servantez



Jovita Baier, Dennis Tomsicek, and Ruby Long

Dennis Tomsicek

Laird, Irvin B.
 Talicker, Shelli
 Lampe Kevin D.
 Langston, Lydia L.
 Langston, Vernon B.
 Lapp, Diane B.
 Largent, Mary M.
 Laufenberg, Wesley
 Lawver, Joan S.
 Le, Thompson H.
 Lee, James M.
 Lee, Robert W.
 Leeds, Ryan O.
 Lehman, Meriam
 Lehner, David W.
 Lill, J. G.
 Lingreen, Karen L.
 Livingston, William C.
 Locke, Duncan
 Loeppke, Stephanie A.
 Lohmann, Lewis
 Long, Ruby J.
 Longstreth, J. W.
 Lowe, Alvin E.
 Loy, Stephen E.
 Lozano, Casimiro
 Lubbers, Sr., Michael A.
 Lynde, Geraldine Wolf
 Lytle, Eldon E.
 Maddux, Albert G.
 Maggard, Sheila
 Mai, LaDonna
 Makens, Thomas P.
 Mangan, Chris
 Mann, Gregory R.
 Mar, Carrie A.
 Mar, Kathryn
 March, Archie Fae
 Mareno, Juan P.
 Mari, Albert
 Martinez, David C.
 Martinez, Jeffrey D.
 Massinga, Rafael
 Matthews, Illa
 Matticks, Heather R.
 Maurer, Eugene M.
 Maxfield, Daniel D.
 Maxwell, Scott R.
 McAtee, Stephanie M.
 McCammond, Claudette E.
 McClure, Marney K.
 McCord, Phillip
 McCoy, Robert D.
 McDonald, Joy E.
 McElroy, Jr., Noel G.
 McFadden, Asa
 McGinn, Danny J.
 McGinn, Terry
 McGraw, Darrin J.
 McVey, Steven S.
 McVicker, Darren E.
 Mead, Dennis L.
 Mead, Jerry A.
 Meadors, Terrance
 Meeks, Mark A.
 Mehrer, Terra R.
 Meier, Joanna C.
 Melgosa, Cathy
 Melgosa, Dennis K.
 Melgosa, Henry E.
 Melgosa, Russell L.
 Meng, Mike G.
 Meng, Ryan J.
 Mereno, Juan
 Metzinger, Joseph W.
 Meyer, Walter R.
 Meylor, Joseph T.
 Micheau, John
 Michel, Steve
 Miller, Angela K.
 Miller, David A.
 Miller, Donna M.
 Miller, Gary W.
 Miller, Sharon E.
 Millershaski, Bruce E.
 Minor, Emma

Mitchell, Steve R.
Mitchell, Tara J.
Mizell, Eric
Moberly, Louis T.
Molina, Alicia
Montgomery, William J.
Moon, David R.
Moore, Michelle L.
Morishita, Don W.
Moseman, Shaun B.
Moyer, Keith P.
Muggee, Stacy T.
Musick, Jack T.
Mustain, Cynthia R.
Myers, Alexandria Taos
Myers, Byrom A.
Myers, Hugh

Needham, Calana L.
Needham, Lano
Needham, Marcola
Needham, Maya
Neff, Fred A.
Nelson, John M.
Nelson, Leroy C.
Newberry, G. Vernon
Newton, David W.
Nguyen, Hai D.
Nguyen, Tuan
Nightingale, Eli
Nightingale, Jeffrey L.
Nolan, Dale A.
Nolan, Justin
Nolan, Migel J.
Nonhof, Arthur G.
Norwood, Charles A
Norwood, Dick G.
Nossaman, Norman L.
Nulton, Rachel D.
Nyswonger, Matthew R.

Ohmes, Francis (Frank) E.
Ohmes, Loretta F.
Old, Ralph
O'Leary, James F.
Orosco, Arlan
Orozco, John L.
Orozco, Richard J.
Ortiz, Ben C.
Owens, Bobby

Paasch, Parker R.
Packard, James S.
Padgett, Gary L.
Padilla, Mario A.
Parks, Richard D.
Parsons, Travis C.
Patterson, Larry B.
Payne, Gina
Payne, J E.
Peat, H. Deanne
Penas, Paul E.
Penrod, Alan
Peoples, Terry S.
Perez, Catherine
Perez, Luis C.
Perez, Moises P.
Perez, Priscilla
Petersen, Johnnie
Petersen, Karen L.
Petersen, Kelli R.
Peterson, Charles
Peterson, Peter Alvin
Phillips, Wesley A.
Pickett, Gary D.
Pierce, Ronald E.
Pishney, Brendon S.
Pollman, Judy A.
Powell, Larry D.
Powell, Marc A.
Powers, William S.
Preston, Autumn Dawn
Proehl, Lester E.
Proudfit-Wedel, Michelle L.
Puckett, Jayanna L.
Purcell, John Mike

Quam, Travis L.

Monty Spangler

Henry Melgosa

Jeff Elliott



Steve Michel

Manny Garcia and Thom Makens

Jovita Baier



Ragan, C. Jean
Raines, Kelly G.
Ralston, Randy R.
Ramirez, Enrique
Randall, Jeff S.
Randolph, James D.
Recalde, Marco J.

Reed, Curtis L.
Reed, H. R.
Reed, Larry J.
Reese, Harold
Regan, Patrick M.
Reichmuth, Brady J.
Reimer, Everett A.
Reimer, Stephanie A.
Renshaw, Daryl J.
Rice, Earle D.
Richert, Paul D.
Rider, Regina
Riley, Shari L. Beckett
Ritter, Rebecca S.
Roberts, Todd A.

Robinson, Betty J.
Robinson, Donald L.
Rock, William L.
Rogers, Brent A.
Rogers, Vicky
Rohleder Deqan
Rome, Steven D.
Romero, Jr., David
Rosenau, Ken F.
Roth, Kevin

Roth, Michael D.
Rupp, Lance
Russell, Richard O.
Russell, William J.
Russett, Fay O.
Rust, David
Ryan, Gerald L.

Salinas, Ismael
Sandoval, David A.
Sandoval, Mike
Sandoval, Steve R.
Santee, Jeremy S.
Saunders, Susan R.
Savage, Kimberly R.
Schaefer, Kurt A.
Schaefer, Rafe A.
Schaffer, Eric K.
Schaffer, James A.
Schiffelbein, Eric A.
Schlegel, Alan J.
Schlender, John R.
Schlotterbeck, Shawn
Schmidt, Frankey R.
Schmidt, Franklin J.
Schmidt, Nathan D.
Schmutz, Richard
Schneider, Andrea L.
Schneider, Larry R.
Schroeder, Allen L.
Schuetz, Raymond
Schultz, Lennis
Schweer, Sonya J.
Scott, Bridget L.
Seavey, Shenna
Seay, LeRoy
See, Shane
Seiler, Rolan J.
Selby, Pamela S.
Selee, Robert S.
Sells, Michele Hedberg
Sells, Shane
Senne, Howard W.
Servantez, Rafael J.
Servantez, Ramon G.
Sewell, M. C.
Shackelton, Kenneth
Shivers, Jerry
Shuman, Michelle L.
Shumate, Donald A.
Silos, Jr., Rafael

Sipes, Susan C.
 Slattery, Jeffrey A.
 Sloan, Leland M.
 Smith, Bryan
 Smith, James L.
 Smith, Jeff
 Smith, Kallie
 Smith, Robert V.
 Snelling, Kenneth W.
 Snelling, Warren M.
 Sniff, Cassandra L.
 Snook, Barry L.
 Snyder, Steve L.
 Spangler, Monty J.
 Spence, Larry D.
 Spinazola, Jean
 Springston, Bradley D.
 Springston, Scott M.
 Spurgeon, William E.
 St. Clair, Scott
 Staats, Kevin L.
 Staats, Norman H.
 Staats, Todd
 Staats, Troy K.
 Stafford, Pauline D.
 Stallsworth, Bruce
 Stebens, William R.
 Stegmeier, William D.
 Steinle, Eric L.
 Steinle, Nathan C.
 Sterling, Steve
 Stevens, Janice J.
 Stevenson, Lawrence D.
 Steward, Margaret L.
 Stokes, Raymond
 Stone, Jay D.
 Stoppel, Arthur
 Stout, Harold L.
 Streeter, Margaret E.
 Stroud, Michael T.
 Stroup, Todd W.
 Stubblefield, Judith A.
 Stutzman, Nathan L.
 Sualla, George A.
 Sullivan, Kenneth L.
 Sundberg, Bryan T.
 Sutton, Lloyd
 Swallow, Joey
 Swenson, Royal Jay
 Synder, Dwayne A.
 Synder, Steve L.

Tabor, William M.
 Tarpley, Matt B.
 Taylor, Jack E.
 Taylor, Rickey
 Teager, Jr., Larry L.
 Tedford, Robert L.
 Teetzen, Briana K.
 Teetzen, Danelle
 Teetzen, Micala
 Temple, Jeannine
 Thompson, Curtis R.
 Thon, Kevin M.
 Tichenor, Dixie L.
 Tiffany, Heather
 Tilton, Elvin W.
 Timm, Cheryl A.
 Tjaden, Marvin D.
 Toews, Cornelius Z.
 Tompkinson, Eric
 Tomsicek, Dennis J.
 Travis, David O.
 Trayer, Danny D.
 Trooien, Todd P.
 Truby, N. Lea
 Truitt, Glenda
 Trujillo, Russell D.
 Tull, Matt L.
 Turner, Wendy J.

Ullom, Jonas
 Ulrich, Jamie J.
 Ulrich, Richard Chad
 Unrein, Matthew
 Unruh, Gerald D.
 Unruh, Mike
 Unruh, Robin R.
 Unruh, Shirley
 Unruh, Theodore A.
 Unruh, Tim D.
 Unruh, Zachary Tyler

Van, Phi H.
 Vanderee, Greg W.
 Vandervort, R. Bruce
 Vass, LeRhea S.
 Vass, Marilyn J.
 Vaughan, Gerald
 Vela Reyes, Marco A.
 VenJohn, Marcy
 Von Trebra, R. L.



Jose Guzman

Joanna Meier

Manuel Garcia



Jovita Baier (left) and Roberta Huddleston

John Wooden

Gary Miller

Wagner, Dale L.
Wagner, Fay A.
Wagner, John
Waldren, Jim T.
Walker, Jeremie W.
Waller, Benjamin B.
Walters, Christine M.
Walters, III, John F.
Warner, Carl S.
Waters, Dewey R.
Waugh, Vernon
Weaver, Aaron J.
Webb, Michael C.
Webb, Raymond W.
Weber, Jody L.
Wedel, Clarence C.
Wedel, Kenneth
Wellmaker, Larrall W.
Wernecke, Edward D.
Wesley, Tony C.
Whipple, Randy
Whipps, Loren E.
White, Dan R.
White, Julie A.
White, Lisa
Whitley, Blake
Wieland, William K.
Wildman, Lisa G.
Wilgus, Roger L.
Wilkinson, Guy E.
Williams, Deborah H.
Williams, Debra L.
Williams, Frankie E.
Willson, Thomas C.
Wilson, Cheryl
Wilson, Dennis E.

Wilson, J. D.
Wilson, Richard T.
Wilson, Robert J.
Wilson, Wade C.
Withee, L. V.
Witt, Jay D.
Witt, Merle D.
Witt, William D.
Wolf, Shaun E.
Wolfe, Joseph G.
Wooden, John D.
Woods, Douglas B.
Woods, Lance
Woolard, Todd M.
Wright, Jennifer L.
Wright, Josh A.
Wright, Loyd
Wyatt, Jimmy

Yakel, Karen S.
Yost, Arlen
Yost, H. Joe
Yost, Wilbur
Yu, Pyung Kyung

Zemp, DeAnna M.
Zhou, Suxian
Zimmerman, Travis
Zubeck, Jimmie D.

This list of employees was compiled from current personnel records of the research center and archived data as available. Although every effort was made to ensure the accuracy of this list, the possibility of omission still exists and is completely unintentional. Names are printed exactly as they were entered into our records.

ROSTER OF EXTENSION EMPLOYEES, 1969-2007

Addison, Conall E.
 Alam, Mahbub
 Andelt, William F.
 Applehaus, Easther
 Aslin, Raymond G.
 Aycock, Roy
 Baughman, Melvin J.
 Boerger, Lesa
 Boggess, Edward K.
 Bogle, T. Roy
 Bolton, Debra
 Bowers, Joan
 Brant, Melanie
 Brooks, Kay
 Bruner, Roberta
 Buchele, Rodney
 Burns, Errol
 Dawson, James
 Dhuyvetter, Kevin C.
 Dome, Rita S.
 Drinkwater, Deborah
 Dumler, Troy J.
 Eck, Douglas
 Eck, Thomas P.
 Edelblute, Dale H.
 Francis, Eugene N.
 Frisbie, Robert
 Gaden, Randall B.
 Gatliff, Edward G.
 Germann, Ralph N.
 Green, Parman
 Gronaw, Don
 Hacker, Donna
 Hale, Ron
 Hartman, Paul D.
 Hendrix, Larry D.
 Herod, Jon
 Hinde, Ramona L.
 Holman, John D.
 Hoskinson, Judy
 Huck, G. Lance
 Huddleston, Roberta
 Hunter, Deanna
 Janssen, Jon R.
 Jones, Milan T.
 Keidel, Sabrina

Knoll, Joyce M.
 Krause, Mark A.
 Kreikemeier, Kelly K.
 Laudert, Scott B.
 Lengkeek, Venance H.
 Lisac, Bob
 Lobmeyer, Harry
 Mann, Ray H.
 Marston, Twig T.
 McGrew, Leslie
 McMinimy, Milton
 Mock, Donald E.
 Moffet, Crissie
 Mosier, Dwight G.
 Neufeld, Dorothy
 Oliver, Rhonda
 Oyler, Trisha
 Parks, Ann
 Peck, Pam
 Pope, David
 Robinson, Betty
 Rohs, Fredrick R.
 Rosas, Eva M.
 Sartwelle, III, James D.
 Saueressig, Lori J.
 Schaffer, James A.
 Schiffelbein, Sharon
 Sells, Marva
 Skinner, Jon P.
 Slate, Carol M.
 Sloderbeck, Phillip E.
 Smerchek, John
 Snyder, Gary
 Starkey, Dale A.
 Stucky, Douglas D.
 Sturdevant, Jim
 Terrant, Anthony
 Thomas, James G.
 Thompson, Curtis R.
 Trayer, Danny
 Truman, Cheryl L.
 Whipps, Loren E.
 Williams, Duane
 Willson, Thomas
 Young, Carol H.
 Zoellner, Kirk A.



Mahbub Alam helps Terry Hudgins and Ray McElroy check for unwanted particulates that may have escaped the filter systems of the subsurface drip irrigation system on Wendell Nicholas' farm.

Ramon Servantez— 25 years of service;
 Dave Romero— 10 years of service;
 Bill Irsik— 10 years of service;
 and Manuel Garcia— 15 years of service.

Trish Olyer and Joanna Meier

Group photo taken fall 2006.

Front row (left to right): Manuel Garcia, Bill Irsik, David Romero, Ramon Servantez;

Second row: Jaylen Koehn, Joanna Meier, Amanda DeBusk, Phil Sloderbeck, Ramona Hinde, John Holman, Monty Spangler, Henry Melgosa;

Back row: Robert Gillen, Dennis Tomsicek, Gary Miller, Jeff Elliott, Larry Buschman, Scott Maxwell, Norman Klocke, and Randall Currie.



