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A Centennial History
of
the Department of Agronomy
Kansas State University

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Mitch Tuinstra, p. 78
Elisabeth Vanderlip, p. 23
Richard Vanderlip, 103
Dave Whitney, p. 185
Walt Woods, p. 29

Contents

Introduction and Acknowledgements **5**
K-State Agronomy in 2006 .... **7**
Heads of Agronomy, 1906–2005 .... **9**
Overview of the Agronomy Department, 1906 - 2006 .... **15**
Teaching Programs **33**
Extension
- Extension Agronomy 47
- Extension Range Management 53
- Extension Weed Science 55

International Activities **57**
Research Programs
- Plant Genetics 65
- Wheat Improvement 67
- Sorghum Improvement 77
- Soybean Improvement 81
- Corn Breeding 91
- Canola Breeding 95
- Alfalfa Breeding 97
- Grass Breeding 101
- Crop Production and Crop Ecology 103
- Crop Physiology 105
- Forage Management and Utilization 107
- Range Management 109
- Weed Science 113
- Soil Classification and Soil Survey 115
- Soil Chemistry 125
- Soil Fertility 127
- Soil Management and Conservation 131
- Soil Physics 135
- Soil Microbiology 139
- Evapotranspiration Laboratory 141
- USDA-ARS Wind Erosion Research Unit 145

Experiment Fields **151**
Agronomy Farm **159**
Ashland Agronomy Farm **167**
Service Programs
- Foundation Seed 171
- Crop Performance Testing 173
- Kansas Crop Improvement Association 181
- Soil Testing Activities 185

Additional Reading **189**

Introduction and Acknowledgements

Looking ahead to the Department of Agronomy Centennial in 2006, a plan for writing this history was initiated in 2002 when Gary Paulsen developed an outline of possible sections and potential authors and submitted it to the Agronomy faculty. Because the submission deadline was fairly far in the future and faculty members were busy with other responsibilities and more pressing deadlines, little response was received. In 2005, we agreed that this project would be a very important part of our Centennial Celebration. Following a meeting with Department Head Dave Mengel and Paulsen, who had retired, Gerry Posler agreed to coordinate the writing effort by updating the list of sections and seeking the assistance of faculty members to be authors.

K-State Agronomy is a large and diverse department with a long and significant history of teaching, research, extension, and international program activities, in part because agriculture in Kansas is based upon its abundant land resources, which are primarily composed of cropland and rangeland and forages for the large livestock industry. A widespread network of experiment fields has also been critical because agronomy is so site-specific. Significant agronomic work was conducted by faculty in Botany, Chemistry, Farm Management, and other departments before the Department of Agronomy was formed, and considerable crops and soils research was conducted before the establishment of the Kansas Agricultural Experiment Station in 1887.

We initially realized that this task could only be completed by compiling sections from many authors, and we agreed to serve as authors of some sections and as editors. We also soon realized that the amount of material to be included was too great for a single affordable printed version. Therefore, plans were made to produce both a printed history and CD ROM version, with several appendices included only on the CD ROM and the department web site. These appendices include the List of Theses and Dissertations, Lists of Classified and Unclassified employees, Faculty Awards, Lists of Undergraduate and Graduate Scholarship Recipients, USDA Wind Erosion Research Unit History, and others. Because of the very large number, no attempt was made to develop a complete list of publications authored by our faculty and their students and colleagues, most of which are available in KAES annual and biennial reports. Some sections were condensed for the printed version and also included full-length on the CD ROM (e.g., Experiment Fields and Soil Survey).

We acknowledge the efforts of all current, emeritus, and former faculty members and others who authored and edited sections. We particularly thank Cynthia Harris, David Whitney, and Mary Beth Kirkham for assisting with multiple sections. We appreciate the efforts of George Ham and Richard Vanderlip for reviewing multiple sections. We also appreciate the enthusiastic support of Interim Department Head Gary M. Pierzynski during the crucial months of completion.

We are deeply indebted to Jennifer Foltz for her graphic designs for the history cover, historical timeline, Centennial logo, registration brochure, and many other posters and literature pieces. We also acknowledge the assistance of Brittany Green for scanning many photos and documents, and her efforts, along with those of Nancy William and Connie Hobbs, for typing several sections and appendices. We also appreciate the helpfulness of the University Archives group, including Anthony Crawford, Pat Patton, and Mallory Peterson.

Although every possible effort was made to be inclusive and accurate, we recognize that some errors and omissions likely remain; they are completely unintentional.

Gerry L. Posler and
Gary M. Paulsen,
Editors

K-State Agronomy in 2006

Gary M. Pierzynski

Agriculture is an important part of the Kansas economy. The Kansas State University Department of Agronomy has statewide responsibilities for teaching, research, and extension in crop, soil, and range sciences, relating directly to the production of crops and feed for livestock on the 65,000 farms and 47.5 million acres of crop, pasture, and range in the state. Programs in weed science, plant breeding and genetics, crop production, cropping systems, soil and water conservation, soil science, range and forage management, and environmental protection are important components of the department. Many research and extension activities are conducted cooperatively with faculty in other departments and colleges at K-State, and with colleagues and organizations beyond Kansas.

Faculty and Staff

The department currently has 36 faculty and staff teaching or conducting research, and extension programs on campus and at six departmentally operated locations across Kansas. An additional 18 adjunct Agronomists/Soil Scientists are located at out-state Research or Research/Extension Centers. More than 50 support staff provide clerical, field, laboratory, and greenhouse assistance for our programs. About 50 graduate students, including 10 students in a Distance Masters program, and many of the approximately 110 undergraduate students majoring in Agronomy, also work in the department.

About half the departmental budget comes from state and federal appropriations each year. These funds are primarily used for salaries and maintenance of facilities, with most of the funds for operating expenses coming from grants and contracts, crop and seed sales, and fees for services. The Department of Agronomy spends over $10 million to conduct research, extension, and teaching activities each year.

Facilities

The Agronomy Department is blessed with excellent classroom, office, laboratory, and greenhouse facilities in the Throckmorton Plant Sciences Center. The department currently uses nearly 80,000 square feet of office, laboratory, and classroom space in Throckmorton, plus 42 greenhouse rooms with an additional 26,250 square feet.

Excellent field-research facilities with appropriate equipment are available in the Manhattan area. The Agronomy North Farm, established in 1909, (2200 Kimball) is a 365-acre facility used for teaching, extension, and research. Several long-term cropping systems and nutrient management research and demonstration projects are located on the North Farm, together with weed and crop gardens, research lysimeters, subsurface drip irrigation facilities, and the departmental shop facilities. A Learning Farm was developed by using a USDA Higher Education Challenge Grant, with the goal of providing more hands-on field experiences to students.

The Ashland Farm contains more than 600 acres of dryland and irrigated cropland, primarily used for research. The Rannells Flint Hills Prairie unit contains more than 2,800 acres dedicated to range, prairie-ecology, and global-climate-change research.

The department also operates six experiment fields/demonstration farms throughout eastern and central Kansas to study specific soil-climate-cropping systems interactions. The departmental Experiment Fields are currently located near Ottawa, Hutchinson, and Hesston (Harvey County); Belleville and Scandia (North Central); Rossville and Silver Lake (Kansas River Valley); and Ellsworth (Armbrust Conservation Demonstration Farm).

Teaching Programs

The Department of Agronomy currently offers five undergraduate options: Crop Consulting and Production, Range Management, Soil and Environmental Science, Business and Industry, and Crop Science and Biotechnology. The Natural Resource Environmental Science secondary major is available and widely used by Agronomy majors. A flexible Agronomy minor is used by many students majoring in Animal Science and Industry, Agricultural Economics, and Agriculture Technology Management. About 65 courses for undergraduate and graduate students are available, in crops, soils, range, weeds, crop breeding/genetics, climatology, and environmental quality.

Graduate programs leading to both M.S. and Ph.D. degrees are available in Agronomy. There currently are about 50 students enrolled in a graduate-degree program in the department. A Distance Masters option was initiated in 2002. This program allows working professionals to work on an advanced degree in their home area. Research can be conducted locally, by using out-state faculty as thesis advisors.

Research Programs

Research in Agronomy identifies the basic biological, chemical, and physical principles that govern the interrelationships of crops, range, soils, and their environment. This knowledge is used to develop efficient crop production systems that conserve and protect our natural resources.

Research in Agronomy at K-State has had a major role in improving dryland agriculture in the region. More efficient use of water in both dryland cropping and under irrigation has contributed much to both increased crop yields and increased crop diversification. Reduced tillage, more efficient use of fertilizers, improved weed-control strategies, intensive winter grazing and supplemental-forage production, and alternative crops such as cotton, sunflower, and canola, are current research themes.

Major advances in crop yields and grain and forage quality have resulted from improved varieties of wheat, soybean, and canola, and from parent lines for sorghum hybrids. Population improvement in these crops has also been enhanced through the release of improved germplasm for use by private companies to develop superior varieties and hybrids for Kansas farmers. Many sources of multiple-pest and stress resistance have been introduced into varieties of all major crops, providing increased and more stable crop yields.

Research in the Agronomy Department is not restricted to cultivated crops. Projects regarding use of fire to control undesirable vegetation and the concept of intensive early stocking have led to widely adopted management practices in the tall-grass prairie region of Kansas, increasing the profitability of many ranch operations. Agronomy faculty are also heavily involved in research dealing with environmental issues. These include issues such as carbon sequestration and global climate change, nutrient management, soil quality and sustainable production practices, and remediation of contaminated sites.

Extension Activities

State and area agronomy extension specialists and multi-county Crop and Soils Specialists conduct educational programs, based on sound, research-based agronomic principles and practices, for county agents, farmers, ranchers, and agribusinesses. These programs result in more efficient production, greater economic returns, conservation of natural resources, and preservation of environmental quality. Extension specialists bring research findings from any source to the cropland and rangeland industry of Kansas. They help producers and agribusinesses apply new methods and technology through applied research and demonstrations. They also help interpret new regulations, solve problems, and participate actively in producer organizations.

Issues currently being addressed by agronomy specialists include: efficacy of labeled and experimental herbicides for all major crops, soil and water conservation, nutrient management, cropping systems, alternative crops such as cotton and sunflowers, and water-quality issues.

Services

The Soil Testing Laboratory provides accurate and timely soil analyses and recommendations to thousands of farmers statewide to aid their crop-management decisions. The fertilizer recommendations were recently reviewed and are available as a bulletin and as a computer program. A major effort is currently under way to update the basic nutrient-response data on which the fertilizer recommendations are based.

Foundation seed of new public wheat, soybean, oat, and canola varieties is produced and distributed to certified seed growers who, in turn, provide seed to Kansas producers. Although not an official part of the department, the Kansas Crop Improvement Association is headquartered at the Agronomy North Farm, serving certified seed growers throughout Kansas.

An excellent Crop Performance Testing Program is conducted statewide to evaluate varieties and hybrids of wheat, sorghum, corn, soybean, alfalfa, sunflower, oats, barley, triticale, and canola. Results of these performance tests are widely publicized to aid producers in choosing the optimum variety or hybrid for crop production.

Heads of Agronomy, 1906–2005

Gary M. Paulsen and Cynthia A. Harris

The Department of Agronomy is pleased to recognize the nine persons who have led it for 100 years. Their tireless efforts have taken the department from rather humble beginnings of one professor and two assistants in 1906 to 51 professors, 110 undergraduate students, 50 graduate students, and more than 50 professional staff today. Facilities have improved from a few cramped offices in a small building to a large, modern office/laboratory/classroom/greenhouse complex, two nearby research farms, and seven experiment fields. Under their leadership, the Agronomy Department has educated thousands of students; extended modern technology to producers; discovered new knowledge of crops, soils, range, and weeds; and served agriculture in Kansas, the United States, and the world.

Teaching is an important part of the mission overseen by the Department Head. Alumni of the department have distinguished themselves in the public and private sectors as crop, soil, and range professionals. They are farmers, agents, educators, administrators, consultants, representatives, scientists, missionaries, military, contractors, and a host of other professions. Many have become leaders in their communities, academia, industry, and government. Others have contributed greatly to world agriculture. They made hybrid corn a practical crop, introduced the wheat seeds for the Green Revolution, developed sorghum into an important crop, made a "Miracle Rice" for Asia, and led national programs in wheat, barley, oat, and alfalfa.

Extension programs— ranging from the popular Farmer Institutes of the early 1900s to the present system of State Specialists, Area Agronomists , and County Agricultural Agents— have kept producers familiar with the latest technology in agronomy. Information on conservation of soil and moisture, tillage and production systems, evaluation of varieties and hybrids of crops, protection of the environment, and assistance with special problems has kept the state's agriculture efficient and competitive.

Research directed in the Agronomy Department by the Department Heads has continually developed new knowledge, new technology, and new varieties of crops for Kansas agriculture. Investigations of fertilizer needs and techniques for applying fertilizers have enhanced productivity of the state's soils. Surveys have mapped the soils in all 105 counties in the state. New methods of tillage have helped to conserve soil and moisture. Range research has kept the state's grasslands productive. Research has led to efficient methods of weed control. Early investigations introduced new varieties of wheat, corn, sorghum, alfalfa, and grasses. Today, a majority of the state's acreage of wheat, and much of its acreage of alfalfa, soybean, and canola, is planted with varieties developed in the Agronomy Department. Over the years, the department has been the major source of information for production of wheat, corn, sorghum, soybean, alfalfa, and forage grasses.

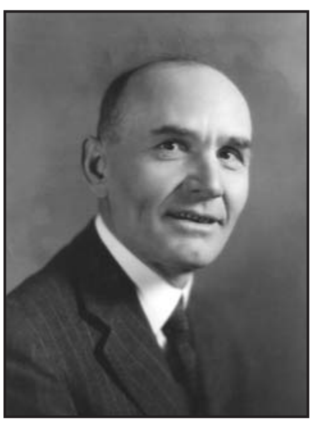
The Department Heads of Agronomy continued to serve society after leading the department. Many became Associate Deans and Deans at K-State and other institutions. One became U.S. Secretary of Agriculture. Some returned to teaching and research. Others led international agricultural development programs in Africa and Asia. Their accomplishments in these endeavors were as impressive as their achievements as Department Heads of the Department of Agronomy.

Albert M. Ten Eyck 1906–1910

Albert M. Ten Eyck (1869–1958) was born in Green County, Wisconsin, and earned a B.S.A. degree from the University of Wisconsin in 1892 and an M.S. degree from Colorado State College in 1897. After working as an Assistant Agriculturist at North Dakota Agriculture

College, he came to Kansas State College in 1902 as Department Head of the Agricultural Department, and was appointed Department Head of Agronomy when it was formed in 1906. The new department had two faculty members, an Assistant Agronomist in Crops and an Assistant Agronomist in Soils. Most of the area that constitutes the North Agronomy Farm was purchased in 1909. Ten Eyck greatly expanded relations of the Agronomy Department with the state's farmers, and conducted highly popular Farmer Institutes to promote improved practices. He was President of the American Society of Agronomy in 1910.

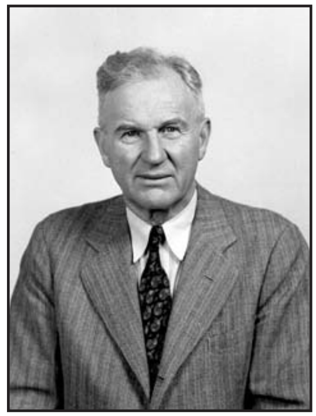
Ten Eyck was reassigned as Professor of Farm Management, a position that he never filled, and Superintendent of the Hays Branch Experiment Station in 1910. He resigned from Kansas State College in 1912 and accepted a position as Extension Professor of Soils and Crops at Iowa State College. He was Agricultural Agent for Winnebago County, Illinois, from 1914 to 1917, and Agriculturalist for the Emerson-Brantingham Implement Company of Rockford, Illinois, from 1918 to 1919. Ten Eyck ended his career as a farmer and fruit grower at Brodhead, Wisconsin, from 1919 to 1945.



William M. Jardine 1910–1913

William M. Jardine (1879–1955) was born in Oneida County, Idaho, and received a B.S.A .degree from Utah State Agricultural College in 1904. He came to the Department of Agronomy as Department Head after serving three years as Assistant Cerealist with the USDA. During his brief term as Department Head, he expanded the Agronomy Department's research and training activities in dryland agriculture, recruited a number of faculty to strengthen the department, and encouraged other faculty to obtain advanced training. He was President of the American Society of Agronomy in 1917.

Jardine became Dean of Agriculture and Director of the Kansas Agricultural Experiment Station in 1913, and President of Kansas State College in 1918. He was appointed U.S. Secretary of Agriculture in 1925 by President Coolidge, serving from 1924 to 1928. After serving as U.S. Ambassador to Egypt, he became the Kansas State Treasurer, and later President of the University of Wichita.



Leland E. Call 1913–1925

Leland E. Call (1881–1969) was born in Ohio, and earned B.S. and M.S. degrees from Ohio State University in 1906 and 1912, respectively. He joined the Department of Agronomy at Kansas State College as an Assistant in Agronomy (Soils) in 1907. During his tenure as Department Head, the first improved wheat variety ('Kanred') was released, research was expanded on alfalfa and corn and initiated on sorghum and soybean, the first Experiment Fields were established in 1923, and county soil surveys were begun. Call served as President of the American Society of Agronomy during 1922.

Call was Dean of Agriculture and Director of the Kansas Agricultural Experiment Station from 1925 to 1945. After retiring, he became Chief of Party of an Agricultural Mission to the Philippines to determine the country's food needs, was a Fullbright Scholar at Silliman University, and later served with the U.S. Mission to direct the Cornell University/University of the Philippines Project, the first of many large overseas projects undertaken by U.S. universities during the 1950s and 1960s.

Ray I. Throckmorton 1925–1946

Ray I. Throckmorton (1886–1979) was born in Pennsylvania, received a B.S. degree from Pennsylvania State College and an M.S. degree from Kansas State College, and did advanced study at Cornell University. He joined Kansas State College as an Assistant in Soil Survey in 1911. As Department Head, he oversaw development of several new Experiment Fields; completion of a number of county soil surveys; and release of many new varieties of wheat, corn, oat, and sorghum. Throckmorton guided the Department through the Depression, drought, and World War II. He was President of the American Society of Agronomy during 1934.

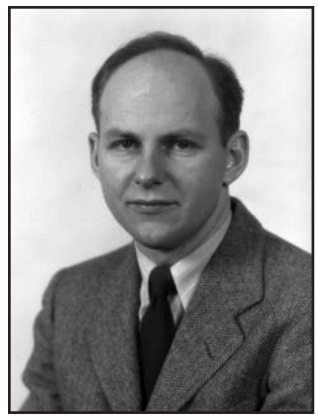
Throckmorton was Dean of Agriculture and Director of the Kansas Agricultural Experiment Station from 1946 to 1952. He also served as Chairman of the Athletic Council, President of the K-State Endowment Association, Consultant for the USDA, and Committee Member for the Association of Land Grant Colleges.

Harold E. Myers 1946–1952

Harold E. Myers (1907–1992) was born in Netawaka, Kansas, and received a B.S. degree from Kansas State College, an M.S. degree from the University of Illinois, and a Ph.D. degree from the University of Missouri. He joined the Department of Agronomy as an Assistant Professor of Soils in 1929 and was Agricultural Advisor for the U.S. Department of State during 1944 to 1946. During his time as Department Head, research on use of nitrogen fertilizer expanded greatly, several oat varieties were released, and a number of new faculty were hired. The Agronomy Department was authorized to award the Ph.D. degree in 1952. Myers served as President of the Soil Science Society of America in 1950 and of the American Society of Agronomy during 1953.

Myers became Assistant Dean of Agriculture and Associate Director of the Kansas Agricultural Experiment Station in 1952. He was Dean of Agriculture at the University of Arizona from 1956 to 1973, and enrollment there nearly tripled during his tenure. Myers initiated a number of international programs as Dean, and became Director of International Programs at Arizona after retiring.

Raymond V. Olson 1952–1970



Raymond V. Olson (1919–1985) was born in North Dakota, and earned a B.S. degree from North Dakota State College and M.S. and Ph.D. degrees from the University of Wisconsin. Olson came to Kansas State College as an Associate Professor of Soils in 1947. During his time as Department Head, the Agronomy Department greatly expanded its faculty and graduate programs; initiated new programs in soils, genetics, and soybean; replaced its facilities after a devastating fire in 1957; and received numerous awards for its contributions to Kansas and U.S. agriculture.

Olson was the first Chief of Party of the KSU-AID program at Ahmada Bello University in Nigeria, and later served there as Dean of Agriculture and Provost for Agriculture and Veterinary Medicine. He was Director of International Agricultural Programs at K-State from 1970 to 1972.

Hyde S. Jacobs
1971–1980

Hyde S. Jacobs (1926–) was born in Idaho. He earned B.S. and M.S. degrees from the University of Idaho in 1952 and 1954, respectively, and the Ph.D. degree from Michigan State University in 1957. He joined K-State as Assistant Professor of Agronomy, and subsequently directed the Kansas Water Resources Research Institute and Kansas Evapotranspiration Laboratory. During his tenure as Department Head, construction of Throckmorton Hall Phase I was initiated, the statewide network of Area Extension Agronomists was completed, and private funding for crop improvement research was enhanced.

Jacobs was Assistant Director of Cooperative Extension and Director of International Agricultural Programs from 1981 to 1986, and Assistant to the Dean of Agriculture from 1986 to 1995. He was legislative liaison for the Kansas Agricultural Experiment Station and Cooperative Extension Service and coordinated projections of teaching and research needs by an Agriculture 2000 Committee of distinguished citizens.

George E. Ham
1980–1990

George E. Ham (1939–) was born in Iowa and received B.S., M.S., and Ph.D. degrees from Iowa State University. He became Department Head of Agronomy at K-State after rising through the academic ranks in the Department of Soil Science at the University of Minnesota. As Department Head, he initiated a number of new programs, recruited faculty for new positions, oversaw the Agronomy Department's move to Phase I of Throckmorton Hall, and promoted funding for Phase II of the Throckmorton Plant Sciences Center.

Ham became Associate Dean of Agriculture and Associate Director of the Kansas Agricultural Experiment Station in 1989. In that position, he acted as Chair of the Throckmorton Plant Sciences Building Committee, fostered the merger of the Agricultural Experiment Station and Cooperative Extension Service into K-State Research and Extension, and promoted interdisciplinary teams among faculty. He returned from retirement to serve as Interim Dean of Agriculture and Director of K-State Research and Extension during 2003 and 2004.

Gerry L. Posler
1990–1998

Gerry L. Posler (1942–) was born and raised on a farm near Cainsville, Missouri. He received his B.S. (cum laude) (1964) and M.S. (1966) degrees from the University of Missouri, and his Ph.D. degree (1969) from Iowa State University. He joined the Department of Agronomy at K-State in 1974 as Associate Professor. During his tenure as Department Head, Phase II of the Throckmorton Plant Sciences Center was completed, providing much enlarged and enhanced office, laboratory, and greenhouse facilities for Agronomy research, teaching, and extension programs.

Before and after serving as Department Head, Posler's primary activities were teaching and advising, but he also had a productive research program in forage management and utilization. Posler advised many student groups, including the Wheat State Agronomy Club and the Student Activities Subdivision of ASA. He coached the K-State Collegiate Crops and NACTA Crops teams, several of which won national championships. He served as President of the National Association of Colleges and Teachers of Agriculture (NACTA) in 1991 and 1992.

David B. Mengel
1998–2005

Dave Mengel (1948–) was raised in the country near Crown Point, Indiana. He received his B.S. in Ag Education in 1970 and M.S. in Agronomy in 1972 from Purdue University, and a Ph.D. in Soil Science from North Carolina State University in 1975. Before serving as Department Head, Mengel worked at the LSU Rice Experiment Station from 1975 to 1979, and at Purdue University from 1979 to 1998.

Mengel is an active member of the American Society of Agronomy and Soil Science Society of America. A strong supporter of the Certified Crop Advisor (CCA) program and the practicing agronomist's role in ASA, Mengel was actively involved in the creation of Division A-9, Professional Practitioners.

Mengel has received several awards, including the National Fertilizer Solutions Association Honorary Member Award in 1985, ASA Agronomic Achievement Award-Soils in 1992, The Wagner Award from the Potash and Phosphate Institute in 2002, and the Extension Education Award in 2003. He was elected Fellow of ASA and SSSA in 1997.

Adapted from Kansas Agricultural Experiment Station Contribution no. 02-156-D.

Campus aerial view, circa 1936.

Overview of the Agronomy Department 1906–2006

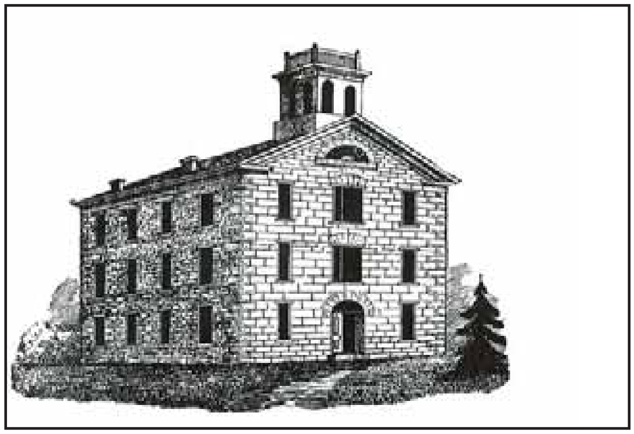
Gerry L. Posler, Gary M. Paulsen, and Floyd W. Smith

The Department of Agronomy was established by action of the Kansas Board of Regents in July 1906 when it was "Moved by Regent Nichols that the name of the Agriculture Department" be changed to Agronomy. Carried." (Board of Regents Minutes, July 17, 1906, page 568).

But "agronomy" was an important part of the research and teaching mission of the University for many years before establishment of the department. E. M. Shelton, Professor of Practical Agriculture from 1874-1889, conducted experiments with alfalfa, cowpeas, and tame grasses and published results in the *Industrialist*. His office was in the southeast room of the second floor of the original Bluemont College building. Shelton resigned at the end of 1889 to go to Australia and eventually was head of the agricultural college at Brisbane.

The first appropriation from the 1887 Hatch Act was made to the university in 1888, and the first AES Annual Report was published in 1888. In a subsequent annual report of the Kansas Agricultural Experiment Station, 67 publications, written between 1888 and 1905, are identified as belonging to "Agronomy" even though the department was not so designated. In addition, several of the earliest Kansas Agricultural Experiment Station bulletins concerned agronomic research, including work done by faculty in the Botany, Chemical, and Agricultural Departments (Table 1).

In June 1902, work in the Farm Department included Agronomy and Animal Husbandry. In September 1902, A. M. Ten Eyck was selected Professor of Agriculture at a salary of $2,100/year, effective December l, 1902. In September 1902, the Agricultural Department was divided into Agronomy, Animal Science, and Dairy. In October 1902, the Agricultural Department included agronomy, zootechny, agrotechny, rural engineering, and rural economy. In June 1904, the Board of Regents … "voted that Soil Physics be carried out in the Farm Department and that Soil Chemistry be carried out in the Chemical Department;" and in March 1905, the *Student Herald* reported "that a new Soil Physics Lab in the Farm Department is nearly finished at a cost of about $2,000." These examples show that change occurred very often in Agriculture and throughout the small university with the hiring and resignations of faculty and changes in the Board of Regents and Legislature.



Bluemont Hall.

1906–1910

Ten Eyck was the first head of the Agronomy Department, having previously been head of the Agricultural Department, and he continued as head of the new department until 1910. He was also elected President of the American Society of Agronomy in 1910, only three years after its founding in 1907.

The new department was small. In 1906, it included Ten Eyck and two assistant agronomists—one each for crops and soils. The crops assistant was Vernon M. Shoesmith and the soils assistant was Henry D. Scudder. The assistant position for soils became vacant during the year when Scudder left to become head of Agronomy at Oregon State University. President Nichols offered the vacancy to Leland E. Call, a recent graduate of Ohio State University, and Call joined the department January 1, 1907, beginning a distinguished career that continued for half a century, including Department Head of Agronomy from 1913-1925 and Dean of Agriculture from 1925 to 1946.

The first AES bulletin published by a member of the new Agronomy Department was B-139, The Study of Corn, by V. M. Shoesmith, in 1906.

Changes in faculty were frequent during the early years as people moved to other locations and took leave for further education. In 1907, the faculty included Ten Eyck, Call, and Edwin G. Schafer, and in 1909 it included Ten Eyck; Call; two Assistants in Agronomy, Charles. S. Knight and Schafer; and Farm Foreman Floyd Howard.

Call brought a new kind of expertise to the department--that concerned with physical properties of soil and related concerns pertaining to moisture storage and retention and to proper tillage methods of Kansas soils. During the winter, Call taught crop production to short-course students. He also taught a class in soil physics, developed other soils courses, and arranged for a modern soils laboratory.

Ten Eyck did much to improve relationships of Kansas State Agricultural College with the farmers of the state. In effect, he developed an extension program to disseminate agronomic information through the press and via "Farm Institutes." He published an overview, "Agronomy at Kansas State Agricultural College" in the May 25, 1907, *Industrialist*, stating that "Agronomy includes four general lines of study: soils, crops, farm management, and farm mechanics." He also noted that "Agriculture is a business; it is not truly a science, but it depends on science, and to understand the principles of agriculture requires a knowledge of many sciences … including physics, botany, chemistry, geology …"

In March 1908, the Kansas Board of Regents

> *"Resolved that in the matter of farm machinery, the principles and construction side of it shall pertain exclusively to the Engineering Department, while the use or application of the same shall be taught by the Agronomy Department."*

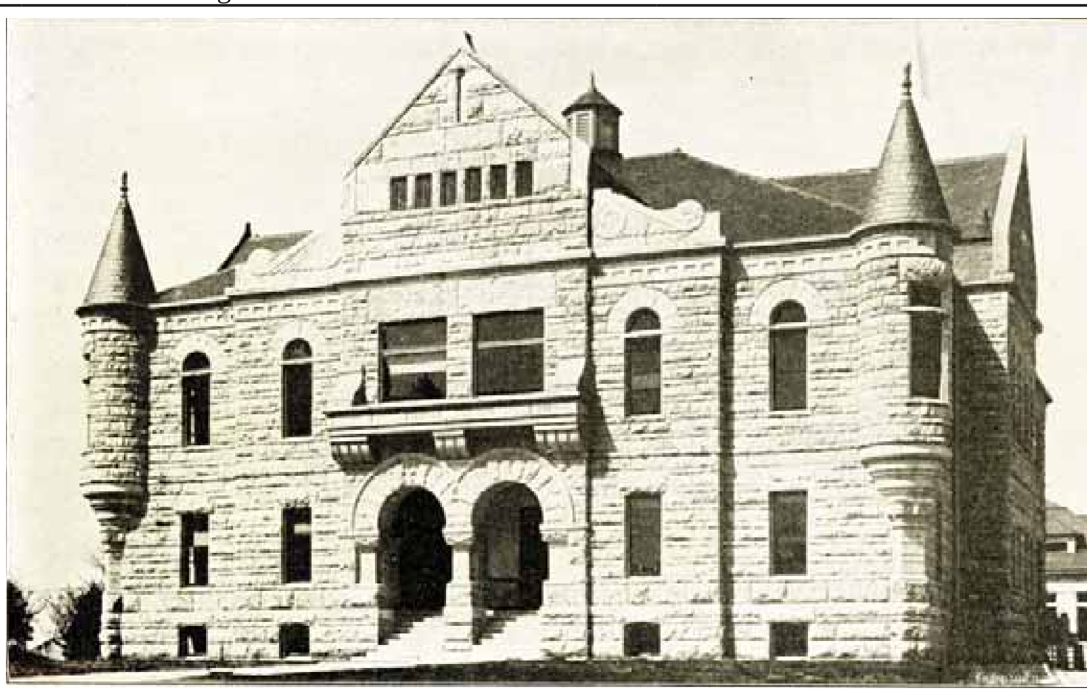
In 1909, a 320-acre farm was purchased, most of which is still used by the department (Agronomy North Farm). Ten Eyck and Call had three assistants, Charles Doryland in soils (1909–1910), Clarence W. Nash in crops (1909–1910), and Schafer (1907–1913), plus Carl F. Chase in farm mechanics and Howard as farm foreman (1910–1912).

Ten Eyck, although popular with many farmers of the state, did not enjoy a particularly favorable reputation as a campus scholar. Effective June 1, 1910, he was reassigned as professor of farm management in the Kansas State Agricultural College and Superintendent of the Fort Hays Branch Experiment Station. He never performed in the farm management position.

Professor Albert M. Ten Eyck with Crop Variety display, probably at the Kansas State Fair, circa 1908.

Table 1. Early "Agronomy" bulletins published by the Kansas Agricultural Experiment Station.

KAES #	Year	Title	Authors
B-2	1888	Experience with Cultivated Grasses and Clovers in Kansas.	E. M. Shelton
B-4	1888	Experiments with Wheat.	E. M. Shelton
B-5	1888	Sorghum and Sorghum Blight.	J. T. Willard (Chemical Dept.) and W. A. Kellerman and W. T. Swingle (Botanical Dept.)
B-7	1889	Experiments with Wheat.	E. M. Shelton
B-13	1890	Experiments with Oats.	C. C. Georgeson, H. M. Cottrell, and Wm. Shelton
B-16	1890	Experiments with Sorghum and Sugar Beets.	G. H. Failyer and J. T. Willard (Chemical Dept.)
B-25.	1891	Sorghum for Sugar.	G. H. Failyer and J. T. Willard
B-27	1891	Crossed Varieties of Corn.	W. A. Kellerman (Botanical Dept.) and C. H. Thompson
B-30	1891	Experiments with Corn.	C. C. Georgeson, F. C. Burtis and Wm. Shelton
B-50	1895	Kansas Weeds I. Seedlings.	A. S. Hitchcock and J. B. S. Norton (Botanical Dept.)
B-52	1895	Kansas Weeds II. Distribution.	A. S. Hitchcock and J. B. S. Norton (Botanical Dept.)
B-57	1896	Kansas Weeds III. Descriptive List.	A. S. Hitchcock and J. B. S. Norton (Botanical Dept.)
B-66	1897	Kansas Weeds IV. Fruits and Seeds.	A. S. Hitchcock and J. B. S. Norton (Botanical Dept.)
B-92	1900	A New Drouth-Resisting Crop: Soybeans.	H. M. Cottrell, et al.
B-93	1900	Kafir-Corn.	H. M. Cottrell, et al.
B-102	1901	Forage Plants for Kansas.	A. S. Hitchcock and J. M. Westgate (Botanical Dept.)
B-107	1902	Analysis of [Indian] Corn with Reference to its Improvement.	J. T. Willard, et al. (Chemical Dept.)
B-114	1902	Growing Alfalfa in Kansas.	H. M. Cottrell



Agricultural Hall.

1910–1920

William M. Jardine, a graduate of the Utah Agricultural College, was appointed professor and Head of the Agronomy Department, effective July 15, 1910, at an annual salary of $2,750 per year. He was thoroughly acquainted with dryland agriculture, having spent three years as assistant cerealist with the Bureau of Plant Industry, United States Department of Agriculture. Jardine served as department head less than three years because he advanced to the position of Dean and Director in early 1913. Call was then appointed Agronomy Department Head.

There were no AES Annual Reports from 1909–1912. The 22nd Report in 1912–13 noted that Agriculture now consisted of 12 departments, plus Branch Stations at Fort Hays, Garden City, Colby, Dodge City, and Tribune. The east wing of Waters Hall was completed in 1913 and housed the departments of Agronomy, Animal Husbandry, Dairy Husbandry, Milling Science, and Poultry Science.

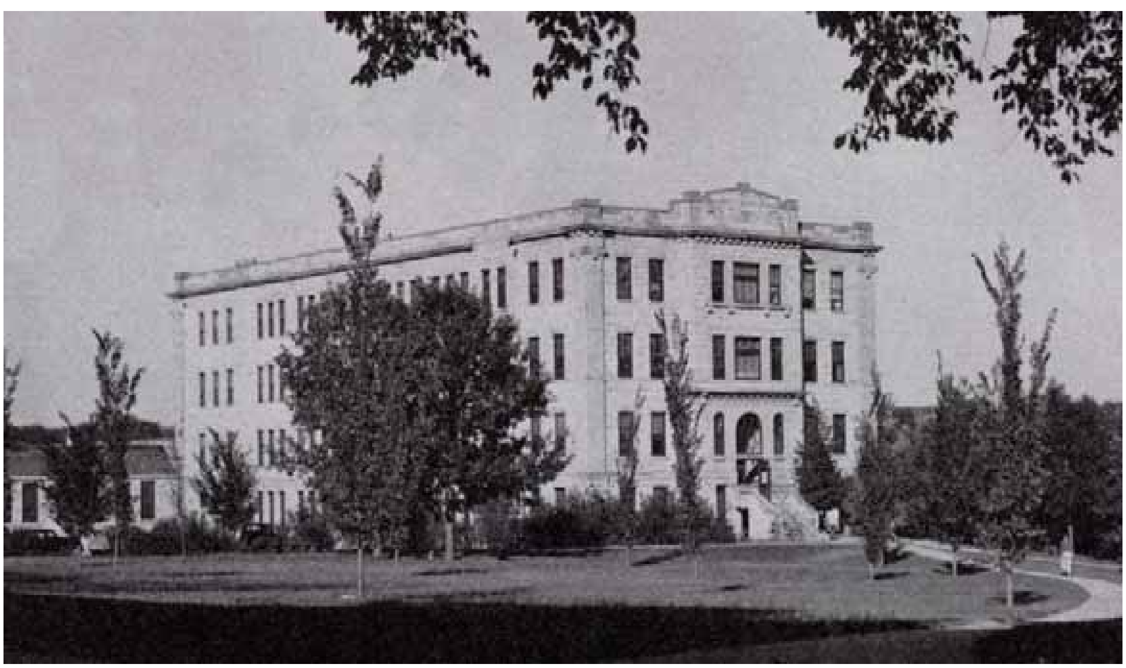
In 1913, the faculty numbered eleven persons: Call, Head; Hilmer H. Laude (1912–1914), S. Cecil Salmon, and Arthur H. Leidigh (1911–1913), crops; Claude C. Cunningham (who transferred from Hays) and Bruce S. Wilson, cooperative experiments; Ray I. Throckmorton and Charles E. Millar, soils; Ralph Kenny and Robert K. Bonnett, crops, and W.E. Grimes, Farm Superintendent.

Research projects included soil fertility, seedbed preparation for wheat, crop experiments, rust resistance in wheat, alfalfa breeding, and physiological investigations of drought-resistant plants (corn, milo, kafir, etc.). Some crop breeding, weed science, and pure seed control was in the Botany Department and some work in soil chemistry was in the Chemistry Department.

Hires

In addition to Call, many other faculty were appointed during these early years, and several made significant long-term contributions to Agronomy.

- Bruce S. Wilson, farm foreman (1910–1912), cooperative experiments (1913), Kansas Crop Improvement Association (KCIA) Sec-Treas. (1914–1920) .
- Harry J.C. Umberger, extension soils (1911–1912).
- Joe G. Lill, soils (1911–1913).
- Ray I. Throckmorton, soils (1911), later became department head in 1926 and Dean and Director from 1946–1952. He is the namesake for Throckmorton Hall.
- Charles E. Millar, soils (1911), later became head of the Soils Department, Michigan State University.
- P.E. Crabtree, extension area crops and soils (1912).
- Robert K. Bonnett, crops (1913), moved to University of Idaho in 1918.



East Waters Hall.

- S. Cecil Salmon, crops (1913), KCIA Sec-Treas. (1921-1924), later became a widely recognized leader in USDA crops research.
- Claude C. Cunningham, cooperative experiments (1912).
- Ralph Kenny, crops and extension crops (1914).
- Harley J. Bowers, extension soils (1914).
- Alfred L. (Al) Clapp, agronomy farm superintendent (1915), later served as leader of cooperative experiments and KCIA Sec-Treas. (1935–1945).
- James W. Zahnley, crops (1915).
- Malcom C. Sewell, soils (1915).
- R. Page Bledsoe, crops (1913–1915).
- W.E. Grimes, farm superintendent (1913), became assistant professor of farm management (1915), later served as a member of the newly developed Agricultural Economics Department (1919), and head of the Department of Economics and Sociology.
- J.W. Crumbaker, farm foreman (1916–1917).
- G.E. Thompson, extension crops (1916).
- John H. Parker, crops (1917) was the first crop breeder in the Department of Agronomy, later became one of the most widely recognized scholars of his era at Kansas State College and an outstanding wheat breeder.
- George H. Phinney, farm foreman (1917).
- Elizabeth Harling, seed analyst (1917) (from Botany).
- Clyde W. Mullen, crops (1918), served as Principal (Assistant Dean) of Agriculture for academic programs from 1939–1962.
- Rudolph. L. Hensel, pasture management (1919).
- A.C. McClymonds, extension crops (1919).
- Hilmer H. Laude, crops, (1920) returned after further studies and became a recognized leader in crop ecology and utilization of statistics.

Accomplishments

1) Release of 'Kanred' wheat by H. Fuller Roberts through the Botany Department.
2) Technical wheat breeding was begun in 1917 (the first crop breeder in Agronomy).
3) Recognition of fertility needs for the Kansas wheat crop, including recommending phosphate fertilizers in the three eastern tiers of counties.
4) Increased emphasis on alfalfa production and developing better varieties.
5) Significant involvement with cooperative experiments—more than 500 total experiments per year conducted in 90 or more counties.

1920–1930

Substantial progress in the development of the Department occurred during this decade.

Hires

- Earnest B. Wells, extension soils (1920), KCIA Sec-Treas. (1928–1934).
- Albert J. Schoth, extension crops (1921).
- Luther E. Willoughby, extension crops (1920).
- Charles D. Davis, crops (1921).
- Jasper J. Bayles, crops (1921–1922).
- Harlan R. Sumner, extension crops (1923).
- Ira K. Landon, SEK Experiment Fields (1923).
- Ross J. Silkett, cooperative experiments (1923).
- Charles R. Enlow, cooperative experiments (1924).
- Frank L. Duley, soil fertility (1925), president of Soil Science Society of America (SSSA) in 1947.
- Alfred E. Aldous (1926), pasture management investigations.
- Arthur M. Brunson, USDA corn breeding (1926).
- Earl H. Teagarden, extension crops (1926–1928).
- Clarence O. Grandfield, USDA alfalfa breeding (1927).
- Raymond H. Davis, soil survey (1927–1929).
- Carl W. Bower, USDA corn investigations (1928).
- Harold E. Myers, soils (1929), later served as Department Head and Associate Director of the Agricultural Experiment Station at K-State and Dean of the College of Agriculture at the University of Arizona.
- Clarence E. Crews, farm superintendent (1928–32), SCK Experiment Fields (1932–1938).
- Francis L. Timmons, cooperative experiments (1929), extension crops (1934) later served many years with USDA at Hays working on bind weed control.
- Ralph O. Lewis, soil survey (1929).

Accomplishments

1) The first experiment fields were established in 1923 at five locations in southeast Kansas.
2) In 1937, two sections of greenhouses, 29 x 100 feet, plus a headhouse, 20 x 126 feet, were authorized by the Kansas Board of Regents.

3) Corn breeding research made significant advancements during this period. In 1927, the high-yielding selection 'Pride of Saline' corn demonstrated appreciable advantage over the original composite selection composing this variety. By 1928, corn hybrids were very promising. In a test of 19 hybrids, six yielded more than 85 bushels per acre, while among the 31 open-pollinated varieties in the same test, only two yielded as much as 75 to 80 bushels per acre and none was above 80.
4) Sorghums became increasingly popular. As early as 1923, 'Kansas Orange' yielded as much as 105 bushels per acre, and a kafir x feterita hybrid yielded 97 bushels per acre.
5) A very significant forage sorghum, 'Atlas' sorgo, a cross of Blackhull kafir x Sourless, was released to farmers.
6) An unusual, but interesting, report, "Cotton in Kansas" was delivered by H. H. Laude at the 1925 annual meetings of the Kansas State Board of Agriculture.
7) Soil survey progress was noteworthy. Completed surveys increased from three counties in 1925 to 11 counties in 1928. A state appropriation of $5,000 assisted this acceleration.
8) Although some had been held in earlier years, annual Agronomy Field Days were begun in 1925.

1930–1940

This decade is recalled by many as one of depression, drought, dust storms, and despair. Despite the many frustrations resulting from the extremely dry weather and extreme economic depression, many significant agronomic advances were achieved.

In the 1930-32 Annual Report, it was reported "The problem of soil conservation continued to receive careful consideration … no problem is of greater fundamental importance … began the use of small terraces on plots to control erosion."

Personnel changes were many. Generally there were more resignations than replacements, due to the depression. In 1930, the faculty consisted of 12 members: Throckmorton, Head; Aldous, pasture management; Salmon, crops; Parker, plant breeding; Laude, cooperative experiments; Sewell, soils; Zahnley, crops; Meyers, soils; Timmons, cooperative experiments; Landon, experiment fields; and Lewis, soil survey.

Hires

- Eugene A. (Gene) Cleavinger, extension crops and soils (1931), extension crops (1935).
- Fulton G. Ackerman, farm foreman (1932), later moved to Hays Branch Station.
- William H. Metzger, soil survey (1932).
- Floyd E. Davidson, SEK Experiment Fields (1934), later moved to SEK Branch Station.
- John R. Latta, farm foreman (1934–1935).
- Frank G. Parsons, cooperative experiments (1935).
- John C. Hide, soils (1935).
- Lawrence L. Compton, extension agronomy (1935), KCIA Sec-Treas. (1946–1953).
- Andrew B. (Andy) Erhart, SWK Experiment Fields (1936), later served as Superintendent of Garden City Branch Station for many years.
- Kling L. Anderson, pasture improvement (1936).
- Hilton D. Hollembeak, cooperative experiments (1936).
- John G. Bell, extension crops (1937).
- Elmer G. Heyne, USDA cereal breeding (1938), wheat breeding (1947).
- Robert F. Sloan, pasture improvement (1938), NCK Experiment Field (1942), Corn Belt Experiment Field (1963).
- Robert W. Jugenheimer, USDA corn breeding (1938).
- Clare R. Porter, SCK Experiment Fields (1938).
- Elva Norris, seed analyst (1938).
- Louis P. Reitz, wheat breeder (1938).

Accomplishments

1) In 1931, the name of the university was changed from Kansas State Agricultural College to Kansas State College of Agriculture and Applied Sciences.
2) The 1931 Kansas Legislature authorized $6,000 per annum for South Central Kansas Experiment Fields (Wichita, Kingman, and Pratt) and $10,000 for establishment of five such fields in northeastern Kansas. Because of economic conditions, these amounts were reduced to $4,500 and $7,500, respectively, during the biennium. The 1935 legislature established a Southwest Kansas Experiment Field in Meade County.
3) Soil surveys had progressed to point of comple-

tion in 23 counties, but due to lack of funds, this effort was suspended.

4) 'Kawvale' and 'Tenmarq' wheat varieties were released in 1932.

5) Pasture management research had expanded considerably, including studies on management of livestock on bluestem pastures, effects of burning native grass pastures, eradication of undesirable plants from pastures, harvesting practices for prairie hay, and fertilizers for native grass.

6) KAES Technical Bulletin 43, *Nitrogen–The Major Cause in the Production of Spotted Wheat Fields,* was published in 1937, paving the way for nitrogen recommendations offered almost immediately after World War II.

1940–1950

Although World War II dominated the first half of this decade, starting in 1946, many new faculty were hired. During World War II, several faculty were on leave of absence, including:

Donald E. Crumbaker
Hilton D. Hollembeak
H. E. Meyers
Hugh G. Myers (killed in action 11/21/46)
Ralph Krenzin
Robert Sloan

Hires

Several new faculty hired during this time contributed significantly to agronomy and KSAC for many years, including:

- Don E. Crumbaker, bindweed experiment field (1942).
- T. Russell Reitz, extension soil conservation (1942).
- Reuben C. Lind, extension soil conservation (1943).
- Louis B. Olmstead, USDA soil physics (1944).
- Milburne C. Axelton, NCK Experiment Field (1944), SWK Experiment Field (1946).
- Walter A. (Walt) Moore, Hutchinson Experiment Field (1944).
- Carl B. Overley, foundation seed program (1946).
- Loyd A. Tatum, USDA corn breeding (1946).
- Frank G. Bieberly, extension agronomy (1946), first extension agronomy state leader (1965–1977).
- Harold E. Jones, extension soils (1946) and (1968), was Director of Extension from 1956 to 1968.
- Victor F. Burns, bindweed experiment field (1946).
- Dale E. Weibel, USDA corn breeding (1947).
- Raymond V. (Ray) Olson, soils (1947), later served as Department Head, Director of International Programs, and Chief of Party at Amadu Bello University in Nigeria.
- Vernon W. Woestmeyer, bindweed experiment field (1947).
- Alice Hartley, seed analyst (1948).
- Ernest L. Mader, crops teaching (1948).
- Floyd W. Smith, soil fertility (1948), later served as Interim Department Head, Director of AES, Acting Vice President for Agriculture, Executive Director of Mid-America International Agricultural Consortium (MIAC), and Director of the Kansas Water Resources Research Institute (KWRRI).
- Harold B. Harper, extension soil conservation (1948).
- Roscoe Ellis, Jr., soil chemistry (1948), became a nationally recognized soil chemist and Editor-in-Chief of SSSA Journal.
- William S. Chepil, USDA Wind Erosion Lab (1948).
- C. Harry Atkinson, USDA soil survey (1949).
- Orville W. Bidwell, soils classification and morphology (1949).
- Oliver G. Russ, Newton Experiment Field (1949), bindweed experiment field (1951), weed science (1965).
- Neal P. Woodruff, USDA Wind Erosion Lab (1949).
- Robert C. Pickett, sorghum breeding (1949).

Accomplishments

1) Many years of intensive corn breeding effort paid off with development and release of high-yielding yellow and white hybrids for commercial adaptation. Agronomy Department hybrids generally were superior to commercial offerings. One white hybrid, K 2234, was especially noteworthy. Each of the parents involved in the double cross hybrid was derived from the 'Pride of Saline' variety.

2) New wheat varieties, 'Pawnee', 'Comanche', and 'Wichita', replaced virtually all previous ones.

3) 'Buffalo' (1945), a new alfalfa variety, provided resistance to bacterial wilt.

4) Oat breeding produced numerous new varieties—some good and some disappointing. 'Osage' and 'Neosho' were released in 1945. Two years later it was realized that these were susceptible to Victoria blight. Fortunately 'Nemaha' and 'Cherokee' had progressed rapidly, and release of these two varieties in 1948 rescued the oat crop.
5) Fertilizer use increased rapidly, especially synthetic nitrogen. In a matter of a few years, fertilizer usage increased more than six-fold.
6) The Soil Conservation curriculum was created in 1945 to prepare graduates to become employees of the newly created Soil Conservation Service (SCS).
7) The first crosses with semi-dwarf varieties were made in 1949 by E.G. Heyne, an effort that would produce major dividends several years later.

1950–1960

Olson became Department Head in 1952 and served until 1970. Retirement of several veteran professors and continued program expansion resulted in several new faculty hires, including:

- James A. (Art) Hobbs, soil conservation (1950).
- Verlin H. Peterson, SEK Experiment Field (1950), extension crops and soils (SE) (1965), extension crops (1971), extension state leader (1977–1984) .
- Arland W. Pauli, crop physiology (1951).
- Frank E. Lowry, Sandyland Experiment Field (1952).
- J. Eddie Braum, ECK Experiment Field (1952).
- George W. Wright, soil testing laboratory (1953).
- Warren Rasmussen, NCK Experiment Field (1953).
- Jake Ubel, (1953).
- L. Van Withee, soil management (1953), the first Assistant Head for Teaching (1971–1982).
- Robert A. (Bob) Bohannon, extension soils (1953) and (1976), served as Director of Extension (1968–1976).
- Jack Casady, USDA sorghum breeding (1954).
- Clyde E. Wassom, Corn Belt Experiment Field (1954), corn breeding (1962).
- Clarence W. Swallow, farm manager (1954).
- Howard D. Wilkens, crops teaching and extension (1954).
- Laurel E. Anderson, weed science (1954).
- Fred C. Stickler, crop ecology (1954).
- Wayne L. Fowler, KCIA Sec-Treas. (1954–1965).
- Carroll Webster, seed analyst (1955).
- Edgar L. (Ted) Sorensen, USDA alfalfa breeding (1955).
- William R. Findley, USDA corn breeding (1955).
- Dale H. Edelblute, area agronomist (SW) (1955).
- Glenn Hardy, extension soil testing (1955).
- Francis L. (Frank) Barnett, grass breeding (1956).
- Marvin C. Lundquist, Sandyland Experiment Field (1956), Minneola Experiment Field (1975), Corn Belt Experiment Field (1982).
- Robert S. (Bob) Raney, NCK Experiment Field (1956).
- Val W. Woodward, genetics (1956).
- John Hanks, USDA soil physics (1957).
- Hyde S. Jacobs, soil physics (1957), Department Head (1971–1980), later was assistant director for Coopertive Extension Service Agricultural and Natural Resources Programs and assistant to Dean Walter Woods.
- Leonard B. Hertz, Corn Belt Experiment Field (1957).
- Francis H. Siddoway, USDA Wind Erosion Lab (1958).
- Thad H. Pittenger, genetics (1959).

On March 13, 1951, the Kansas Board of Regents authorized Kansas State Agricultural College to offer graduate work leading to the Ph.D. degree in Agronomy, effective June 1, 1951, increasing the number of fields offering the Ph.D. at K-State to 12. In 1952, the Agronomy Department began offering the Ph.D. in Soils, and added 11 new courses to support that program.

Accomplishments

1) A USDA soil physicist (John Hanks) was assigned to the Agronomy Department, paving the way for establishment of highly sophisticated soil physics research program.
2) Fertilizer research expanded at a rapid pace, primarily as sponsored projects supported by fertilizer trade associations and national manufacturers of fertilizers.
3) Accompanying the enormous interest in fertilizer usage was a related interest in soil testing. Soil testing laboratories were developed in 60

counties, in addition to two state laboratories at Manhattan and Garden City.

4) Sorghum breeders developed shorter combine varieties that were rapidly adopted, but commercial hybrids replaced most of these varieties before 1960.
5) Four new experiment fields (Sandyland, East Central Kansas, Corn Belt, and Irrigation) were authorized during the 1950s.
6) A technical agronomy curriculum was adopted in 1953 to enhance the education of undergraduates receiving B.S. degrees. This paid some interesting dividends in the middle and latter part of the decade, when agronomy graduates encountered considerable difficulty finding employment. At least four students pursuing this kind of training entered medical schools and became successful practitioners. Many others gained quick acceptance in various scientific disciplines.
7) The Soils Judging Team was begun in 1958 by O. W. Bidwell as coach (1958–1984).
8) In 1959, the university name was changed to Kansas State University.
9) ‘Cody’ (1959) alfalfa was released, providing spotted alfalfa aphid resistance.

1960–1970

This decade saw the Agronomy Department receive major recognition for its many years of scholarly contribution to Kansas State University, to the State of Kansas, and to the United States.

Kansas State University celebrated its centennial anniversary at a gala assembly on February 16, 1963. Agronomy was prominent in this event and during the year as additional recognitions were accorded, including the following:

Three of eight special distinguished service awards were given to agronomists:

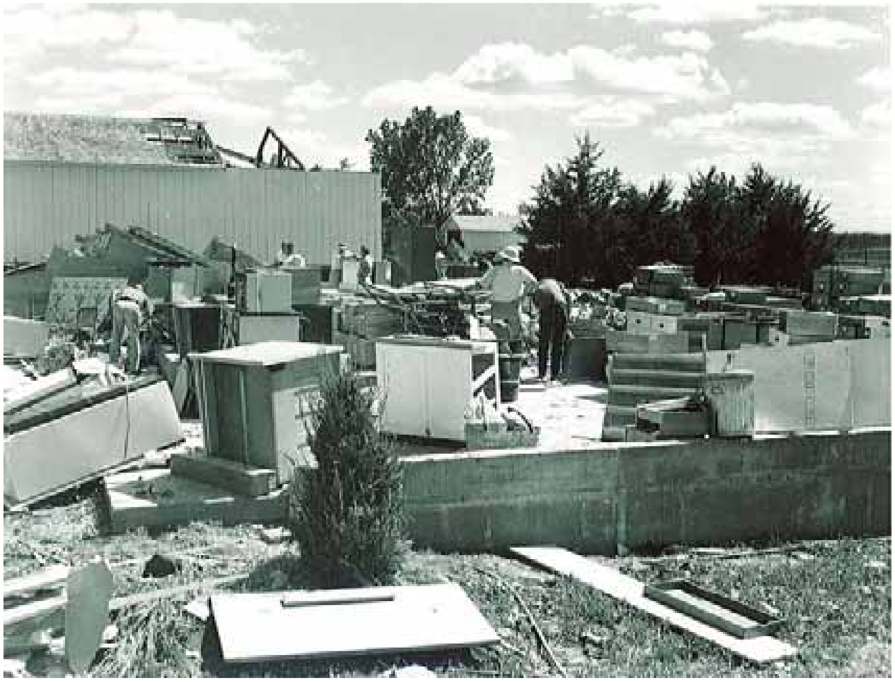
- F.D. Farrell, charter member of the American Society of Agronomy and President Emeritus, Kansas State University.
- L.E. Call, past president of the American Society of Agronomy, Dean and Director Emeritus, and former department head.
- R.I. Throckmorton, past president of the American Society of Agronomy, Dean and Director Emeritus, and former department head.

K-State's Agronomy Department was actively involved in basic genetics research at this time, and played a prominent role in hosting several of the centennial special lecturers.

Fire in East Waters Hall, 1957

On August 25, 1957, a fire destroyed the milling wing of East Waters Hall and severely damaged the third floor east wing housing the Department of Agronomy. Several faculty lost all their office possessions, including John Hanks, Carl Overley, Al Clapp, and Orville Bidwell. Elmer Heyne and Ernest Mader also had serious losses. Many faculty were relocated during repairs and reoccupied the renovated space in July 1960 and early 1961.

Tornado at the Agronomy Farm, 1966



A 1966 tornado destroyed a number of buildings at the Agronomy Farm.

The president of the centennial faculty senate was Withee. K-State's Agronomy Department ranked number one during 1963. Olson, Agronomy Department Head, was chosen as the first chief of party for the Nigerian agricultural and veterinary medicine development project during 1964 to 1966, and F.W. Smith and R.A. Bohannon served as Interim Heads during this time.

Hires

- Ted L. Walter, crop performance testing (1960).
- Jack V. Baird, extension crops (1961).
- Kenneth W. Snelling, Corn Belt Experiment Field (1961).
- Robert E. Morin, NCK Experiment Field (1961).
- George W. Wright, extension soil testing (1961).
- Edward L. Skidmore, USDA Wind Erosion Lab (1963).
- George H. L. Liang, genetics (1964).
- Donald H. Sander, extension area agronomist, extension soil fertility (1964).
- James E. Congrove, NCK Experiment Field (1964).
- Richard L. Vanderlip, crop ecology (1964).
- Clenton E. Owensby, range science (1964).
- Lowell A. Burchett, NCK Experiment Field (1965), Exec. Director of KCIA (1973–1998).
- Donald M. (Don) Gronau, Newton Experiment Field (1965).
- Donald H. Sander, extension soils (1965).
- Gary M. Paulsen, crop physiology (1965).
- Larry S. Murphy, soil fertility (1965).
- Erick B. Nilson, extension weed science (1965).
- Kurt C. Feltner, weed science (1965).
- William L. (Bill) Powers, soil physics (1966).
- David A. (Dave) Whitney, extension soil fertility (1966), extension state agronomy leader (1985–2000).
- Eddie Beason, area agronomist (1966).
- Robert M. (Bob) Hyde, extension forages (1966).
- Dean D. Dicken, area agronomist (NE) (1967).
- Leslie W. Tobin, extension soils (1967).
- Guy E. Wilkinson, international agronomy (1967).
- Clifford N. (Cliff) Gruver, ECK Experiment Field (1967).
- Gerald O. McMaster, area agronomist (SE) (1967).
- Cecil D. Nickell, soybean breeding (1968).
- Kenneth L. Failes, Newton Experiment Field (1968).

- Leon Lyles, USDA Wind Erosion Lab (1968).
- Iwan D. Teare, Evapotranspiration Lab (1969).
- Edward T. (Ed) Kanamasu, ET Lab (1969).
- Donald J. Boone, NCK and SWK experiment fields (1969).
- John F. Vesecky, weed science (1969).
- Steven J. (Steve) Thien, soils teaching (1970).
- Neil E. Humburg, KS River Valley Experiment Field (1970), Newton Experiment Field (1974).

Accomplishments

Significant accomplishments, facilities expansion, and program enhancements included:

1) Two agronomy experiment fields were added: Sandyland irrigation field near St. John and the Kansas River Valley irrigation field at Rossville and Silver Lake.
2) Extension agronomy faculty were relocated from Umberger Hall to Waters Hall in 1963 to better facilitate interaction with agronomy research and teaching faculty
3) Congressional appropriation and Kansas Board of Regents action assigned leadership of the Kansas Water Resources Research Institute (KWRRI) to Kansas State University in 1964. Soil scientists have served as directors of this institute during its entire history.
4) The 1968 Kansas Legislature authorized the establishment of the Evapotranspiration Laboratory, and provided three new research scientist positions. Faculty who made vital contributions included Jacobs, Kanamasu, Powers, Stone, Kirkham, and Teare.
5) During the late 1960s, physiological and crop breeding efforts were initiated to develop adapted hard white wheat varieties.
6) Although some work had been done previously, the modern soybean breeding program was initiated with the hiring of Nickell.
7) In 1960, the Agronomy curriculum contained options in Applied Agronomy and Soil Conservation, Soil Science, and Crop Science. In 1964, options were Business and Industry, Science, and Production, and a Service option was added in 1968. An interdisciplinary option, Natural Resources Conservation and Use was begun in 1966 with options in Soil and Water Conservation, and Conservation of Recreational Areas.

1970–1980

During this decade, an important focus for the department became energy issues, including research studies related to reduced tillage, nitrogen use efficiency and recovery from fertilizers, possible conversion of sugars from sweet sorghum to alcohol for fuel, and conservation of irrigation water.

In 1970–71, Bidwell served as Interim Head and Chair of the search committee that resulted in the hiring of Hyde S. Jacobs, who served as Agronomy Department Head, 1971–1980. Jacobs later served as Assistant Director of the Cooperative Extension Service for Agriculture and Natural Resource Programs, and then as Assistant to Dean Walter Woods.

Hires

- James H. Stigler, extension soil survey/soil and water conservation (1971).
- Gary L. Kilgore, extension crops and soils (SE) (1972).
- Stanley W. (Stan) Ehler, crops teaching (1972).
- Loyd R. Stone, soil physics (1973).
- Charles W. (Charlie) Knight, ECK Experiment Field (1973).
- Robert F. (Bob) Nuttleman, extension crops and soils (SC) (1973).
- R. Hunter Follett, extension soils (1974).
- Gerry L. Posler, forage research and teaching (1974), served as assistant head for teaching and Department Head.
- Leslie R. (Les) Reinhardt, extension crops and soils (NW), crops and weed science (1973).
- Paul D. (Ole) Ohlenbusch, extension range (1975).
- Larry D. Maddux, Kansas River Valley Experiment Field (1975).
- Phil R. Rahn, Sandyland Experiment Field (1975).
- Phil W. Stahlman, Hesston Experiment Field (1975).
- Loren R. Moshier, weed science (1977).
- Quentin Kingsley, ECK Experiment Field (1977).
- Mark M. Claassen, Corn Belt Experiment Field (1977), Hesston Experiment Field (1982).
- Joseph P. (Joe) O' Connor, Hesston Experiment Field (1977) .
- James D. (Jim) Ball, Sandyland Experiment Field (1977).
- Larry C. Bonczkowski, extension crop protection (NE) (1977) .

- Walter R. (Walt) Fick, range ecology (1978), extension range management (2003).
- Merrel E. Mikesell, extension crops and soils (NW) (1978).
- William T. Schapaugh Jr., soybean breeding (1979).
- Keith A. Janssen, ECK Experiment Field (1979), soil conservation research and extension (2004).
- Rollin G. (Rollie) Sears, wheat breeding (1980).
- David E. (Dave) Kissel, soil fertility (1980).
- Mary Beth Kirkham, crop physiology (ET Lab) (1980).
- James P. (Jim) Shroyer, extension crops (1980).
- George E. Ham, Department Head (1980).
- James A. (Jim) Schaffer, extension crops and soils (SW) (1980).

Accomplishments

1) Release of 'Kanza' alfalfa (1970), plus several germplasms with improved multiple-pest resistance.
2) In 1977, 'Newton' wheat, the first public semidwarf cultivar released in Kansas, had major impact on the wheat industry throughout the Great Plains.
3) A significant publication, *Kansas Rangelands: Their Management Based on a Half Century of Research* (1978), was very well received by clientele in the forage-livestock industry.
4) Waste disposal became a concern, and important research was conducted to evaluate application on agricultural lands.

Throckmorton Phase I Groundbreaking, May 20, 1978

After efforts over a period of many years, legislative approval and funding were obtained for Throckmorton Hall Phase I. Participants included Governor Robert F. Bennett, K-State President Duane Acker, and Throckmorton family members.

5) Resources were reallocated to address higher-priority concerns, including control of southwestern corn borer, control of alfalfa weevil, feasibility of developing hard white winter wheat, near-infrared (NIR) protein analysis of wheat, and biological control of musk thistle.
6) In 1972, the Natural Resource Conservation and Use curriculum was renamed Natural Resource Management (NRM), and the Range Management option replaced Economics of Conservation in 1974. A Communications option was added to Agronomy in 1973 and dropped in 1982.

1980–1990

In 1980, George E. Ham was named Department Head of Agronomy, serving until 1989, when he became Associate Dean and Associate Director of the Agricultural Experiment Station (AES) from 1989 to 2001. During 2003–04, he returned from retirement to serve one year as Interim Dean of Agriculture and Director of AES and Cooperative Extension (CES).

During his tenure as Agronomy Department Head, he provided leadership for many significant changes that enhanced the status of the department. A major enhancement for the agronomy program was the completion and dedication of Throckmorton Hall Phase I in 1981 to house the departments of Agronomy and Plant Pathology. The additional quality and quantity of space greatly enhanced the teaching and research programs. Graduate student numbers increased markedly, particularly at the Ph.D. level. The new greenhouse facilities greatly benefited the wheat, alfalfa, corn, and sorghum breeding programs.

Through the tireless efforts and leadership of George Ham during this decade, and after a difficult funding struggle, Throckmorton Hall, Phase II, was approved for construction to provide additional research and greenhouse space for Agronomy and Plant Pathology, and also to accommodate all programs of the Department of Horticulture, Forestry, and Recreation Resources.

Hires

During this decade of growth, plus retirements and resignations, many new faculty were hired.

- Daniel M. (Dan) Rogers, sorghum breeding (1981).
- George E. Mueller-Warrant, SC Experiment Field (1981).
- David L. (Dave) Regehr, extension weeds (1981).
- Dale L. Fjell, extension crops and soils (SC) (1982), and extension crops (1990).
- James B. (Buck) Sisson, soil physics (1982).
- Ray E. Lamond, extension crops and soils (NE) (1982) and extension soils (1985).
- A. Paul Schwab, soil chemistry (1983).
- James H. (Jim) Long, Sandyland Experiment Field (1983), Corn Belt Experiment Field (1985).
- John S. Hickman, extension soil and water conservation (1983).
- Edward G. (Ed) Gatliff, extension crops and soils (SW) (1983).
- Michel D. (Mickey) Ransom, soil genesis/classification (1984).
- Thomas S. (Stan) Cox, wheat genetics (USDA) (1984).
- Richard G. Greenland, Sandyland Experiment Field (1985).
- William F. (Bill) Heer, South Central field (1985)
- John L. Havlin, soil fertility (1985), later was Head of Soil Science at NCSU and President of Soil Science Society of America (2005).
- Paula J. Bramel-Cox, sorghum breeding (1985)
- Dwight G. Mosier, extension crops and soils (SW) (1986).
- Daniel L. (Dan) Devlin, extension crops and soils (NE) (1986) and extension Environmental Quality Coordinator (1994).
- Vernon A. Schaffer, foundation seed program (1987).
- Charles W. (Chuck) Rice, soil microbiology (1988).
- Gary M. Pierzynski, soil chemistry (1989).
- Gerard J. Kluitenberg, soil physics (1989).
- Dallas E. Peterson, extension weeds (1989).

Accomplishments

1) The Agronomy Newsletter was initiated in Spring 1982 to improve communications with Agronomy alumni and friends. Bidwell edited the first five issues, some after his retirement.
2) The wheat breeding research team released several superior varieties, including ‘Karl’ (1988), ‘Karl 92’, and ‘Arlin’ (hard white) (1992), that had outstanding agronomic and milling and baking characteristics.

3) Establishment of the Wheat Genetics Resource Center under the direction of Bikrum Gill (in Plant Pathology) paved the way for release of numerous germplasms with resistance to various diseases and insects.
4) Pioneer Hi-Bred International, Inc., donated its entire hard red winter wheat breeding program materials to the KAES, including widely grown varieties '2157', '2158', '2163', and '2180'.
5) In 1984, the Soil and Water Conservation and Range Management options were moved to Agronomy when the NRM curriculum was discontinued.
6) Increased emphasis was placed on environmental quality, particularly water resources, and several faculty were hired in new or redirected positions, including Schwab, Sisson, Pierzynski, and Kluitenberg.
7) A new position, Coordinator for Environmental Quality in CES, was established and filled by Hickman in 1989.
8) The soil microbiology program was moved from the Division of Biology to Agronomy in 1988.
9) After a sustained effort led by Bidwell, Governor Mike Hayden signed Senate Bill 96, an Act designating Harney silt loam as the state soil of Kansas on April 12, 1990.
10) Departmental computing/data analysis was shifted from the campus mainframe computer to personal computers as PCs rapidly evolved. The Agronomy Department was at the forefront of the campus in this effort.
11) Faculty were encouraged to submit a greater number of nominations for professional society awards, resulting in a greatly increased number of awards and recognition for departmental faculty.
12) Two faculty, Kissel and Kanamasu, left in 1988 and 1989, respectively, to become head of Agronomy Department and head of the Georgia Experiment Station (Griffin).
13) The Crops and Soils Industry Council was established in 1983, and was an important support group to obtain funding for Throckmorton, Phase II.
14) The Roscoe Ellis, Jr., and Elmer Heyne lectureships were established in 1982, supporting lectures by outstanding scientists across the United States and providing excellent opportunities for graduate student and faculty interaction with the lecturers.
15) The Hilas Bay Rannells Flint Hills Prairie Preserve was established for rangeland research, primarily from gifts from Helen Sampson.
16) The SW (Mineola) Experiment Field was closed in 1981.
17) The Kansas Crop Improvement Association constructed a new headquarters facility at 2000 Kimball that was occupied in 1986.

1990–2000

In late 1989, Posler was selected as Interim Department Head and named Agronomy Department Head in June 1990. He served until 1998, and then returned to the faculty, primarily in crops teaching. Mengel was selected as Agronomy Department Head in 1998, and served through 2005.

During this decade, a major accomplishment was construction and occupancy of Phase II of Throckmorton Hall, providing significantly more and high-quality research laboratories, offices, and greenhouse space, plus significant additional research equipment. Agronomy faculty endured working in a construction zone between groundbreaking in March 1992 and dedication ceremonies on October 14 and 15, 1994.

Hires

With continued retirements, reassignments, and resignations, many more new faculty were hired, including:

- Jay M. Ham, environmental physics (1990).
- Walter B. (Barney) Gordon, NCK and Irrigation experiment fields (1990) .
- Hans Kok, extension soil and water conservation (1990).
- Stephen M. (Steve) Welch, systems modeling (1990).
- Kraig L. Roozeboom, crop performance testing program (1990), extension cropping systems (2006).
- Stewart R. (Stu) Duncan, extension crops and soils (SC) (1991), extension crops and soils NE (2004)
- John O. Fritz, forage physiology (1991).
- Brian H. Marsh, Corn Belt Experiment Field (1991).
- Michael J. (Mike) Horak, weed ecology (1991).

Throckmorton Phase II Groundbreaking, March 1992

From left, Walt Woods, Jon Wefald, Doyle Rahjes, Warren Beavers, Milton Giedinghagen, John Brown, Don Keesling, Lea Minton, Ron Fehr, and Art Howell participate in groundbreaking ceremonies for Throckmorton Phase II.

- Victor L. (Vic) Martin, Sandyland Experiment Field (1991), annual forages and alternative crops research and extension (2005).
- Daniel Z. (Dan) Skinner, USDA alfalfa genetics (1992).
- Anne Rogers, canola breeding (1992).
- William L. (Bill) Rooney, alfalfa breeding (1992).
- Curtis R. (Curt) Thompson, extension crops and soils (SW) (1993).
- Charlie Rife, canola breeding (1993).
- William M. (Bill) Eberle, extension land resources (1993).
- Rhonda R. Janke, extension sustainable cropping systems (1994).
- Karlson E. (Karl) Mannschreck, research farm operations (1994).
- Scott A. Staggenborg, extension crops and soils (NE) (1995), cropping systems (2004).
- Randall E. (Randy) Brown, extension crops and soils (NW) (1995).
- Kassim Al-Khatib, weed physiology (1996).
- Paul C. St. Amand, alfalfa breeding (1997).
- John Schmidt, soil fertility (1997).
- Mitchell R. (Mitch) Tuinstra, sorghum breeding (1997).
- Kang Xia, soil organic chemistry (1998).
- J. Anita Dille, weed ecology (1999).
- Gina Brown-Guedira, USDA wheat genetics (1997).
- Roger Stockton, extension crops and soils (NW) (1999).
- Kent McVay, extension soil and water conservation (1999).

Research Accomplishments

Several enhancements to programs and facilities were accomplished, including:

1) The King L. Anderson Lectureship was established in 1991 to complement the Ellis and Heyne Lectureships.
2) A canola breeding program was initiated, supported primarily through USDA special grant funding.

3) A headquarters facility was obtained for the Rannells Flint Hills Prairie Preserve to enhance range research efforts.
4) Continued major updates and enhancements of departmental computing facilities occurred.
5) Updated facilities were constructed at Harvey County, Irrigation, and Kansas River Valley fields, at Ashland Research Center, and for the K-State Foundation Seed program.
6) A new policy was developed and implemented for release and marketing of KAES soybean varieties.
7) 'Jagger' hard red wheat (1994), 'Betty', and 'Heyne' hard white wheat (1998) varieties were released and grown widely in Kansas and the Southern Plains.
8) The Crop Consulting option was added to Agronomy as the Crop Protection curriculum was discontinued.
9) The Kansas Center for Agricultural Resources and the Environment (KCARE) was established with John Havlin as Director.
10) The first computer multimedia agronomy classroom was developed in TH 1018.

2000–2006

The final years of the first century started with a major planning effort in preparation for a USDA-CSREES Program Review. The review included all Agronomy research, extension, and teaching programs in Kansas, including those at the Southeast Research Center, the four locations composing the Western Kansas Agricultural Research Center (Hays, Colby, Tribune, and Garden City), and the Area Extension Agronomy activities. Some of the outcomes of this review were the department's first staffing plan, an overall direction and focus for departmental programming, and a plan for modernization of the experiment field system. In addition, an undergraduate curriculum review was initiated.

During this period, significant state and federal budget reductions and internal reallocations occurred. As a result, several positions vacated through retirements or resignations were lost or remained open for an extended period, resulting in a significant reduction in faculty, support positions, and graduate students.

Hires

- Allan K. Fritz, wheat breeding (2000).
- Dale F. Leikam, extension soil fertility (2001).
- Guihua Bai, USDA genetics (2003).
- Zoran Ristic, USDA stress physiology (2005).
- Michael J. (Mike) Stamm, canola breeding (2005).
- P.Vara Prasad, crop physiology (2005).
- Nathan O. Nelson, soil fertility (2005).
- Brian L.S. Olson, extension crops and soils (NW) (2005).
- Jianming Yu, sorghum genetics (2006).

Accomplishments

Despite the difficult budget climate, faculty members actively sought grants and contracts to improve departmental programs. As a result, the following program and facility enhancements were made, funded almost entirely from "soft" money and gifts:

1) The Sorghum Improvement Center was established.
2) The first student services support professional position was created in the college to support undergraduate student recruitment and retention.
3) The "Learning Farm" at the Agronomy North Farm was established to support hands-on instruction.
4) The undergraduate curriculum was revised, with creation of the Plant Science and Biotechnology and the Soil and Environmental Science options
5) The Collegiate and NACTA Crops Teams had unprecedented success, with the Collegiate team winning six straight National Championships from 1999 to 2004, and the NACTA Crops Teams winning five National Contests between 1998 and 2005.
6) Significant additions of land for research were made at the Ashland Farm through purchase of 318 acres from the Otto estate in 2000, 15 acres adjacent to Unit I in 2001 from the Berry family, and the 65-acre former Horticulture Farm in 2004. The Otto purchase was funded by the sale of 40 acres of the Agronomy North Farm.
7) The Irrigation Field at Scandia was expanded to include overhead sprinkler irrigation facilities to support irrigation research.
8) The North Central Kansas Dryland Field at Belleville was expanded through a gift/purchase of the adjacent Harold Johnson Farm.

9) The South Central Kansas Experiment Field near Hutchinson was expanded through the gift of 300 acres at Partridge, Kansas, from the Redd-Bagdill estates.
10) The Armbrust Conservation Demonstration Farm near Ellsworth was added, through a gift from Art and Barbara Armbrust.
11) The Corn Belt and Sandyland fields were closed.
12) Merger of computer support facilities and programs with the departments of Plant Pathology and Horticulture allowed adding graphics and Web support and poster printing capabilities.
13) The multi-state Consortium for Agricultural and Soils Mitigation of Greenhouse Gases (CASMGS) was established.

This period will also be remembered as the time when "traits" entered the seed industry and the K-State breeding programs. License agreements were developed to allow departmental breeding programs to incorporate novel traits, such as herbicide resistance, owned by chemical and seed companies into K-State varieties and germplasm. Agreements were also developed that allowed commercialization of K-State-developed varieties and parent lines containing these unique traits to other companies and organizations. The "Wildcat Genetics" trademark was obtained to support these efforts.

Mengel moved to a faculty position at the end of 2005, and Gary M. Pierzynski was appointed Interim Department Head for 2006.

Adapted from Seventy-Five Years of Agronomy at Kansas State University (1906-1981) *by Floyd W. Smith, with editing assistance by Orville W. Bidwell, Elmer G. Heyne, George E. Ham, Richard L. Vanderlip, David A. Whitney, and others.*

Throckmorton Hall.

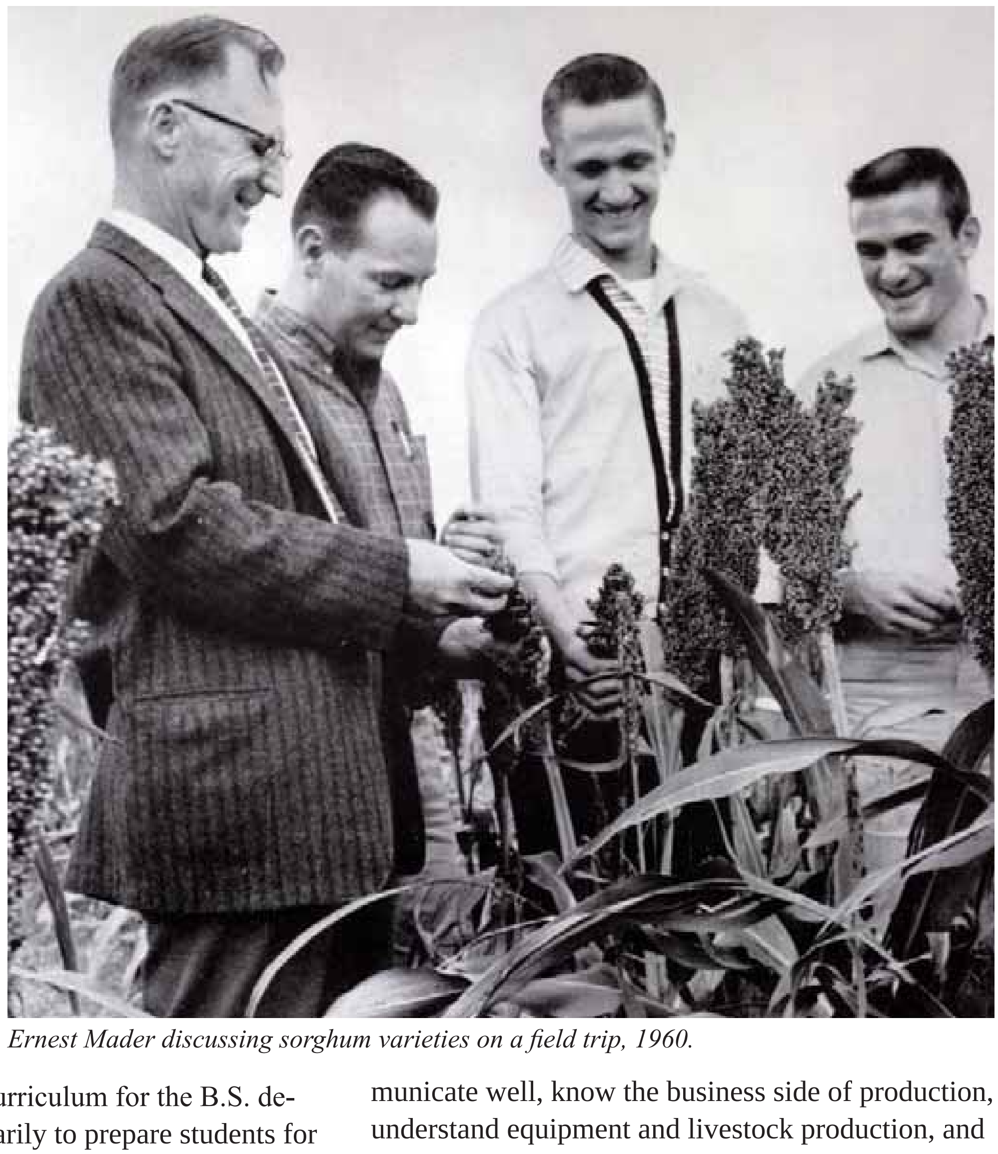
Teaching Programs

Gerry L. Posler and Steve J. Thien

Introduction

Teaching is the basic mission of any University and an essential part of the Land Grant mission that includes teaching, research, extension, and international programs. Preparing students for careers in production agriculture, agricultural businesses and industries, governmental agencies, faith-based and charitable-assistance programs, graduate study, and other opportunities has been a key goal of K-State Agronomy since its inception.

From its earliest days, Kansas has been primarily an agricultural state because of its large and excellent soils resource for cropland and rangeland production. Although the primary crop was corn in the earliest years, environmental limitations made wheat and sorghum its largest acreage crops, particularly before widespread use of irrigation. After the introduction of 'Turkey' hard red winter wheat in 1874, Kansas became "the breadbasket of the world." Grasslands are also great resources that support the large livestock industry, particularly beef and dairy cattle.


Ernest Mader discussing sorghum varieties on a field trip, 1960.

The first agronomy curriculum for the B.S. degree was developed primarily to prepare students for farming, but opportunities also existed for graduates in educational institutions, agricultural businesses, and governmental agencies. Soon after, M.S. degree programs were developed and, much later, Ph.D. programs were approved in Agronomy (1951) and Soils (1952).

It was immediately evident to our early K-State agronomists, including A. M. Ten Eyck and L E. Call, that agronomy is not a science in itself, but agronomists must know both technical agronomy and how to apply scientific principles to the field of agronomy. Agronomists also must be able to communicate well, know the business side of production, understand equipment and livestock production, and have adequate coursework in the social sciences and humanities to be well rounded and become influential citizens in the community.

This concept of a balanced graduate still exists today, and is similar to ideals of groups such as 4-H, who focus on Head, Heart, Health, and Hands, and William H. Danforth, who, in his book *I Dare You*, challenged young people to “Think Tall (Mental), Stand Tall (Physical), Smile Tall (Social), and Live Tall (Spiritual).”

Early faculty members in agronomy had multiple roles in teaching, research, and extension (Farmer Short Courses, e.g.), and split appointments have existed for most faculty to the present time. Therefore, a large percentage of research faculty, except those in Cooperative Extension after its founding, taught one or more courses each year, were involved in curriculum matters, and advised students.

Fewer faculty had primarily teaching appointments, and a very few were 100% teaching. These faculty had significant and long-term responsibilities for teaching—beginning courses in crops, soils, range, and weed science—and provided leadership for course and curriculum efforts. They regularly served as advisors to the Klod and Kernel Klub and later the Wheat State Agronomy Club; coached Crops, Soils and Weeds judging teams; advised the majority of undergraduate students; and served on college and university committees involved in teaching efforts. These faculty included:

Soils - Call, Throckmorton, Meyers, Withee, Jacobs, Bidwell, Thien
Crops - Zahnley, Davis, Mader, Feltner, Ehler, Posler
Weed Science - Zahnley, L. Anderson, Ehler, Moshier, Horak, Dille
Range Science - Aldous, Anderson, Owensby
Crops Team Coach - Zahnley, Mader, Posler
Soils Team Coach - Bidwell, Ransom
Weeds Team Coach - Peterson, Dille

As the department grew larger, and student enrollment increased significantly during the 1950s to 1970s, a part-time Assistant Head for Teaching position was created to coordinate undergraduate teaching activities. Those serving in this role were:

Withee, 1971 - 1982
Posler, 1982 - 1989
Thien, 1990 - 2000
Ransom, 2000 - date

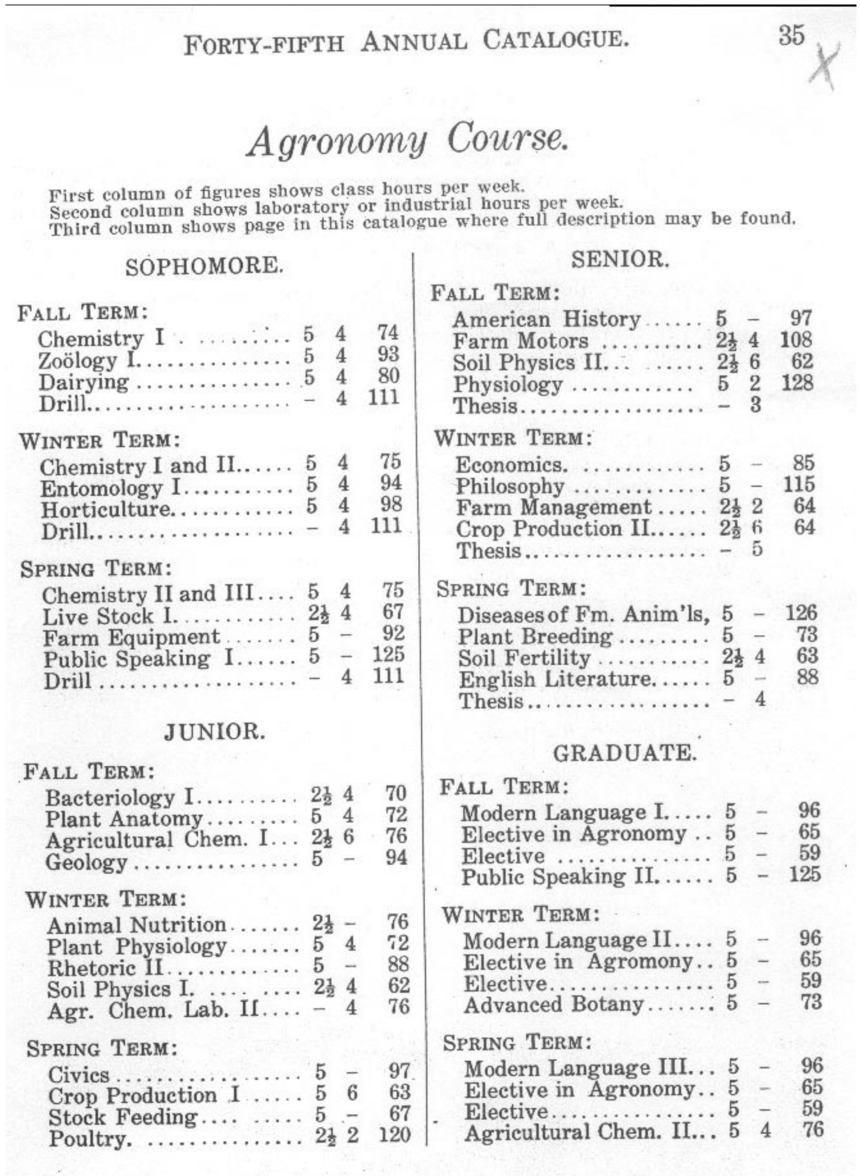
Farmers have always taken pride in their products and enjoyed participating in county and state fairs to exhibit their grains and livestock and compete for prizes. Early short courses were developed to assist farmers in selecting superior corn for planting and to exhibit at these events, and courses were developed in weed and crop ID, grain grading and judging, and market grading of cereals. The first K-State Crops Judging Team competed in Chicago in 1923. The Soils Judging Team was begun in 1958 by O. W. Bidwell, and the Weeds Team was started in 1981 by Loren Moshier.

To provide opportunities for undergraduate students to interact with peers who had common interests, develop leadership skills, and attend regional and national meetings, the Klod and Kernel Klub (Tri K) was begun in 1916. The name was changed to Wheat State Agronomy Club in 1964, and it has been a very visible group at the campus, regional, and national level for many years. A notable opportunity for fundraising occurred when KSU Stadium (now Bill Snyder Family Stadium) was built on land formerly used for agronomy plots, immediately adjacent to the Agronomy Farm headquarters on Kimball Avenue. Clarence Swallow, Farm Manager, offered the club the opportunity to park cars at football games if they would clean the area after each game. As the football fortunes vastly improved during the past 15 years, this became a major source of income for the Club, and is likely the largest fundraising activity for any agronomy club in the United States.

The Agronomy Department faculty has been committed to excellence in undergraduate and graduate teaching throughout its history, developing relevant courses and curricula, and to meeting changing student needs and providing extracurricular activities, such as judging teams and student clubs, to foster development of leadership abilities. The department also was in the forefront of efforts at K-State to provide extension education for producers, through Farmers Short Courses and extension education programs.

1906–1908

In 1906-07, Agronomy included four general lines of study: soils, crops, farm mechanics, and farm management. “It is prepared to make the agricultural studies thoroughly practical. Agriculture is a business. It is not truly a science, but it depends upon science, and to understand the “principles of agriculture” requires a knowledge of many sciences…”



FORTY-FIFTH ANNUAL CATALOGUE. 35

Agronomy Course.

First column of figures shows class hours per week.
Second column shows laboratory or industrial hours per week.
Third column shows page in this catalogue where full description may be found.

SOPHOMORE.

FALL TERM:

Chemistry I	5	4	74
Zoölogy I	5	4	93
Dairying	5	4	80
Drill	–	4	111

WINTER TERM:

Chemistry I and II	5	4	75
Entomology I	5	4	94
Horticulture	5	4	98
Drill	–	4	111

SPRING TERM:

Chemistry II and III	5	4	75
Live Stock I	2½	4	67
Farm Equipment	5	–	92
Public Speaking I	5	–	125
Drill	–	4	111

JUNIOR.

FALL TERM:

Bacteriology I	2½	4	70
Plant Anatomy	5	4	72
Agricultural Chem. I	2½	6	76
Geology	5	–	94

WINTER TERM:

Animal Nutrition	2½	–	76
Plant Physiology	5	4	72
Rhetoric II	5	–	88
Soil Physics I	2½	4	62
Agr. Chem. Lab. II	–	4	76

SPRING TERM:

Civics	5	–	97
Crop Production I	5	6	63
Stock Feeding	5	–	67
Poultry	2½	2	120

SENIOR.

FALL TERM:

American History	5	–	97
Farm Motors	2½	4	108
Soil Physics II	2½	6	62
Physiology	5	2	128
Thesis	–	3	

WINTER TERM:

Economics	5	–	85
Philosophy	5	–	115
Farm Management	2½	2	64
Crop Production II	2½	6	64
Thesis	–	5	

SPRING TERM:

Diseases of Fm. Anim'ls	5	–	126
Plant Breeding	5	–	73
Soil Fertility	2½	4	63
English Literature	5	–	88
Thesis	–	4	

GRADUATE.

FALL TERM:

Modern Language I	5	–	96
Elective in Agronomy	5	–	65
Elective	5	–	59
Public Speaking II	5	–	125

WINTER TERM:

Modern Language II	5	–	96
Elective in Agromony	5	–	65
Elective	5	–	59
Advanced Botany	5	–	73

SPRING TERM:

Modern Language III	5	–	96
Elective in Agronomy	5	–	65
Elective	5	–	59
Agricultural Chem. II	5	4	76

Figure 1. Agronomy Course (Forty-fifth Annual Catalogue)

Courses included Agriculture (the soil, the plant, the animal), Crop Production with Grain Judging laboratory, Farm Mechanics and Management, Soil Physics with laboratory, Farm Mechanics II, and Crop Production II.

The Agronomy Course outlined in the 45th Annual Kansas State Agricultural College Catalogue in 1907-08 (Fig. 1), included many concepts still quite evident in our programs today, including coursework in Agronomy, Physical and Biological Sciences, Social Sciences, Economics and Humanities, Oral and Written Communication, Other Agriculture, Drill, and Senior Thesis.

"This is an age of specialists, yet the specialist is far better equipped for his life-work if he is well grounded in the fundamental branches of knowledge. The College is better equipped than ever before, in the special lines of agriculture, horticulture, and animal husbandry and dairying, for giving the student thorough preparation and training in these lines. The sciences which are related to agriculture are not slighted, and all of the essential fundamental studies are given.

The young men who take the agronomy course will not only be well prepared successfully to carry on various lines of farming for themselves, but they will be competent to act as foremen, and, after some experience, as managers and superintendents of large farms or other agricultural interests.

They will also be prepared to take positions in our agricultural colleges and experiment stations as instructors and assistants. More than this, the graduate from the agriculture course, whatever calling he may choose or wherever he may make his home, will be a strong and influential citizen as well as a skillful producer, because, while the studies of the agriculture course are primarily practical, emphasizing the business side of life, yet enough "culture" studies are offered to give the student a well-balanced and well-rounded education.

It is not so easy to make a good living at farming today as it was forty or even twenty years ago. The soil is poorer, competition is greater. There are many educated, hustling men engaged in the various lines of farming today, and if you want successfully to compete with them you must be educated, too. You must understand the soil and the great principles of cultivation, aeration, and soil-moisture conservation. You must know the science of plant growth and propagation; you must know the chemistry of the plant and of the soil. You must learn the principles of animal nutrition and balanced rations in stock-feeding. You must study the animal and be practiced in stock judging, in order to select your breeding stock. You must know a thousand things about agriculture which you may not know now, if you hope successfully to compete with those who have knowledge and training in these things.

The motto of the Agricultural College is practice with science. This does not mean, however, that the agriculture course student is put to work on the farm. The Agriculture Course is a course of study, not manual labor. Some manual labor is required as practice work in the field and laboratory. The student is taught to handle tools in carpentry and blacksmithing; he is given some practice in handling livestock, grafting, tree-planting, and general farm management. He is not sent into the fields to plow, harrow, or cultivate, but he has an opportunity to observe the best methods of farm practice and become acquainted with the great principles of agriculture which apply everywhere and upon which crop production and stock-breeding and stock-raising depend.

Every young farmer in the state of Kansas should take one of the agriculture courses. It does not matter so much how long a man lives, as how much he lives, and one can live so much more and accomplish so much more after spending four years in College that the time spent is never missed. Every young man can find means to carry him through College. Where there's a will there's a way." -- Kansas State Agricultural College, 47th Annual Catalogue

1920–1921

In 1920–21, the Agronomy faculty included eight professors (Call, Salmon, Throckmorton, Parker, Hensel, Sewell, Zahnley, and Laude) and four assistants (Dale, Harling, Lyons, and Phinney).

Courses were offered in cereal and forage crop production and improvement, pasture management, soils and soil fertility, soil survey, and dryland farming; 100-level courses were for undergraduate credit, 200-level courses for Undergraduate or graduate credit, and 300-level courses for graduate credit only.

Courses in Farm Crops for undergraduates:

101. Grain Crop Production (3). Sophomore year. Parker, Zahnley
102. Forage Crop Production (3). Sophomore year. Zahnley
103. Farm Crops (4). Sophomore year. Zahnley
105. Seed Identification and Weed Control (2). Sophomore year. Zahnley, Harling
107. Special Crops (2). Elective. Zahnley

For graduate and undergraduates:

201. Crop Improvement (3). Elective. Parker
202. Advanced Grain Crops (2). Elective. Salmon
203. Advanced Forage Crops (2). Elective. Zahnley
205. Principles of Agronomic Experimentation (1). Elective. Salmon
206. Agronomy Seminar (1). Elective. Call
207. Pasture Management (2). Elective. Hensel
208. Plant Genetics (3). Elective. Parker

Courses in Soils for undergraduates:

131. Soils (4). Junior and senior years. Call, Throckmorton, Sewell, Lyons
132. Soil Fertility (3). Junior and senior years. Call, Throckmorton, Sewell, Lyons
231. Dryland Farming (2). Elective. Throckmorton
232. Advanced Soil Fertility (2). Elective. Throckmorton
233. Soil Survey (2). Elective. Throckmorton
234. Soil Management (2). Elective. Throckmorton
235. Advanced Soils Laboratory (1-4). Elective. Throckmorton, Lyons

1929–1930

In 1929–30, the Agronomy faculty had grown to ten professors (Throckmorton, Salmon, Parker, Aldous, Duley, Sewell, Zahnley, Laude, Davis, and Timmons), one instructor, two assistants, three graduate assistants, and the farm superintendent (Crews), plus four USDA positions (Brunson and Bower, Corn Breeding; Grandfield, Alfalfa Breeding; Stevenson, assistant; and Landon (Southeast Kansas Experiment Fields). The Agronomy Farm consisted of 320 acres and owned equipment valued at $28,869. Several laboratory courses required deposits or fees ranging from $1.00 to $5.00.

The four curricula in the College of Agriculture included three 4-year programs: agriculture (farm operation); agricultural administration (agricultural industries, agricultural journalism, teaching, USDA, etc.); and landscape gardening; and included one 6-year program—animal husbandry and veterinary medicine. The four-year programs required completion of 124 credits, plus 4 in military science, a total of 128 credits, including:

Agriculture	- Required - 31
	- Elective - 21
Non-agriculture	- Required - 47
	- Electives - 19

Undergraduate courses offered in Agronomy now totalled 15 in crops, eight in soils, plus four courses for graduate credit only, two more than in 1920–21. New course titles included:

108. Grain Grading and Judging (2). Zahnley
114. Advanced Grain Judging (2). Zahnley
211. Crop Ecology (2). Salmon
212. Origin and Classification of Crop Plants (3). Zahnley
243. Soil and Crop Management (3). Duley
247. Interrelationships of Soils and Crop Plants (3). Sewell

1939–1940

In 1939-40, the faculty included 11 professors (Throckmorton, Laude, Clapp, Zahnley, Reitz, Metzger, Meyers, Mullen, Davis, Hide, and Anderson), one assistant (Hollembeck), one Seed Analyst (Norris), and two Graduate Research Assistants.

Courses offered for undergraduate credit only included five in Crops and one in Soils, with an additional ten Crops and six Soils courses for undergraduate or graduate credit, and two courses, Research in Crops and Research in Soils, for graduate credit only.

New course titles included:

115. Market Grading of Cereals (3). Zahnley, Mullen
214. Advanced Crops (3). Zahnley
215. Pasture Improvement II. Anderson (Experiment methods and breeding pasture plants)
235. Development and Classification of Soils (3). Metzger
244. Soil Management (3). Meyers (replaced soil and crop management)

The Klod and Kernel Klub was listed under agricultural societies with the following narrative:

> *"The Klod and Kernel Klub meets on the second and fourth Tuesdays of each month. Membership is open to all students and members of the agronomic faculty. The object of the society is to arouse more interest in agronomic work and to help students and faculty members of the Department of Agronomy to become better acquainted. Faculty members and outside speakers appear on the programs."*

1949–1950

In 1949–50, Harold E. Meyers, Head of Agronomy, was listed in the K-State General Catalog information, but no other listing of faculty or course instructors was provided.

Courses for undergraduate credit included:

108. Grain Grading and Judging (2)
110. Farm Crops (3)
111. Farm Crops Lab (1)
112. Seed Testing (2)
114. Advanced Grain Judging (2)
115. Market Grading of Cereals (3)
116. General Crops (4)
117. Soils and Fertilizers (3)
130. Soils (4)

Courses for undergraduate or graduate credit included:

201. Crop Improvement (2)
203. Pasture Improvement I (3)
206. Principles of Agronomic Experimentation (3)
207. Methods of Plant Breeding (3)
208. Plant Genetics (3)

210. Crop Problems (Arranged)
211. Crop Ecology (2)
214. Advanced Crops (3)
217. Weed Control (2)
218. Pasture Improvement I Laboratory (1)
219. Pasture and Range Surveys (2)
220. Agronomy Seminar (1)
231. Soil Conservation II (2)
235. Development and Classification of Soils (3)
236. Soil Problems (Arranged)
244. Soil Conservation I (3)
249. Methods of Soil Investigation (2)
250. Chemical Properties of Soil (3)
251. Soil Fertility (3)
252. Soil Physics (3)

1954–1955

In 1954-55, the Kansas State College Bulletin stated:

"The School of Agriculture prepares students for farming, for the scientific investigations of agricultural problems in state and national institutions, for agricultural extension work, for the teaching of agriculture, for service in industries closely related to agriculture, and for a variety of other public and private services of an agricultural nature."

Curricula were offered in Agriculture, Technical Agronomy, Agricultural Education, Agricultural Administration, County Extension Work, Dairy Manufacturing, Agricultural Journalism, Pretheological Courses (pre-seminary for rural ministry), Landscape Design, Horticulture, Flour and Feed Milling Industries, and Certificates for Teachers of Vocational Agriculture. In addition, a number of correspondence courses were offered for non-resident students, under the title "Home Study," in the Division of College Extension. The Agriculture curriculum allowed students to "major" in any department in the School of Agriculture, plus Botany, Zoology, Bacteriology, Chemistry, or Agricultural Engineering.

"Any candidate for a degree in Agriculture must have had at least 6 months of farm experience approved by the Dean of the School of Agriculture. The student who completes the freshman and sophomore years will have had basic studies in soils, farm crops, livestock, dairying, poultry husbandry, horticulture, and agricultural economics, giving him a general knowledge of the whole range of agriculture. More than one-third of his time will have been devoted to strictly agricultural courses. During his junior and senior years, the student continues his studies of fundamental science and begins to learn to apply science to agriculture."

The curriculum for Technical Agronomy was designed to provide training for students interested in professional work [careers] in agronomy and included four options: Soil Science, Applied Agronomy and Soil Conservation, Crop Science, and Wildlife Conservation. This curriculum required more math, chemistry, physics, statistics, etc. than the Curriculum for Agriculture.

Klod and Kernel Klub members prepare samples for high school crops contests.

Course offerings in Agronomy were expanded and numbered from 100 through 600s for undergraduate courses and 800s and 900s for graduate courses. New courses offered included:

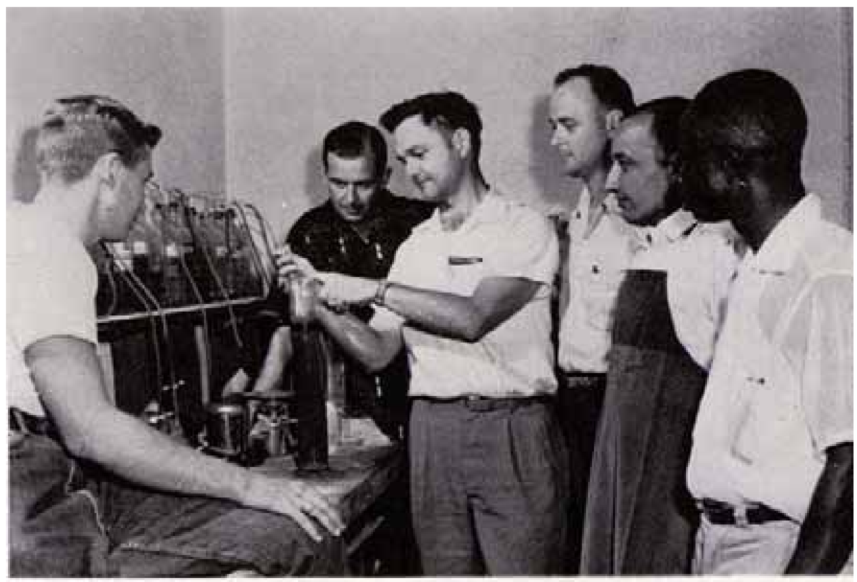
108. Forage Crops (3)
454. Special Crops (3) (replaced Advanced Crops)
467. Identification of Pasture Plants (1)
474. Pasture and Range Surveys (2)
605. Advanced Crop Ecology (3)
502. Management of Irrigated Soils (2)
519. Chemical Fertilizers (3)
544. Soil Analysis Applications (3)

Eighteen new graduate-level courses, seven in Crops and 11 in Soils, were added for students in the new Ph.D. programs approved for Agronomy (1951) and Soils (1952).

1959–1960

In the 1959-60 K-State Bulletin, the department head was Ray V. Olson, and the department offered seven crops and three soils courses for undergraduates only (100), 15 crops and eight soils courses for undergraduate or graduate credit (400s through 600s), and eight Crops and seven Soils courses for graduate credit (800s and 900s). New courses included:

476. Range Ecology (3)
478. Field Course in Range Management (2) (summer)
610. Developmental Genetics (3)



Roscoe Ellis Jr., teaching graduate students about soil testing procedures.

1964–1966

In the 1964-66 Kansas State University Bulletin, Floyd W. Smith was Acting Department Head, and the faculty totalled 41 members, plus four Emeritus: Professors Anderson, Bidwell, Bieberly, Cleavenger, Davidson, Ellis, Heyne, Hobbs, Olson, Pittenger, and F. W. Smith; Associate Professors L.E. Anderson, Atkinson, Baird, Barnett, Jacobs, Mader, Pauli, Stickler, and Wassom; Assistant Professors Brown, Casady, Edelblute, Harper, Moore, Overley, Peterson, Skidmore, Sloan, R.M. Smith, Sorensen, Swallow, Walter, Woodruff, and Wright; Instructors Azelton, Congrove, Lundquist, Raney, Wilkins, and Withee; and Emeritus Professors Clapp, Davis, Laude, and Zahnley. In addition, graduate faculty were noted with an asterisk.

Because entering students differ considerably in their academic backgrounds and their capacity to pursue college work rapidly, academic advisers work individually with new students in planning credit loads and lists of courses to be taken the first year. With the greater flexibility, "example" freshman-year course schedules and "suggested" or "typical" programs were listed with common (required) courses: English Composition I and II (6); Oral Communication (two courses); Ag in Our Society (2); College Algebra (3); Economics I (3); Chemistry I (5); PE (0); Air or Military Science (4); and Humanities (6). In addition, each student completed courses prescribed by his or her major department.

All agronomy majors were required to complete plant science (4) and soils (4), plus 12 additional credits to strengthen their abilities in Science, Business and Industries, or Production. In Agronomy, students could specialize in Agricultural Chemical Sales, Soil Science, Crop Science, Range Management, Soil Conservation, or Irrigation.

Course listings now included 200- and 300-level for undergraduate credit, 400- and 500-level for undergraduate and graduate credit in minor field only, 600- and 700-level for undergraduate and graduate credit, and 800 and 900 level for graduate credit.

New courses for undergraduates included:

200. Plant Science (4) (taught cooperatively with Horticulture)
221. Grain and Industrial Crops (3)
300. Soil Management and Moisture Conservation (3)
410. Range Management I (3) (replaced Pasture Management)
720. Management of Irrigated Soils (2)
740. Range Management II (3) (replaced Range Ecology)
750. Soil Erosion and Control (3)
751. Soil Erosion Laboratory (1)

1970–1971

In the 1970-71 K-State General Catalog, R.V. Olson was Agronomy Department Head, and the Agronomy faculty consisted of 53 Professors and Instructors, plus six Emeritus faculty.

Undergraduate students majoring in agronomy could choose from four programs of study: Agricultural Science, including crop science, soil science, and range management; agricultural production; agricultural services; and agricultural business and industry. Flexibility in programs of study was maintained to meet individual needs.

Major work leading to M.S. and Ph.D. degrees was offered in crop production, crop physiology, crop ecology, pasture improvement, plant breeding, weed science, plant genetics, soil chemistry, soil fertility, soil physics, dryland farming, soil management, irrigation, soil classification, and dynamics of wind erosion.

A total of 32 courses were available for undergraduates, plus 12 courses for graduate credit only were offered.

New courses included:

401. Microclimatology (3)
430. Tropical Agronomy (3)
620. Weed Science (3)
665. Advanced Microclimatology (3)
701. Crop Physiology (3)
840. Advanced Crop Ecology (3)
860. Advanced Forage Crops (3)
890. Soil Physical Chemistry (3)
770. Plant Genetics (3)
920. Soil Genesis (3)

In the 1960s, interest in environmental issues was stimulated by the book, *Silent Spring*, by Rachel Carson, and a new curriculum, Natural Resource Conservation—later Natural Resource Management—was developed, with Soils and Range Management as two of the options. It attracted a large number of majors from about 1966 until it was discontinued in 1984.

1974–1975

In the 1974-75 Kansas State University Bulletin, Agronomy has the sub-heading Crops, Soils, Range Management. Listed faculty were Hyde S. Jacobs, Department Head; Professors Bidwell, Bieberly, Casady, Ellis, Heyne, Hobbs, Jacobs, Jones, Mader, Olson, Sorensen, Withee, and Woodruff; Associate Professors Atkinson, Barnett, Edelblute, Follett, Harper, Liang, Lyles, Murphy, Nilson, Overley, Paulsen, Peterson, Powers, Russ, Sloan, Skidmore, Teare, Vanderlip, Wassom, and Whitney; Assistant Professors Burchett, Dicken, Ehler, Humburg, Kanemasu, Lundquist, Moore, Nickell, Owensby, Raney, Stone, Swallow, Thien, and Walter; Instructors Armbrust, Boone, Dickerson, Disrud, Gronau, Hagan, and Knight; and Emeritus Professors Anderson, Axelton, Clapp, Cleavinger, Lind, Throckmorton, and Zahnley.

Undergraduate students could choose one of four options: production, science, business and industry, or communications. Programs in the science option included crop science, soil science, and range management. The soil and water conservation option of the NRM curriculum and the Crop Protection curriculum could also be selected, and Agronomy faculty were key advisors in these multidisciplinary curricula.

Graduate studies leading to M.S. and Ph.D degrees were offered in the fields of crop production, crop physiology, crop ecology, pasture improvement, plant breeding, weed science, plant genetics, soil chemistry, soil fertility, soil physics, soil management, erosion, irrigation, and soil classification.

Course offerings included 10 courses for undergraduate credit, five for undergraduate or graduate credit in minor field, 20 courses for undergraduate or graduate credit, and 13 courses for graduate credit.

Several courses were modified or added to attract students interested in natural resources and environmental studies, including:

David Riesig applying a herbicide to field bindweed for his special problem.

150. Crops and Soils for Crop Production (3)
190. Environmental Impact of Food Production (3)
505. Soil as a Natural Resource
525. Crop and Soil Management (3)
645. Physical Environment of Crops and Soils (3) (formerly Soil Physics)
675. Soil Interpretation for Land Use Planning (3)

New graduate level courses included:

870. Agronomic Plant Breeding (3)
905. Soil Physical Chemistry (3) (formerly 890)
915. Soil Physics (3)
925. Soil Genesis (3) (formerly 920)
950. Advanced Crop Ecology (3) (formerly 840)

1980–1981

In the 1980-81 K-State General Catalog, the Agronomy faculty consisted of 25 Professors, 13 Associate Professors, 14 Assistant Professors, four Instructors, and 11 Emeritus Professors: Jacobs, Department Head; Professors Bidwell, Bohannon, Ellis, Follett, Heyne, Hobbs, Jacobs, Kanemasu, Kissel, Liang, Lyles, Mader, Nilson, Olson, Owensby, Paulsen, Peterson, Pomeranz, Powers, Skidmore, Sorensen, Vanderlip, Wassom, Whitney, and Withee; Associate Professors Barnett, Dicken, Ehler, Harper,Kilgore, Nuttleman, Overley, Posler, Raney, Reinhardt, Russ, Stone, Swallow, and Thien; Assistant Professors Burchett, Claassen, Fick, Janssen, Lundquist, Maddux, Mikesell, Moore, Mosier, Ohlenbusch, Schapaugh, Ten Eyck, and Walter; Instructors Ball, Dickerson, Hagen, and O' Connor; and Emeritus Professors Anderson, Bieberly, Casady, Clapp, Cleavinger, Edelblute, Jones, Lind, and Woodruff.

Undergraduate options remained the same as in 1974-75, except that range management was now part of the NRM curriculum.

New courses included:

101. Short Course in Agronomy (2) (for College of Agriculture Short Course participants only)
240. Weed Management (3)
415. Soil Morphology (3)
520. Grain Production (3)
550. Forage Management and Utilization (3)
681. Range Ecology (3)
715. Herbicide Interactions (3)
762. Range Grasses (2)
765. Advanced Soil Fertility (3)
790. Range Management Planning (3)
805. Mechanics of Soil Erosion and Its Control (3)
809. Agronomic Presentation (3)
815. Soil Root Environment (3)
820. Plant-Water Relations (3)
871. Breeding Self-Pollinated Species of Field Crops (3)
872. Breeding Cross-Pollinated Species of Field Crops (3)

1990–1992

In the 1990-92 K-State General Catalog, Gerry Posler was Department Head, S.J. Thien was Assistant Head - Teaching, and the Faculty consisted of 15 Professors, 15 Associate Professors, 21 Assistant

Professors, one Assistant Agronomist, and 25 Emeritus faculty, including: Professors Barnett, Kilgore, Kirkham, Liang, Owensby, Paulsen, Posler, Sears, Skidmore, Stone, Swallow, Thien, Vanderlip, Wassom, and Whitney; Associate Professors Armbrust, Atkinson, Cox, Ehler, Fick, Fjell, Harper, Lamond, Maddux, Mikesell, Mosier, Ohlenbusch, Overley, Regehr, Schapaugh, Schwab, Shroyer, and Walter; Assistant Professors Bramel-Cox, Brotemarkle, Burchett, Claassen, Cole, Devlin, Greenland, Hagen, J. Ham, Havlin, Heer, Janssen, Kluitenberg, Kok, Long, Lundquist, Moore, Mosier, Peterson, Pierzynski, Ransom, Rice, and Ten Eyck; Instructor Dickerson; Assistant Agronomist Schaffer; and Emeritus Professors Anderson, Bidwell, Bieberly, Bohannon, Casady, Dicken, Edelblute, Heyne, Hobbs, Jones, Lind, Lyles, Mader, Nilson, Russ, Smith, Sorensen, Withee, and Woodruff.

Undergraduate options were Business and Industry, Production, Range Management Science, and Soil and Water Conservation. Students could also select the Crop Production curriculum that was cooperatively administered by faculty in the departments of Agronomy; Entomology; Plant Pathology; and Horticulture, Forestry and Recreation Resources.

New courses included:

- 315. Properties of Soil (1) (not open to Agriculture majors)
- 335. Environmental Quality (3)
- 360. Crop Growth and Development (3)
- 405. Internship in Agronomy (1-3)
- 415. Soils Judging (1)
- 420. Field Course in Weed Science (1)
- 455. Computer Applications in Agronomy (3)
- 598. Agronomy - The Profession (1)
- 630. Principles of Crop Improvement (3)
- 635. Soil Conservation and Management (3)
- 660. Range Research Techniques (3)
- 830. Quantitative Genetics in Relation to Plant Breeding (3)
- 840. Crop Physiology (3)
- 860. Applied Plant Breeding (3)
- 895. Nutrient Cycling Models (2)
- 916. Advanced Soil Physics (3)
- 920. Agricultural Climatology (3)
- 940. Genetic Manipulation of Crop Plants (3)
- 945. Soil Mineralogy (3)
- 970. Advanced Plant Breeding (3)

1998–2000

In the 1998-00 K-State General Catalog, Dave Mengel was Department Head, and the faculty consisted of 23 Professors, 21 Associate Professors, 11 Assistant Professors, three Associate Agronomists, and 22 Emeritus faculty.

Undergraduate options were the same, except that the Crop Consulting option was added when the multidisciplinary Crop Protection option was discontinued in the 1991 catalog.

New courses included:

- 450. Crops Team (2)
- 505. Biotechnology (3)
- 605. Soil and Environmental Chemistry (3)
- 645. Soil Microbiology
- 655. GIS and Site Specific Agriculture (3)
- 720. Weed Ecology
- 780. Orientation to Field Crop Breeding (1)
- 790. Range Management Planning (3)

2004–2006

The 2004-06 K-State General Catalog (online at www.courses.k-state.edu/catalog/undergraduate/ag/agron.html), has Mengel, Department Head; M.D. Ransom, Assistant Head-Teaching; and the Agronomy faculty consists of 29 Professors, 14 Associate Professors, three Assistant Professors, two Research Assistant Professors, two Instructors, one Agronomist, two Associate Agronomists, and 19 Emeritus faculty, including: Professors Al-Khatib, Buchholz, Claassen, Devlin, Donnelly, Fjell, Gordon, Ham, Hargrove, Kilgore, Kirkham, Kluitenberg, Lamond, Liang, Maddux, Mengel, Ohlenbusch, Owensby, Pierzynski, Peterson, Posler, Ransom, Regehr, Rice, Schapaugh, Shroyer, Skidmore, Stone, Thien, and Welch; Associate Professors Brown-Guedira, Duncan, Eberle, Ehler, Fick, A. Fritz, J. Fritz, Hagen, Heer, Janssen, Leikam, Martin, Ohlenbusch, Staggenborg, Thompson, Tuinstra, and Walter; Assistant Professors Dille, Lundquist, McVay, Moore, and Wagner; Research Assistant Professors Kulakow and Rife; Instructors Cunningham and D. Minihan; Agronomist Schaffer; Associate Agronomists Mannschreck and Roozeboom; and Emeritus Professors Barnett, Bidwell, Bieberly, Bohannon, Hobbs, Jacobs, Mader, Paulsen, Russ, Swallow, Vanderlip, Wassom, Whitney, and Withee.

Undergraduate options include Business and Industry, Consulting and Production, Range Management, Plant Science and Biotechnology, and Soil and Environmental Science.

New courses for undergraduate students include:

320. Seed Technology (3)
640. Cropping Systems (3)
650. Integrated Weed Management (3)
655. Site Specific Agriculture (3)

In the K-State Graduate Catalog (online at www.k-state.edu/grad/catalog/agron.html), Bill Schapaugh is Graduate Coordinator, and the Agronomy Graduate faculty consists of 50 members and nine Adjunct members, located on campus, across Kansas, and at other locations, including private industry. Study areas include: agricultural climatology, crop-climate modeling, crop ecology, crop physiology, crop production, cytogenetics, environmental chemistry, environmental physics, forage management, plant breeding, plant genetics, range science, soil biochemistry, soil fertility, soil genesis and classification, soil microbiology, soil-plant-water relations, soil physics/biophysics, soil/water chemistry, soil/water conservation, soil/water management, and weed science.

New or modified courses include:

822. Herbicide Interactions (3) (formerly 716)
824. Advanced Weed Ecology (3) (formerly 720)
835. Nutrient Sources, Uptake, and Cycling (3)
855. Soil Organic Chemistry (3)
893. Agricultural Simulation Modelling (3)
900. Micrometeorology (3)
901. Environmental Instrumentation (3)
905. Advanced Soil Chemistry (3)
955. Soil Microbial Ecology (3)
980. Molecular Tools for Genetic Analysis (3)

Current undergraduate courses include:

220. Crop Science (4)
305. Soils (4)
330. Weed Science (3)
335. Environmental Quality (3)
360. Crop Growth and Development (3)
375. Soil Fertility (3)
385. Soil Fertility Lab (2)
405. Internship in Agronomy (3)
455. Computer Applications in Agronomy (3)
501. Range Management (3)
515. Soil Genesis and Classification (3)
560. Field Identification of Range and Pasture Plants (1)
605. Soil and Environmental Chemistry (3)
610. Biotechnology (3)
630. Crop Improvement and Biotechnology (3)
635. Soil Conservation and Management (3)
645. Soil Microbiology (4)
646. Soil Microbiology Lab (1)
650. Integrated Weed Management (3)
660. Range Research Techniques (3)
670. Range Management Problems (3)
681. Range Ecology (3)
762. Range Grasses (2)
770. Plant Genetics (3)
790. Range Management Planning (3)

Graduate courses include:

810. Agronomy Seminar (1)
816. Soil Physics (3)
820. Plant Water Relations (3)
822. Herbicide Interactions (3)
824. Advanced Weed Ecology (3)
825. Soil and Plant Analysis (3)
830. Quantitative Genetics in Relation to Plant Breeding (3)
835. Nutrient Sources, Uptake and Cycling (3)
840. Crop Physiology (3)
855. Soil Organic Chemistry (3)
860. Applied Plant Breeding (3)
893. Agricultural Simulation Modeling (4)
898. Master’s Report (2)
899. Master’s Research (Var.)
900. Micrometeorology (3)
901. Environmental Instrumentation (1)
905. Advanced Soil Chemistry (3)
910. Topics in Plant Breeding (Var.)
916. Advanced Soil Physics (3)
925. Advanced Soil Genesis and Classification (2)
930. Topics in Plant Genetics (Var.)
935. Topics in Soils (Var.)
945. Soil Mineralogy (4)
950. Advanced Crop Ecology (3)
955. Soil Microbial Ecology (3)
960. Topics in Crop Physiology and Ecology (Var.)
970. Advanced Plant Breeding I (3)
980. Molecular Tools for Genetic Analyses (3)
999. Ph.D. Research (Var.)

Teaching Publications

A flavor for significant activities, changing emphases, and new thrusts in the teaching realm of the Agronomy Department has been captured through the publications involving its faculty. L.E. Call, in 1912, was the first in the department to publish a teaching-related article. Between 1912 and 2005, 33 different K-State agronomy faculty members published 28 articles. The articles cited here identify the K-State agronomy faculty in bold type.

Agronomists have published teaching-based articles primarily in the American Society of Agronomy journals that have evolved under several names. Precursors of the current *Agronomy Journal* first appeared in 1910, just three years after the ASA was founded. The first four volumes were titled *Proceedings of the American Society of Agronomy*. From 1913 through 1948,, the name was the *Journal of the American Society of Agronomy*. In 1949 the name was changed to *Agronomy Journal*. In 1971, an outgrowth of the agronomic education section was established as a separate journal under the title *Journal of Agronomic Education*. In 1992 this journal's name was changed to *Journal of Natural Resources and Life Sciences Education.*

Call, L. E. 1912. A method of recording the results of students' work in the soils laboratory. *Agronomy Journal* 4:49-51.

Call, L. E. 1921. Prerequisites for agronomy subjects. *Agronomy Journal* 13:49-53.

Parker, J. H. 1923. Laboratory instruction in field crops at Kansas State Agricultural College. *Agronomy Journal* 15:43-54.

Buckman, H. O., P. E. Karraker, and **R. I. Throckmorton.** 1924. The organization of a general introductory course in soils with special reference to the laboratory exercises. *Agronomy Journal* 16:86-91.

Throckmorton, R. I. 1939. Laboratory teaching in beginning courses in crops and soils. *Agronomy Journal* 31:232-238.

Hobbs, J. E. and L. E. Wittsell. 1963. Mechanics of water movements and storage in soils: a teaching technique. *Agronomy Journal* 55: 67-70.

Teare, I. D. and W. L. Powers. 1972. The agronomy seminar - boring or stimulating. *Journal of Agronomic Education* 1:75-77.

Thien, S. J. 1973. A Learning Center Approach to Introductory Courses. *Journal of Agronomic Education* 2:75-79.

Thien, S. J. 1977. Avogadro's concept of equivalents for teaching cation exchange capacity. *Journal of Agronomic Education* 6:35-38.

Thien, S. J. 1979. A flow diagram for teaching texture-by-feel analysis. *Journal of Agronomic Education* 8:54-55.

Thien, S. J. and J. D. Oster, 1981. The international system of units and its particular application to soil chemistry. *Journal of Agronomic Education* 10:62-70.

Bidwell, O. W. 1983. What courses are we requiring of our soil science majors? *Journal of Agronomic Education* 12:67-69.

Thien, S. J. 1986. Residue management: a computer program about conservation tillage decisions. *Journal of Agronomic Education* 15:23-26.

Burnett, R. B. and A. P. Schwab. 1987. A computer program to aid in teaching diffuse layer theory. *Journal of Agronomic Education* 16:30-33.

Jones, R. S. and A. P. Schwab. 1989. BALANCER: a computer program for balancing chemical equations. *Journal of Agronomic Education* 18:29-32.

Shroyer, J. P., H. L. Brooks, **D. A. Whitney**, **E. B. Nilson**, W.G. Willis, and R.O. Graham. 1989. Diagnosing wheat production problems. *Journal of Agronomic Education* 18:111-114.

Khan, A. H., **L. R. Stone**, O. H. Buller, **A. J. Schlegel**, **M. C. Knapp**, J. I. Perng, H. L. Manges, and **D. H. Rogers**. 1996. Educational software for illustration of drainage, evapotranspiration, and crop yield. *Journal of Natural Resources and Life Sciences Education* 25:170-174.

Pierzynski, G. M. and S. J. Thien. 1997. Undergraduate academic programs in environmental soil science and environmental science: survey results. *Journal of Natural Resources and Life Sciences Education* 26:34-39.

Schumacher, S., M. A. Boland, **G. Ham**, and R. L. Madl. 1999. Hard white wheat variety release: a decision case. *Journal of Natural Resources and Life Sciences Education* 28:63-71.

Schmidt, J. P., **M. D. Ransom**, **G. J. Kluitenberg**, M. D. Schrock, J. A. Harrington, Jr., R. K. Taylor, and **J. L. Havlin**. 2001. Teaching site-specific agriculture: three semesters' experience with a multi-disciplinary approach. *Journal of Natural Resources and Life Sciences Education* 30:77-83.

Pierzynski, G., **P. Kulakow**, L. Erickson, and L. Jackson. 2002. Plant system technologies for environmental management of metals in soils: educational materials. *Journal of Natural Resources and Life Sciences Education* 31:31-37.

Poland, J. A. 2003. Mapping of *Aegliops tauschii* derived leaf rust resistance genes in common wheat. *Journal of Natural Resources and Life Sciences Education* 32:8-11.

Thien, S. J. 2003. A teaching-learning trinity: foundation to my teaching philosophy. *Journal of Natural Resources and Life Sciences Education* 32:87-92.

Eberle, W. M., **J. P. Shroyer**, and T. J. Herrman. 2004. Constraints to adoption of hard white wheat in western Kansas. *Journal of Natural Resources and Life Sciences Education* 33:1-6.

Pierzynski, G. M. and **K. A. Gehl**. 2004. An alternative method for remediating lead-contaminated soils in residential areas: a decision case study. *Journal of Natural Resources and Life Sciences Education* 33:63-69.

Mitchell, R., V. Allen, J. Waller, and **P. Ohlenbusch.** 2004. A mobile classroom approach to graduate education in forage and range sciences. *Journal of Natural Resources and Life Sciences Education* 33:117-120.

Nelson, N. O. and R. L. Mikkelsen. 2005. Balancing the phosphorus budget of a swine farm: a case study. *Journal of Natural Resources and Life Sciences Education* 34:90-97.

Dille, J. A. and D. M. Namuth. 2005. Appearance of herbicide resistance in a weed population. (Web lesson learning activity: http://citnews.unl.edu/croptechnology'viewLesson.cgi?LessonID=998689386). *Journal of Natural Resources and Life Sciences Education* 34:125.

Participants observing weather data collection equipment at a Kids Field Day in Manhattan.

Extension

Extension Agronomy

James P. Shroyer and David A. Whitney

Extension Agronomy has had a successful 100 years, providing dynamic and visible programs across the state. The names and faces of the extension agronomists have changed, as well as some methods used to extend information, but the goal to deliver timely, pertinent agronomic education programs to our clientele is still the priority. A list of Extension Agronomists and state, area, and district specialists is included at the end of this section.

Extension Agronomy 2006

A current, basic overview of Extension Agronomy includes the subject-matter areas of crop production (crop selection, weed control, soil fertility); rangeland and pasture management; environmental quality, with an emphasis on water quality; soil and water conservation; nutrient management; and waste management. Extension Agronomy specialists work in cooperation with Area Crops and Soils Specialists to assist County and District Agricultural Agents in developing and conducting their extension programs.

Extension agronomists have cooperated with county extension personnel to develop demonstration plots since the very beginning of the department.

The objective of the crop production program is to enhance profitability and sustainability for the producer through appropriate use of production inputs, with minimal negative impact on natural resources (soil, air, and water). Seed, fertilizer, and herbicides are major input costs for production of the major crops. Efficient use of these inputs is critical to profitable production. Programs/issues in this area include crop rotation decisions, variety/hybrid selection, planting date, planting rate and row spacing decisions, nutrient rate/source/application method decisions, weed-control method and herbicide selection decisions, and integrated cropping systems.

The objective of the rangeland and pasture management program is to provide information and assistance in developing an efficient; ecologically, environmentally, and economically sound; and sustainable production system. Complementary use of forages to provide year-round grazing systems is emphasized. Goal setting, planning, and evaluation must be part of management. Combining the management of a business and a forage-livestock production system requires a knowledge of the management principles and practices available. Primary topics are prescribed burning, grazing management, water quality, invasive species, and brush and weed management.

Conservation of our soil and water resources is of major concern to both farmers and the public. Federal and state legislation require certain soil and water conservation practices be implemented by farmers. This program has the objective of creating farmer awareness of their own management impact on soil and water resources, and provides alternative management approaches to help comply with these regulations while maintaining profitability. This program focuses on efficient use of precipitation in both dryland and irrigated production agriculture, and strives to help producers make the best use of the precipitation their land receives by encouraging the adoption of conservation-tillage systems.

The environmental quality program focuses on best management practices to protect surface and groundwater quality from pesticide and nutrient contamination. The program also interacts with state and federal agencies on water quality issues.

1906-2006

The early years of Extension Agronomy, as well as the overall Kansas Cooperative Extension Service, have been described by Earl Teagarden (1964). In his three-volume text, *History of the Kansas Extension Service from 1868 to 1964*, he details the people and their extension activities. Agronomy faculty quickly recognized that research information and improved practices needed to be delivered to farmers across the state. Agronomists cooperated with railroad companies to conduct educational programs from trains at stops along the line. The Wheat Trains, Lime Trains, and Farmer Institutes were a means to transfer this information, and they were well attended. Teagarden lists "selection of superior varieties of crops, the use of good seed by seed selection, planning crop rotations, the control of weeds, proper tillage of the soil, improved soil treatments, pasture improvement and management, and soil conservation" as typical topics of the Farmer Institutes. Also, Teagarden describes the various methods used to deliver an extension program. He lists lectures and demonstrations as the primary teaching methods. Method demonstrations were used to show the "how to" of a particular practice, whereas result demonstrations were conducted in farmers' fields to compare practices. The breadth and importance of these result demonstrations cannot be overstated. Teagarden reports that in 1938 L.L. Compton, crops

Eleanor Roosevelt and T. Russell Reitz tour Kansas Extension soil conservation activities after the Dust Bowl.

specialist, had 752 farmer cooperators in western Kansas conducting demonstrations comparing wheat yields on fallow land versus non-fallowed land. The wheat on fallow land yielded three bushels per acre more than on the non-fallowed land (12.4 vs 9.4 bu/acre). In the 1950s, stubble-mulch demonstrations were used to show the importance of moisture conservation, compared with clean-fallow.

Over the years, extension specialists initiated and assisted with yield contests for various crops in an effort to promote new technologies and improved production practices. Results were compiled and distributed to producers, and they could see what practices were the most efficient and promising. This lead to rapid adoption of improved practices.

In the early 1960s, Teagarden lists crop improvement, legume production and soil improvement, pasture improvement, soil management, weed control, and soil conservation as the major topics of the Soil Management and Crop Production project. By this time, other technologies and practices were becoming important, such as hybrid corn and sorghum and commercial fertilizer. Also, in the early 1960s, Extension agronomists moved from Umberger Hall into the Agronomy Department in Waters Hall. This lead to more specialization of extension agronomists, and they became more subject-matter focused. Area Extension Agronomists were assigned to the five area Extension offices in the early 1970s, and became more involved with requests and planning with county agricultural agents. The first area agronomists were Dale Edelblute in Southwest, Dean Dicken in Northeast, Bob Nuttelman in South Central, Verlin Peterson in Southeast, and Les Reinhardt in Northwest Kansas. In the 1980s, as research faculty in crop production were not replaced, extension agronomists were given split extension-research appointments, and became more involved in on-station and on-farm research. Extension faculty were involved with the development of practices such as dual placement of nitrogen and phosphorus; use of an in-row starter application of phosphorus to ameliorate the effects of aluminum toxicity caused by low pH; no-till alfalfa planting; the early-corn concept, in which early-maturing hybrids are planted slightly earlier than normal to avoid late-summer drought; no-till wheat planting after row crop harvest; narrow-row soybeans; optimum corn populations; reduced herbicide rates; and the use of wheat variety blends to stabilize yields.

From the 1960s through the 1980s, "full-load" meetings that included extension specialists from agronomy, entomology, plant pathology, agricultural engineering, and economics devoted one day to a particular crop and were intended to supplement single-county winter meetings. Frank Bieberly, as Extension Agronomy program leader, coordinated the development of the full-load school concept. It was common for the team of specialists to leave Monday morning and return Friday. An outcome of the full-load concept was the production handbooks for the major crops. These handbooks have been used widely across Kansas and continue to be updated as needed.

In addition to the full-load schools that provided information in detail on production of a particular crop, schools focused on in-depth training in a particular subject-matter area were initiated in the late 1950s. In-depth soils and soil fertility schools were started by Eugene Cleavenger, using research and teaching faculty as instructors. A *Soils and Soil Fertility Manual* was initiated by Donald Sander as a reference manual for the in-depth soils schools. There have been several revisions over the past four decades, with the current manual authored by Ray Lamond and Dale Leikam.

During the 1970s and 1980s, Erick Nilson coordinated Reduced Tillage Conferences, which were held across the state and brought in researchers, extension specialists, and producers who shared their results and experiences. These were very successful and well attended. An in-depth weed management school was initiated in the 1980s by weed science specialists Dallas Peterson and David Regehr, with a weed management reference manual.

In recent years, extension meetings have tended to be shorter and more focused on a particular topic. The use of short meetings, such as pre-plant wheat schools, provides producers information as they are making important cropping decisions.

Extension Agronomists have provided the leadership in coordinating various departmental activities. They have coordinated the Agronomy Field Day, and served as co-chairs of the experiment field advisory committees. Also, specialists have worked with youth in 4-H/FFA Land Judging and Homesite Evaluation Contests and Kids' Field Day.

Extension agronomists have served in roles other than strictly producer-education roles. Specialists were instrumental in working with growers to start the various commodity organizations. Verlin Peterson worked tirelessly to organize the Kansas Soybean Producers Association, and served as its secretary for many years. Gary Kilgore was a key member of the organizational group that started the Kansas Forage and Grassland Council, and continues to serve on its board. Other specialists have served in secretary roles for commodity groups, but most of these commodity groups today are self sufficient and are managed by producers and their staff.

As computer technology improved and the internet became a valuable source of information, most producers have gained access to the internet. Extension specialists have developed Web sites that contain extension publications, as well as current topics, so clientele have immediate access to reliable information. Extension Agronomy recently initiated a weekly e-mail newsletter that is distributed to agricultural agents and agribusiness personnel. This is a new delivery method, replacing the monthly newsletter for agricultural agents that was developed by Cleavenger and Luther Willoughby during the 1940s and the Agronomy-In-Action newsletter of the 1980s through the early 2000s.

Although technologies have changed over the past 100 years, one consistent component of Extension Agronomy's role has been the training of county and district agents. Because local agents are K-State's representatives across the state, it is important that they are prepared to answer clientele questions. Extension Agronomy has provided updates and training for agents, as well as impromptu training events during the growing season that are conducted by area agronomists. Over the past twenty years, as agricultural consultants and agribusiness have expanded, there has been a need to train these individuals. This has been accomplished by cooperating with industry agronomists to establish hands-on diagnostic training sessions, conducted in Manhattan in mid-summer for spring-seeded crops and in Garden City in the spring for wheat. These were coordinated by David Whitney, Peterson, and Leikam over the years for the spring-seeded crop diagnostic training, and by Dwight Mosier and Curtis Thompson for the wheat diagnostic training in Garden City. Diagnostic slide sets and take-to-the-field handbooks for corn, wheat, and grain sorghum were developed for producers and agribusiness personnel.

With environmental concerns of the past several decades from agricultural inputs, a Certified Crop Advisor Program was initiated in the early 1990s for certification of those assisting farmers in making crop production decisions, with national and state components for certification. Extension specialists, including agronomists, were responsible for development of the state certification exam questions, educational training materials in preparation for taking the exam, and performance objectives. Specialists also serve on the Kansas Certified Crop Advisor Board.

Another consistent role Extension of Agronomy has been coordinating the county wheat variety

Extension Agronomists and state, area, and district specialists, 1912 to present

NAME	TYPE	YEAR BEGINNING	YEAR ENDING
P. E. Crabtree	Area Crops/Soils	1912	1916
Harley Bower	Soils	1914	1920
G. E. Thompson	Crops	1916	1918
Ralph Kenney	Crops	1918	1920
A. C. McClymonds	Crops	1919	1919
Ernest Wells	Crops/Soils Management	1929	1935
J. J. Bayles	Crops	1921	1922
Luther Willoughby	Crops	1920	1957
Harlan Sumner	Crops	1923	1928
A. L. Clapp	Crops	1928	1931
Eugene Cleavenger	Area Crops/Soils	1931	1935
	Crops/Soils	1935	1967
Lawrence Compton	Crops/Soils Management	1935	1946
John Bell	Crops	1937	1941
T. Russell Reitz	Soil Conservation	1942	1943
Reuben Lind	Soil Conservation	1943	1965
Harold Harper	Soil Conservation	1946	1973
Frank Bieberly	Soil Mgt/ Crop Production	1946	1977
Robert Bohannon	Soil Testing	1953	1961
	Soil/Water Consservation	1976	1984
Glen Hardy	Soil Testing	1955	1956
Howard Wilkins	Soil Mgt/ Crop Production	1959	1971
	Crops/Soils	1977	1979
Dale Edelblute	Area Crops/Soils	1955	1980
Jack Baird	Area Crops/Soils	1961	1964
George Wright	Soil Testing	1961	1966
D. Dean Dicken	Area Crops/Soils	1967	1982
Donald Sander	Area Crops/Soils	1964	1966
	Soil Fertility	1966	1967
Erick Nilson	Pesticide Safety	1965	1989
Verlin Peterson	Area Crops/Soils	1965	1971
	Crop Production	1971	1984
Eddie Beason	Area Crops/Soils	1966	1967
Robert Hyde	Range/Pasture Development	1966	1973
David Whitney	Soil Testing	1966	2001
Gerald McMaster	Area Crops/Soils	1967	1973
Leslie Tobin	Soil Fertility and Management	1967	1971
Harold Jones	Soil Fertility and Management	1947	1956
	Soil/Water	1968	1977

demonstration program and 4-H wheat varieties project, currently conducted by Jim Shroyer. Wheat seed requests from county agents for their variety demonstrations are compiled and then delivered to them before planting in the early fall. This has been a mainstay for the adoption of improved wheat varieties.

Soil and water conservation specialists played a major role in development and delivery of educational meetings for distribution of the modern county soil survey manuals, starting with Saline County in 1959. Also, these specialists led the adoption of conservation-tillage practices in Kansas. They established on-farm demonstrations, coordinated development of the *Kansas No-till Handbook*, and conducted numerous rainfall-simulator demonstrations.

NAME	TYPE	YEAR BEGINNING	YEAR ENDING
James Stiegler	Land Utilization	1971	1973
Gary Kilgore	Area Crops/Soils	1972	present
Robert Nuttelman	Area Crops/Soils	1972	1981
Leslie Reinhardt	Area Soil/Water	1973	1977
	Weed Science/Crop Production	1977	1980
R. Hunter Follett	Soil Fertility	1974	1981
Paul Ohlenbusch	Range/Pasture	1975	2003
Larry Bonczkowski	Area Crop Protection	1977	1989
Merrel Mikesell	Area Crops/Soils	1978	1995
Jim Shroyer	Crop Production	1980	present
James Schaffer	Area Crops/Soils	1980	1983
Dave Regher	Weed Science	1981	present
Ray Lamond	Area Crops/Soils	1982	1985
	Soils Fertility and Management	1985	2004
Dale Fjell	Area Crops/Soils	1982	1990
	Crop Production	1990	2005
Edward Gatliff	Area Crops/Soils	1983	1984
John Hickman	Soil/Water Conservation	1983	1994
Jack Brotemarkle	Weed Science/Crops	1984	1993
Dan Devlin	Area Crops/Soils	1985	1994
	Environmental Quality	1994	present
Dwight Mosier	Area Crops/Soils	1986	1991
Dallas Peterson	Weed Science	1989	present
Hans Kok	Soil Conservation	1990	1998
Stewart Duncan	Area Crops/Soils	1991	present
Curtis Thompson	Area Crops/Soils	1993	present
Bill Eberle	Land Resources	1993	present
Scott Staggenborg	Area Crops/Soils	1995	2004
Randy Brown	Area Crops/Soils	1995	1997
Roger Stockton	Area Crops/Soils	1999	2004
Kent McVay	Soil Conservation	1999	2006
Dale Leikam	Nutrient Management	2001	present
Walt Fick	Range Management	2003	present
Keith Janssen	Soil Conservation	2005	present
Vic Martin	Annual Forage/Alternative Crops	2005	present
Brian Olson	Area Crops/Soils	2005	present
Kraig Roozeboom	Cropping Systems	2006	present

The rainfall simulator was set up in an area with different amounts of crop residue, which represented the amount of residue that would be left after different tillage practices. The rainfall simulator would apply a given amount of precipitation, and the amount of runoff and sediment would be measured. This was a valuable tool to make producers aware of residue-management issues. (This program was initiated by John Hickman, and continued by Hans Kok and Kent McVay.)

In 1990, national and state concerns were raised about the adverse effects of agricultural practices on environmental quality. Due to the concerns, the department established a new extension position, Extension Specialist and Coordinator, Environmental Quality. Hickman moved into the position and initiated programs focused on farmer implementation of Best Management Practices (BMP). He focused particularly on reducing nitrate contamination of groundwater and pesticide contamination of surface water. Dan Devlin moved into the position in 1994. His extension programs concentrated on improving the quality of surface waters and reducing the impact of crop production practices. He developed BMP for tillage, pesticides, and nutrients, and evaluated the effectiveness of implementation of BMP. Field demonstrations, public meetings, web sites, and printed publications were provided to assist farmers in implementing best management practices.

Extension agronomists' talents have not been confined to Kansas farmers. Over the past 40 years, a number of agronomists have participated in foreign development projects, generally serving as technical specialists and technology transfer specialists.

Selected Publications

L-875	No-Till Alfalfa Establishment
MF-844	Specialty and Non-Traditional Crops
MF-1088	Cotton Production in Kansas
MF-1095	Early Corn Production
MF-876	Spring Oats in Kansas
AF-127	Doublecropping With Sunflowers
AF-87	Soybean Inoculation
MF-1072	Small Grain Cereals for Forage
C-613	Bermuda Grass Establishment and Management
C-713	Wheat Pastures in Kansas
C-567	Range Grasses of Kansas
MF-1021	Rangeland Brush Management
MF-1168	Sewage Sludge Use On Agricultural Land
AF-115	Soil Compaction - an Overlooked Problem
C-662	Ridge Till Row Crops
AF-40	Phosphorus Placement For Wheat
C-646	Spring Freeze Injury to Kansas Wheat
C-509	Soil Test Interpretations and Recommendations
L-778	Using Legumes in Crop Rotation
MF-1022	Mgmt of Saline and Sodic Soils
MF-913	Field Bindweed Control in Crops and Fallow
C-715	Herbicide Mode of Action
L-816	Noxious Weed Control in CRP
MF-857	Nitrates & Groundwater
C-449	Soybean Production Handbook
C-529	Wheat Production Handbook
C-560	Corn Production Handbook
C-683	Alfalfa Production Handbook
C-687	Grain Sorghum Production Handbook

Extension Agronomy faculty, 1985.
Back: Jim Shroyer, Dale Fjell, John Hickman, Ray Lamond, Merrel Mikesell.
Center: Erick Nilson, Gary Kilgore, Paul Ohlenbusch.
Front: Dave Whitney, George Ham, Jack Brotemarkle, Larry Bonczkowski.

Extension Range Management

Walter H. Fick and Paul D. Ohlenbusch

The first extension specialist in range and pasture management was Robert M. Hyde, hired in 1966. In addition to his extension duties, Hyde also had research responsibilities, serving as major professor for three students, including J.P. Benfer, C.E. Owensby, and J.D. McKendrick. Hyde provided statewide leadership in extension range and pasture management and published several extension leaflets and circulars on topics including livestock distribution tools, range judging and plant identification, smooth brome production, bluestem haying, and tall fescue production. Hyde co-authored two refereed publications during his tenure at K-State. He left in 1973 for an extension position at Colorado State University.

Paul D. Ohlenbusch was extension specialist in range and pasture management from 1975-2003. He essentially spent his entire career at K-State in an extension position, although he did have 0.1 research time for a short period, and he served as agronomy extension state leader for three years. Ohlenbusch developed and conducted in-depth schools and workshops to meet the needs of the Kansas farmer and rancher. These training sessions included brush and weed control, prescribed burning, and the Kansas Grazingland Management workshops. He cooperated closely with extension agricultural economists to meet the public's need for information concerning the establishment, management, and subsequent use of Conservation Reserve Program (CRP) stands. He obtained substantial grant support from the Kansas Department of Health and Environment (KDHE) related to water quality.

Along with extension agricultural economist Rodney Jones, Ohlenbusch developed the Kansas Grazing Land Water Quality Program and the Water Quality Financial Analysis and Resource Evaluation Stewardship Program. These programs were developed to help agricultural producers identify problems related to water quality, and to guide them in developing protection measures on grazing lands.

Ohlenbusch was also active in the invasive-weed subject area, helping organize the Multi-State *Sericea Lespedeza* Work Group. He developed several Web sites, not only for his own program but also for other organizations, including the Tallgrass Legacy Alliance, Kansas Section of the Society for Range Management, and the Kansas Grazing Land Coalition.

Throughout his career, Ohlenbusch maintained an applied-research program. He initially started a brush and weed control project on range and pasture. He worked with numerous local extension agents in demonstrating basal control of unwanted species such as osage orange and common honeylocust. He cooperated with other K-State Research and Extension personnel in investigating the use of Spike® herbicide (tebuthiuron) for control of brush species in northeastern Kansas. The spot application of Velpar® L (hexazinone) for control of small soapweed also came from Ohlenbusch's work. He conducted studies on haying and grazing use of CRP. In cooperation with extension animal science and the NRCS Plant Materials Center, he established cool-season grass stands in western Kansas to assess adaptability and production capabilities.

Ohlenbusch was very active in the Society for Range Management (SRM). He served the Kansas-Oklahoma Section as President and for five years as newsletter editor. He served on the editorial board of *Rangelands* and as an associate editor for the *Journal of Range Management*. Ohlenbusch served on three SRM annual meeting committees, as co-chair for publicity, registration, and program.

Ohlenbusch published nearly 60 numbered extension articles and more than 20 proceedings papers. He received the 1999 Meritorious Service Award from the Alpha Rho Chapter, Epsilon Sigma Phi, and the 1999 Team Award from K-State Research and Extension. In 2004, Ohlenbusch received an Outstanding Achievement Award from the Society for Range Management and the Award of Excellence from the Kansas Forage and Grassland Council.

After Ohlenbusch's retirement in 2003, Walter H. Fick agreed to modify his teaching/research appointment to include 0.4 time in extension. Today, Fick's appointment includes 0.6 time as extension specialist in range and pasture management. Fick conducts prescribed-burning workshops, annually serves as an instructor and councilor at the Kansas Range Youth Camp, assists with adult range-management schools, assists with the Basic Noxious

Agronomy extension specialists and county agents regularly confer individually with producers to discuss management decisions. Photo circa 1978.

Weed Short Course, and provides expertise on invasive species, noxious weed identification, and vegetation management at recertification training programs for commercial pesticide applicators.

County extension educators, area specialists, federal agencies, and private industry typically request information on a broad range of topics including grazing distribution tools, balancing stocking rates with forage production, grazing systems, drought management, prescribed burning, brush and weed control, invasive species, and herbicides used on rangeland. Forage topics include eastern gamagrass establishment and production, forage management and utilization, and alfalfa quality.

A major thrust of Fick's extension program has been the Kansas Grassland Water Quality Program (KGLWQP). Along with Jones in agricultural economics, Fick obtained funding through KDHE to assemble an interdisciplinary team with expertise in grazing management, agricultural economics, and GPS/GIS skills. The KGLWQP team assists land managers in adopting best management practices in voluntary support of state total maximum daily load (TMDL) compliance efforts. As part of the WRAPS process (Watershed Restoration and Protection Strategy), the KGLWQP team is available to assist land managers in a basic pasture inventory; assess potential water quality issues related to current management; consider alternative management strategies, including the economic feasibility of each alternative; and implement a plan.

Prescribed-burning safety and environmental issues continue to be of concern. Fick has been part of a team made up of K-State Research and Extension, Kansas Department of Agriculture, and Environmental Protection Agency personnel, assembled to address methods of monitoring and managing particulates and other smoke-related issues.

The long-term goal of Fick's extension activities is to provide an up-to-date, research-based education program in rangeland and pasture management to meet information demands throughout Kansas. Fick serves as an advisor to groups such as the KACD Grasslands Committee and the Kansas Grazing Lands Coalition, and is active in the Kansas Section of the Society for Range Management and in the Tallgrass Legacy Alliance.

Over the years, a number of other individuals have contributed to the extension range and pasture program in Kansas. Throughout his career, Gary Kilgore, Southeast Area Crops and Soils Specialist, has been especially helpful in addressing range and forage issues in southeastern Kansas.

Extension Weed Science

Dallas E. Peterson

Weed management is an important component of successful crop and pasture management, and thus has always been an important part of the Extension Agronomy educational programs. The complexity and available options to Kansas farmers and ranchers for weed control changed dramatically during the first 100 years of the K-State Agronomy Department. Likewise, the emphasis and focus on weed science in Extension Agronomy increased and evolved as new weed-management technologies were developed and adopted.

Weed-control questions and educational efforts were generally handled by the Extension Crops and Soils Specialists during the first half century of the Agronomy Department. Tillage, hand removal, and sanitation were the primary ways in which weeds were managed during the early 1900s. Field bindweed rapidly became a serious weed problem after its unintentional introduction from Russia. Demonstration plots were established by a number of county extension agents, starting in 1926 and continuing for several years, to demonstrate the effects of clean tillage, smother crops, salt, and sodium chlorate applications on field bindweed populations. The field bindweed demonstration programs were supervised and coordinated by the Extension Crops Specialists and James W. Zahnley from the Agronomy Department. Earl Teagarden was temporarily hired as an Extension Weed Specialist in the Department in 1929, but was transferred to another position after just four months because funds were not appropriated for the position.

Extension Crops and Soils Specialists continued to provide information on weed identification and control as a part of their general agronomy programs through the 1940s and 1950s. In 1959, Harold Harper, Extension Soil Conservation Specialist, was assigned the responsibility to work with the K-State Agricultural Experiment Station and the Weed Control Division of the Kansas Board of Agriculture to develop an educational program on weed control for the County Extension Agents and County Noxious Weed Supervisors. Harper might be considered the first permanent extension weed specialist at K-State, although he was never officially assigned that title. He worked closely with the State Noxious Weed Director and focused on noxious weed identification and management. He developed several weed identification and management publications with the Kansas Department of Agriculture, and conducted two-day weed control workshops for County Extension Agents and County Weed Supervisors during the early 1960s.

The discovery and introduction of 2,4-D during World War II ushered in a new era of chemical weed control. A number of companies began to screen and develop herbicides to selectively control weeds. The introduction of new herbicides provided a new tool for weed control and increased the need for more education on the proper use and performance of these products. Erick Nilson was hired as the first fully funded Extension Weed Specialist at K-State in 1965, with a primary focus on proper herbicide use. Nilson coordinated the development of *Chemical Weed Control in Field Crops*, which provided farmers and herbicide applicators with information on herbicide application and performance. The publication is revised annually and is one of the most widely distributed and popular publications from K-State. Nilson acquired funding through the federal Integrated Pest Management (IPM) program to purchase sprayer equipment, and implemented a number of on-farm demonstration and research projects to evaluate and demonstrate various integrated weed-management strategies.

The enactment of the Federal Insecticide, Fungicide, and Rodenticide Act in 1971 required that all private and commercial pesticide applicators who purchased and applied restricted-use pesticides be certified. Since that time, Extension Weed Specialists have been involved with the development of training manuals and annual training sessions for pesticide applicator recertification, in cooperation with other specialists in the College of Agriculture and the Kansas Department of Agriculture.

Funding for a second Extension Weed Specialist was approved in 1977. Leslie Reinhardt was hired for that position in 1978, and worked cooperatively with Nilson until 1981. David Regehr was hired as a replacement for Reinhardt in 1981, and has continued in that position through the centennial year of the Agronomy Department, except for an international assignment in Morocco from 1984 through 1987. Jack Brotemarkle served as temporary Extension Weed Specialist while Regehr was in Morocco.

The focus of Regehr's program was integrated weed management, with a special interest in no-till cropping systems and weed management. He also was greatly involved with the development of the first-ever Pesticide Management Area in the Delaware River watershed in response to surface-water contamination issues. Regehr was the leader in further development of Best Management Practices that could be adopted to minimize atrazine runoff. Several publications were developed by Regehr, in collaboration with other specialists and scientists, to address atrazine stewardship. Regehr was recognized as a Fellow of the North Central Weed Science Society in 2004 in recognition of his contributions to the weed science discipline in the north central region.

Dallas Peterson was hired after Nilson's retirement in 1989. At that same time, the responsibility for much of the field herbicide evaluation work previously coordinated by Oliver Russ was shifted from research to extension under the direction of Peterson and Regehr. Peterson was assigned the lead role for herbicide evaluation and extension programming for weed control in wheat, soybeans, alfalfa, and other minor crops, and Regehr assumed the lead role for corn and sorghum. Both specialists continued to work cooperatively on applied research and educational programs. One of the primary educational programs they developed was the In-Depth Weed Management Schools. The weed schools also involved the participation of the Area Crops and Soils Specialists and the Application Technology Specialist from the Department of Agricultural Engineering. Topics covered during the 1- and 2-day schools included integrated weed management, weed seedling identification, weed biology, herbicide behavior in soils, herbicide mode of action, weed control updates, and sprayer application technology.

Peterson worked closely with the weed research faculty and was involved in the early confirmations of several herbicide-resistant weeds, particularly the *Amaranthus*, or pigweed, species. Several publications resulted from the work, including a color pigweed identification bulletin, which was widely used by industry in other states. Other major educational efforts included managing herbicide-resistant weeds, herbicide-resistant crops, and spray application technology. Peterson worked cooperatively with Anita Dille to help introduce a Kansas version of WeedSOFT in 2002. WeedSOFT is an economic and biology based computer software program to help make weed-management decisions. WeedSOFT developed out of a regional project involving several states in the north central region and is revised annually.

Peterson also developed the KSU Weed Management Web site in 2003, which is used by the extension weed specialists to provide the public with easy access to weed-management educational resources and research summaries. Peterson is active in professional weed science societies, serving on numerous committees and in leadership roles with the North Central Weed Science Society, including a term as President in 2002. He was recognized as a Fellow of the North Central Weed Science Society in 2005.

Weed- and brush-control issues in pasture and rangeland were addressed over the years primarily by the Extension Range and Pasture Management Specialists, Robert Hyde, Paul Ohlenbusch, and Walter Fick. Area Crops and Soils Specialists also played a key role in the weed- and brush-management educational efforts and in responding to the day-to-day questions on weed control. Several of the Area Specialists had weed science backgrounds and continued to focus on specific weed-management issues as Area Specialists. Area Crops and Soils Specialists with significant extension weed science contributions included Dean Dicken, Gary Kilgore, Dwight Mosier, Dan Devlin, Curtis Thompson, and Brian Olson.

International Activities

Mary Beth Kirkham, George H. Liang, and Gary M. Paulsen

Past International Activities

The traditional roles of land-grant universities are three-fold: instruction, research, and extension. A fourth dimension, international agricultural programs, is more recent and equally important (Paulsen, 1997). International agricultural programs—partnerships between land-grant universities and the U.S. Agency for International Development (USAID) and other sponsors—were major successes in the United States foreign aid program after World War II. These collaborations rebuilt and improved universities that were devastated by the war and, in some instances, established entirely new institutions to meet the food crisis in developing countries. The collaborations also started the large exchange programs of foreign students at universities in the United States. These programs trained scientists and teachers to return to their homelands and assume responsibility for developing agricultural resources in their countries. Faculty in the Department of Agronomy at Kansas State University participated in these partnerships, some by training foreign students, and others by serving as advisors, often for several years, in developing countries.

The first major international project at K-State was with Andhra Pradesh Agricultural University in India, which began in the late 1950s (Paulsen, 1997). This was followed by similar projects with Ahmadu Bello University in Nigeria in the 1960s and early 1970s and Central Luzon State University in the Philippines in the 1970s. Howard Wilkins, Extension Agronomist, was a consultant for the World Bank in the 1970s, and was killed in a small-airplane crash in1979 during an overseas consulting assignment. He was an outstanding Extension Specialist and also served as Secretary-Treasurer of the Kansas Crop Improvement Association, in a split appointment, for several years. Table 1 lists the professionals involved in India, Nigeria, the Philippines, and the World Bank, dates of service, and area of responsibility (Jacobs and Larson, 2006).

In the 1980s, international projects were completed in Morocco and Botswana by the Mid-America International Agricultural Consortium (MIAC), an association of K-State, Iowa State University, University of Missouri, University of Nebraska, and Oklahoma State University. Another project in the 1980s was INSORMIL (International Sorghum and Millet Research), a collaboration of K-State and other universities, funded by USAID. It had as its goal to improve sorghum and millet production in Africa. Richard L. Vanderlip, L.Van Withee, and Edward T. Kanemasu had projects supported by INSORMIL, and traveled to Africa.

The origin of the international agricultural dimension of land-grant universities in the United States, and the first project of its kind, are due to a former head of the Department of Agronomy, Leland E. Call (Paulsen, 1997). Call joined K-State as an assistant professor in 1907, became head of the Department of Agronomy in 1913, and was appointed Dean of the College of Agriculture in 1925. His career in international agriculture started when he retired as Dean in 1946. The USDA Office of Foreign Agriculture in 1946 appointed Call as Chief of Party of a mission to advise the U.S. government on restoring agriculture in the Philippines.

The situation was particularly desperate in that country, which was a U.S. commonwealth until 1946. The University of the Philippines' College of Agriculture at Los Baños (UPLB) was an internment camp for American civilians during the war, and was largely destroyed. A major recommendation of the mission's report was to rehabilitate facilities and train personnel at UPLB. The UPLB project was undertaken by Cornell University. Call became Research Advisor and Director of the Cornell/UPLB Project for the U.S. Agricultural Mission in the Philippines, a position that he held until 1956. He received many honors for his contributions to UPLB. At K-State, Call Hall, which houses the Food Science program of the Department of Animal Sciences and Industry, was named after him.

The Department of Agronomy has another link to agricultural development in the Philippines. In 1933, when Call was Dean of the College of Agriculture, a young student, Henry Beachell, completed his graduate degree in the Department of Agronomy at K-State. After an outstanding career with the USDA, Beachell became head of the Varietal Improvement Department at the International Rice Research Institute (IRRI), which was established adjacent to the UPLB campus in 1962. This location for IRRI was selected because of UPLB's reputation as the outstanding agricultural university in the region, a status that resulted from Call's leadership. Beachell developed IR-8 "Miracle Rice" at IRRI, an achievement that revolutionized rice production in Asia, and resulted in his being co-recipient (with Gurdev Khush of India) of the 1996 World Food Prize.

The project at Andhra Pradesh Agricultural University in India was one of four major programs in that country funded by USAID. It also was a major undertaking by K-State, involving both long-term and short-term commitments by faculty, and training of many students in the United States. Especially prominent roles were played by Ernest Mader, Carl Overley, Verlin Peterson, and Bob Raney, who each devoted several years in India. Their efforts helped Andhra Pradesh Agricultural University become one of the outstanding institutions in India.

Considerable leadership was provided by department faculty to the project at Ahmadu Bello University in Nigeria. Raymond Olson served as team leader and Dean of Agriculture and L.V. Withee served as Assistant Dean of Agriculture at ABU. Other persons with extended assignments included James Hobbs and Guy Wilkinson. Olson later served as Director of International Agricultural Programs at K-State.

The project at Central Luzon State University in the Philippines was primarily directed at improving the food production and processing capabilities of the region. Ernest Mader played a major role as agronomist for the project. He also later served in Indonesia in a project to increase agricultural production in that country.

In 1981, a five-year Mid-America International Agricultural Consortium project was established. K-State was the lead institution in the Botswana Agricultural Technology Improvement project. Agronomists from K-State worked on the project (Department of Agronomy Newsletter, 1982).

In 1982, Jay Siebert began working as the farming systems agronomist for the MIAC project in Botswana. He completed an M.S. degree in 1978 under the direction of Clyde Wassom in corn breeding, and completed his Ph.D. at the University of Georgia in 1982. In 1983, Geoffrey Heinrich joined the Botswana project. He worked in Botswana from 1975 through 1978, and he had experience at ICRISAT (International Center for Research in the Semi-Arid Tropics) in India. At the same time (1983), Hobbs was beginning his second year as research-extension liaison officer in the Botswana Ministry of Agriculture's Field Service Division. In June 1982, Tareke Berhe, a member of the agronomy faculty, began his work for the INSORMIL project at El-Obeid, Sudan. He conducted projects, under the direction of Francis Barnett, that involved evaluation of millet germplasm; collection of local millet, sorghum, and cowpea germplasms; and introduction and evaluation of early and drought-tolerant legumes. Funding for the first two years of this INSORMIL project amounted to $130,000. (Department of Agronomy Newsletter, 1983)

In 1984, Hobbs was continuing as the research-extension liaison officer for the MIAC/Botswana project and he was located in Gabarone, Botswana. Siebert and Heinrich were stationed at Mahalapye and Francistown, Botswana, respectively (Department of Agronomy Newsletter, 1984). David Regehr accepted an assignment with the MIAC Project in Morocco, and he, his wife, Judy, and two sons left in August 1984, for two years. The aim of Regehr's work was to develop a regional center for agronomic research in an area that produces most of Morocco's wheat and barley. The center was operated under the aegis of MIAC (USAID funding) and the Moroccan government. Regehr also provided professional knowledge in the field of weed control (Department of Agronomy Newsletter, 1984).

In 1984, INSORMIL was authorized $340,000 for continuation of K-State's 1985 part of it. By then, the INSORMIL project was five years old. In the spring of 1984, an INSORMIL project in Botswana was established, and agronomists Doug Carter and Wayne Youngquist were working on it (Department of Agronomy Newsletter, 1984).

On September 1, 1985, Hobbs retired at the conclusion of a three-year term as a research-extension liaison officer in Botswana and a 35.5-year association with K-State. He rose from assistant professor to professor by 1958. In addition to his teaching and research on the K-State campus, he had international assignments in Nigeria and Botswana. In Nigeria, he was professor and head of soil science at Ahmadu Bello University from 1964 to 1966 and 1970 to 1974, and dean of agriculture from 1965 to 1966 and 1971 to 1972. In addition, he served as deputy chief of party (agriculture) from 1970 to 1974. While in Nigeria, Hobbs successfully amalgamated the knowledge, customs, and habits of the British and Nigerian academic and research systems with the land-grant college philosophy and performance. His extension and research experience proved valuable in Botswana, where Hobbs went in August 1982. There he diplomatically sought to develop an active two-way exchange of crop-production information between the extension and research groups so that critical agricultural problems could be brought to the attention of the researchers, and their results, in turn, could be translated into appropriate crop-production information for presentation to farm families (Department of Agronomy Newsletter, 1985).

In July 1987, Regehr and his family returned from Morocco after working there for three years (Department of Agronomy Newsletter, 1988). He was a member of a group of 12 U.S. professionals working on the Applied Dryland Farming Research Program. He served as Section Leader for the plant pathologists, entomologists, and weed scientists concerned with plant protection. Regehr and his family lived at Settat, about 45 miles from Casablanca, in a semi-arid region that is an important wheat-producing region for Morocco. In August 1987, James P. Shroyer replaced Regehr in Morocco. Shroyer was Crop Production Specialist on the Applied Dryland Farming Research Project at Settat, where he established numerous trials to evaluate varieties and improved production practices (Department of Agronomy Newsletter, 1988).

Shroyer returned to K-State from Morocco in 1988. In May 1994, he presented two posters at the Conference on Dryland Agricultural Research in Rabat, Morocco. This conference was the summarization of the MIAC/Morocco Dryland Agricultural Project at Settat, Morocco (Department of Agronomy Newsletter, 1995). Since Shroyer's return from Morocco in 1988, no other faculty member from the Department of Agronomy has had an extended stay abroad on a federally funded project, but individual faculty members still travel to developing countries to consult. For example, Mitchell Tuinstra, sorghum breeder, recently traveled to Ethiopia and other African countries with food shortages to consult and obtain germplasm.

International Activities in Recent Years

In this summary, we do not include international trips that faculty members have led to take undergraduate students abroad for short tours. The Department of Agronomy Newsletters (1982-2006) document several study tours to Central and South America, Australia and New Zealand, and Europe led by Gerry Posler, Steve Thien, Mickey Ransom, and Hans Kok. We also do not include short visits to experimental sites or international conferences. Again, the Department of Agronomy Newsletters (1982-2006) document many of these trips. Here we include only long-term international collaborations. Such activities often mean sacrificing family life by leaving the family behind when working in foreign locations. If children are school age, it is difficult to bring a family along. Sabbatical leaves also often require financial sacrifice and using personal savings to finance them. Even though K-State has a generous policy to provide the opportunity for sabbatical leaves up to 12 months every seven years, it pays only five months of salary during a 12-month leave. Few faculty members are willing or able to make these personal and financial sacrifices to take sabbatical leaves. Those who do, however, reap lifelong benefits. Children who accompany them do, too, by learning a foreign language and culture, and they often travel abroad themselves when they become adults.

International activities also involve accepting foreign students and visiting scientists into the Department of Agronomy laboratories for training and cooperative research. Many faculty members in the department have been deeply involved in this regard. For example, of the 130 graduate students, postdoctoral fellows, and visiting scientists that worked in George H. Liang's laboratory during his 42-year career (1964-2006), many were from other countries, including China, Thailand, South Korea, Egypt, and Tunisia. Accepting foreign students for degrees has multi-fold purposes: sharing American values with others; playing a diplomatic role, because many students have taken important jobs after returning to their home countries; introducing American culture and fundamental principles, such as democracy and human rights; and assisting in research, because many foreign students are highly selected scholars who are diligent and intelligent workers.

In addition, international activities include inviting foreign speakers to present seminars. In these presentations, the speakers introduce their agricultural practices, training procedures, crops grown in their countries, research priorities, and needs for further development. For many years, the Department of Agronomy has hosted an International Seminar series that includes speakers from around the world, in addition to overviews of travel by K-State faculty in Agronomy and related departments.

Examples of international activities by current faculty members are listed below.

Dale L. Fjell and Dallas E. Peterson

Since 1998, Dale Fjell and Dallas Peterson have had extensive travels in Latin America and have traveled to Bolivia five times to work with a large soybean grower in the Santa Cruz region. The years and dates were: fall 1998, fall 2000, fall 2002, fall 2004, and spring 2005. Fjell also traveled to Brazil in spring 2001 to tour soybean growing and processing centers.

Mary Beth Kirkham

Since arriving at K-State in 1990, Kirkham has attended at least one international meeting every year and presented a paper at each. She has been a guest lecturer in China (1985), Italy (1989), New Zealand (1991, 1998, 2005), The Netherlands (1991), South Korea (1993), Spain (1999), and Germany (2003) She has taken three sabbatical leaves:

- 1991: Visiting Scientist, Environmental Physics Section, Department of Science and Industrial Research, Palmerston North, New Zealand (Host: Brent E. Clothier)
- 1998: Visiting Scientist, Landcare Research, Crown Research Institute, Canterbury Agriculture and Science Centre, Lincoln, New Zealand (Host: Frank M. Kelliher); Visiting Scientist, Environmental and Risk Management Group, The Horticultural and Food Research Institute, Crown Research Institute, Palmerston North, New Zealand (Host: Brent E. Clothier)
- 2005: Visiting Scientist, Environment Group, The Horticultural and Food Research Institute, Ltd., Crown Research Institute, Palmerston North, New Zealand (Host: Brent E. Clothier)

Gerard J. Kluitenberg

Kluitenberg has taken three extended trips abroad. His first trip was to Australia and New Zealand from September 16 through October 15, 1994. Host scientists were Keith Bristow, CSIRO Division of Soils, Davies Laboratory, Townsville, Australia, and Brent Clothier, Environmental Physics Section, Crown Research Institute, Palmerston North, New Zealand. The primary purpose of this trip was to continue collaborative research with Bristow on the development of thermal methods for characterizing soil physical properties. Kluitenberg spent approximately three weeks with Bristow at the Davies Laboratory in Townsville and four days visiting with scientists at the CSIRO Division of Soils, Canberra Laboratories in Canberra, Australia. The trip concluded with a four-day visit to Palmerston North, New Zealand, where Kluitenberg interacted with Brent Clothier, David Scotter of Massey University, and several other scientists.

His second trip was to Japan from November 2 through November 22, 1996. Host Scientist was Michihiro Hara, Department of Agronomy and Forestry, Iwate University, Morioka, Japan. The primary purpose of this trip was to initiate collaborative research with Hara on thermal methods for characterizing soil physical properties. Kluitenberg spent a week with Hara at Iwate University, and then spent the rest of his time traveling to a variety of institutions. He visited and presented seminars at the National Institute of Agro-Environmental Sciences in Tsukuba, The University of Tokyo, Kyoto University, and Hokkaido University.

His third trip was to Australia, from November 5 through December 11, 1998, to continue collaborative research with Bristow and John Philip on development of thermal methods for characterizing soil physical properties. A secondary purpose was to share his expertise with CSIRO scientists on the possible application of site-specific farming techniques in sugarcane production. He spent four days with Philip at the Pye Laboratory in Canberra and two days with Peter Thorburn and Brian Keating (CSIRO Tropical Agriculture) at the Cunningham Laboratory in Brisbane. The remaining four weeks were spent with Bristow at the Davies Laboratory in Townsville.

George H. Liang

- Consulted in China for the World Bank Development Fund
- Consulted in China for the United Nations Development Program
- Invited speaker in China 1979, 1981, 1982, 1983, 1984, 1987, and 2002.

David L. Regehr

The Department of Agronomy Newsletter of 1996 reported that Regehr took a five-month sabbatical leave in Paraguay (1995–1996). There he worked with agronomists at three agricultural cooperatives in the central Chaco region. This dryland farming area is about 250 miles northwest of Asuncion, the capital of Paraguay. The region has rainfall patterns and amounts very much like northeast Kansas, but with much higher evaporative demand, because it is situated on the Tropic of Capricorn. The objectives of Regehr's visit were to address conservation tillage and weed management. Regehr's trip was underwritten by the Farmer-to-Farmer section of the Kansas/Paraguay Partners.

Regehr returned to Paraguay for another five-month sabbatical leave in 2003-2004. His two times in Paraguay coincided with winter in the United States. On both occasions, he worked with Mennonite Colonies in the Chaco region on pest management, tillage systems, sustainable agriculture, and pesticide testing programs.

Charles W. Rice

Rice travels to many international meetings; he currently (as of 2006) is on the soils panel of the Intergovernmental Panel on Climate Change (IPCC), which is writing its next report. The panel meets in different locations, and Rice has been to Europe, South America, and China for panel meetings.

Edward L. Skidmore

Skidmore is Director of the USDA Wind Erosion Research Unit and Adjunct Professor in the Department of Agronomy at K-State. He has traveled to countries around the world, and is one of the most traveled members of the Department of Agronomy. Since 1980, he has been co-director (with Donald Gabriels of the University of Ghent, Belgium) of the College on Soil Physics, held every two years at the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy. He helped to edit the volume with papers commemorating the twentieth anniversary of the College (Gabriels et al., 2004). The most recent College on Soil Physics was held in September 2005. To date, more than 600 scientists, from approximately 70 countries, have participated in these soil physics activities held at ICTP. The College of Soil Physics is one of the longest continuous running programs at ICTP.

The Wind Erosion Research Unit has long and continuous contacts with China. On May 20, 2002, Skidmore had the honor of being invited to participate in the Opening Ceremony at Northwest Sci-Tech University of Agriculture and Forestry, Yangling, which was attended by Rodney Brown, Deputy Undersecretary of USDA-Research, Education, and Economics.

The Wind Erosion Research Unit has hosted many foreign visitors, and its scientists have had major roles in wind erosion workshops in several countries, including Belgium; China; Egypt; the FAO in Rome, Italy; Hungary; Mexico; The Netherlands; Niger; Pakistan; Turkey; and the Sudan. The scientists have co-authored papers with scientists in Belgium, Canada, China, Egypt, Germany, The Netherlands, Poland, Russia, and Turkey. And they have served either as major professor, member of a graduate committee, or adjudicator of international graduate students from Libya, China, the Philippines, Cameroon, India, Iran, China, The Netherlands, Belgium, and Senegal. Since 1999, the unit has hosted scientists from Austria, China, Romania, Germany, Canada, Turkey, The Netherlands, Syria, Argentina, and Mexico

Mitchell R. Tuinstra

Tuinstra took a five-month sabbatical leave between May and October 2005, with the Crop and Weed Ecology Group at Wageningen University in The Netherlands, to study sorghum and weed interactions. Tuinstra also coordinates a sorghum crop improvement and utilization research program in West Africa (Niger, Mali, Senegal, and Ghana) that has been running for the past four years (2002–2006).

Richard L. Vanderlip

Vanderlip has taken several sabbatical leaves to Australia. He was on sabbatical leave from July through December 1983, working at the CSIRO Cunningham Laboratory, Brisbane, Australia, to simulate yield components of grain sorghum. He worked with David Charles-Edwards, Mike Foale, and Bob Myers of the CSIRO (Commonwealth Scientific, Industrial, and Research Organization) Division of Tropical Crops and Pastures (Department of Agronomy Newsletter, 1984). From July to December, 1997, Vanderlip took another sabbatical leave to Australia (Department of Agronomy Newsletter, 1998). He was with the Agricultural Production Systems Research Unit in Toowoomba, Queensland, Australia, working with his former student, Graeme Hammer (Ph.D., Kansas State University, 1987).

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Table 1. International Agriculture – Department of Agronomy (Jacobs and Larson, 2006)

Professional	Date of Service	Area of Responsibility
	INDIA	
Floyd W. Smith	1973 (2 weeks)	Consultant
Dean Dicken	1969-1971	Soil Fertility
Roscoe Ellis, Jr.	June-July, 1970	Soil Chemistry
Russell Herpich[1]	March-April, 1968	Irrigation
Ernest Mader	1970-1972	Soil Conservation & Rice Culture
Carl Overley	1967-1969	Seed Production
Verlin Peterson	1967-1969	Soil Fertility
Robert Raney	1969-1972	Irrigation
F.N. Elbertson[2]	1956-1958	Agronomist
Roy Donahue[2]	1956-1961	Agronomist
John Hammond[2]	1964-1965	Seed Production, Seed Storage
J.A. Jackobs[2]	1958-1960	Agronomist
	NIGERIA	
Ray V. Olson	1964-1965	Dean of Agriculture
	1972-1974	Team Leader
L.V. Withee	1966-1968	Soil Scientist, Asst. Dean of Agriculture
J. Arthur Hobbs	1964-1966	Soil Scientist
	1970-1974	Soil Scientist
Guy E. Wilkinson[2]	1968-1970	Soil Scientist
W.W. Worzella[2]	1970-1972	Agronomist
O.W. Bidwell	January-April, 1973	Soils
	PHILIPPINES	
Ray V. Olson	1977	Pre-Contract Conference
Hyde S. Jacobs	1977	Pre-Contract Conference
Ernest L.Mader	1978-1980	Agronomist
	WORLD BANK	
Howard Wilkins[3]	1979	Consultant

[1] K-State Extension Agricultural Engineer

[2] Adjunct Professor

[3] Killed in a small-plane crash overseas while consulting for the World Bank

Research Programs

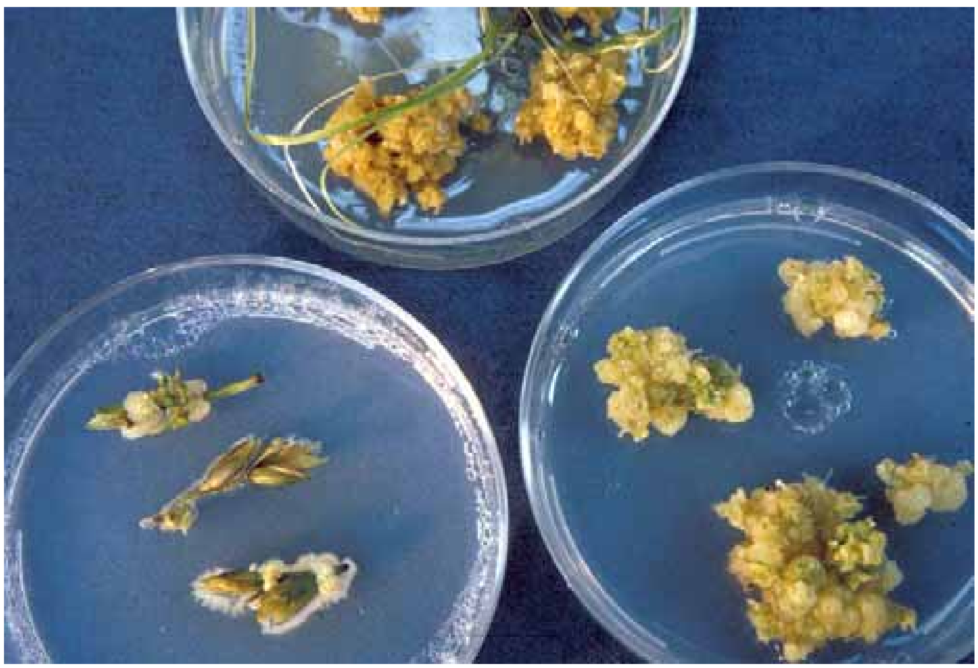
Plant Genetics

George L. Liang

Plant Genetics is a branch of Crop Science, and those in plant genetics usually work closely with plant breeders in the department in teaching and research activities. Plant Genetics also is an independent unit, conducting research, either independently or teamed with others in the same department or in other departments, for which emphasis is determined primarily by the plant geneticist.

The Plant Genetics section also is closely tied to the interdepartmental Genetics Program on campus. Many graduate students from Agronomy, Horticulture, Entomology, Plant Pathology, Biology, Biochemistry, and Statistics prefer to be housed in their respective departments but have a major in Genetics, which offers a different curriculum and course requirements than available in those departments.

The first plant geneticist working in Agronomy was John W. Schmidt, born in Moundridge, Kansas, who was reared on a wheat farm. He received his Ph.D. degree from the University of Nebraska in 1952 and worked as an associate agronomist (plant geneticist) in the Department of Agronomy at K-State until 1954. He worked on wheat germplasm development and was tied closely to the wheat breeding program, but his main interest was wheat breeding. Later he was hired by the University of Nebraska – Lincoln (UNL) in 1954, where he worked as a wheat breeder until he retired in 1985. He was a very successful breeder and released 25 hard red winter wheat cultivars with high yield and stability, notably 'Scott' and 'Centurk'. He was part of a six-person wheat research team at Nebraska, and was an advocate of early generation selection for the retention of heterogeneity. This provides populational buffering in the variable Great Plains environment – thus broad adaptation, more stable, and thus more productive. His famous words are "plant breeding is part science, part art, but mostly just hard work." At Nebraska, he was the advisor of 16 M.S. and 8 Ph.D. students, 11 of whom came from foreign countries. Through his career, Schmidt received more than 20 honors and awards, including ASA Fellow, the Crop Science Award from CSSA, and the USDA Superior Service Award. He traveled extensively to foreign countries, giving scientific papers, visiting wheat



Callus tissue is a crucial step to regenerate transformed plants than contain a desired gene introduced with a gene gun.

breeding projects, and consulting with foreign scientists, including those in England, Yugoslavia, France, China, Soviet Union, Italy, India, Argentina, Netherlands, Tunisia, Bulgaria, Pakistan, Jordan, Iran, and many others. He was a member of Gamma Sigma Delta, Phi Kappa Phi, and Sigma Xi. He retired in 1985 and passed away in 1997. (Information from UNL.)

After Schmidt left K-State, Thad Pittenger was hired. He was a graduate from the University of Nebraska in 1951, an Atomic Energy Commission (AEC) Postdoctoral Fellow at California Institute of Technology (1951-53), a Research Associate at Oak Ridge National Laboratory of Biology (1953-57), and an Assistant Professor in the Department of Biology at Marquette University, Milwaukee, Wisconsin (1957-59). He worked on *Neurospora* genetics, and received funding from the National Science Foundation for his research. He taught Plant Genetics and Developmental Genetics at the graduate level. Because his research interest was not in the area of higher plants, he rarely worked with the crop breeders. Also, his genetics classes were concerned mainly with *Neurospora*, rather than crop species. Subject matters of interest to Agronomy and Horticulture students, such as aneuploid analysis, wide crosses, tissue culture, polyploidy, linkage analysis and mapping, and probability, were not covered in his classes. In 1973, he became a full professor in the Division of Biology, working with faculty conducting research on developmental genetics and microbial genetics. He later became interested in potato tissue culture and worked with those in the Department of Plant Pathology, and also worked on a flour beetle project. He retired in December 1987, and passed away in 2003. He was a member of Phi Beta Kappa, Sigma Xi, Gamma Sigma Delta, and Phi Kappa Phi. (Information from Division of Biology)

George H. Liang received his Ph.D. degree from University of Wisconsin–Madison, and was hired in October 1964, as a plant geneticist working on crop species important to Kansas. Realizing the importance of teamwork, he cooperated with wheat breeders Elmer Heyne and Rollie Sears; sorghum breeders Jack Casady, Dan Rodgers, and Mitch Tuinstra; alfalfa breeder Ted Sorensen and alfalfa geneticist Dan Skinner; corn breeder Clyde Wassom; grass breeder Francis Barnett; and soybean breeder William Schapaugh, and he published journal articles together with each of these colleagues. He also worked with weed control specialists Kurt Feltner and Oliver Russ on cytogenetic effects of herbicides on sorghum. He was also interested in anther culture and immature embryo rescue of wide crosses involving crop species. He developed and cooperatively released germplasms of wheat, sorghum, and alfalfa with respective breeders. In addition, he worked with Arthur Dayton, George Milliken, and Raj Nassar in the Department of Statistics on gene action and phenotypic stability. Since the middle of the 1970s, he worked closely with those in the Department of Biochemistry, including Bryce Cunningham on peroxidase activity of sorghum height isogenic lines and S. Muthukrishnan on mitochondrial and chloroplast genomes and crop transformation or genetic engineering. He taught Plant Genetics (since 1968) and Quantitative Genetics in Relation to Plant Breeding (since 1975) at the graduate level. He is a member of American Society of Agronomy, American Genetics Association, and Genetics Society of Canada.

During his tenure, 130 graduate students, visiting scientists, and postdoctoral fellows worked in his laboratory, for times ranging from six months to four years. He and his colleagues published three books, more than 125 journal articles, and numerous abstracts and newsletters. He encouraged his coworkers in the laboratory to present oral presentations and posters at professional meetings, such as American Society of Agronomy, Plant and Animal Genome, and *In Vitro* Biology, to learn and to introduce research findings. His basic philosophy was to compete with yourself instead of with others; if one is predestined to accomplish 100 things in a lifetime and, due to extra effort, accomplishes 105 things, then he/she is a winner. He received Fellow awards from American Society of Agronomy and Crop Science Society of America, the distinguished professorship of Gamma Sigma Delta (KSU Chapter), and several distinguished professorships from academic institutions of China. He is a member of Alpha Zeta, Gamma Sigma Delta, Phi Kappa Phi, and Sigma Xi. After 41 years of service at K-State, Liang retired in spring 2006.

Wheat Improvement

Gary M. Paulsen and Allan K. Fritz

Wheat is the most important crop in Kansas. It supports growers, their communities, and an array of industries, as well as feeding millions of people around the world. Kansas didn't become the "Wheat State" by accident. Settlers introduced numerous kinds of wheat, learned to grow them by trial and error, and suffered crop failures during many years. Today's growers, in contrast, have varieties adapted to Kansas; modern methods and machinery for producing the crop; and up-to-date information on tilling the soil, protecting the plants against adverse conditions, and marketing the grain.

Most of the improved varieties and much of the modern technology for producing wheat in Kansas were developed at K-State. As recently as 2003, more than three-fourths of the Kansas acreage planted was planted to K-State varieties, and more than half of the 2006 Kansas wheat crop was planted to K-State varieties (Table 1). These varieties became popular because they are productive, yield high-quality grain, and resist the pests and adverse weather that often damage wheat in the state. Their contribution to Kansas agriculture amounts to hundreds of millions of dollars each year.

Table 1. Percentage of 2006 Kansas wheat crop planted to varieties released by K-State.

Variety	Percentage of 2006 crop
Jagger	19.7*
Overley	15.3
2137	3.1
Ike	1.1
Karl/Karl 92	1.1
2145	0.8
Stanton	0.8
Trego	0.4
Blends**	7.9
Other**	0.4
Total	50.6

**Data from Kansas Agricultural Statistics Service release February 1, 2006.*
***Percentage estimated as the proportion of named varieties in the 2006 Kansas wheat crop.*

The high percentage of K-State varieties in the 2006 crop continues a long tradition of improving wheat for Kansas growers. Thirty-six varieties have been released since 1917, each of them an improvement in some respect over its predecessors (Table 2). Several of the varieties represented exceptional advances. 'Tenmarq', the first variety developed by hybridization, greatly increased the productivity and quality of grain in the state. 'Pawnee', the most important of the "Indian varieties" released during the World War II era, was widely adapted and grown throughout the Midwest. 'Newton' was the first popular semi-dwarf variety, and greatly increased the yield potential of wheat in Kansas. 'Jagger', another semi-dwarf variety, combined high yield with excellent quality.

In addition to improved productivity and resistance to pests and weather, all of the quality traits of Kansas wheat have been maintained and many of them have been enhanced (Table 3). It is difficult to improve some traits, such as protein, as yield increases because of an inverse relationship between those traits and yield. But new varieties have been developed with the same amount of protein as old varieties, plus a longer flour mixing time, larger loaf volume, better crumb structure, and a much higher quality rating.

Development of new crops for a region typically follows a sequence of evaluation of introduced varieties, selection of genotypes from the genetic diversity in introduced varieties, and hybridization to create new genotypes. Improvement of wheat at K-State followed the same course. Early researchers tested numerous varieties from around the world, selected strains from the best introductions to develop the first improved variety, and then began crossing parents with desirable traits to create new varieties.

Introduction of Wheat in Kansas

The first wheat crop in Kansas was grown at the Shawnee Methodist Mission near Fairway in Johnson County in 1839. Production spread westward as the state was settled during the 1800s, but yields were low. Annual state wheat production did not reach one million bushels until 1866 and 100 million bushels until 1914, but production then climbed to over 500 million bushels in 1997. Yields averaged less than 20 bu/acre until 1914, and less than 30 bu/acre until 1969, but then reached 40 bu/acre in 1983 and the record of 49 bu/acre in 1998.

Lack of suitable varieties was a major cause of low wheat production during the early years. Settlers mostly used familiar varieties that they brought with them to Kansas from the eastern United States or western Europe. Most of these wheats were ill-adapted to the state. Spring wheat predominated until the 1870s, but delayed maturity exposed it to attack by rust diseases and the hot, dry conditions of late spring and early summer. Winter wheats were mostly soft-grain varieties that lacked adequate hardiness to freezing during winter and drought during spring. The few hard wheats that were available were heavily discounted by millers because of the difficulty in processing them.

Four introductions were particularly important for improving productivity of wheat in Kansas. The first was the well-known import of 'Turkey' hard red winter wheat from the Crimea to south-central Kansas by German Mennonite settlers from the Ukraine in 1873. Many families brought a bushel or so of the variety with them to the state. Both 'Turkey' wheat and the traditional production practices of the

Table 2. Wheat varieties released by Kansas State University, and their class, pedigree, year released, and highest percentage of state wheat area.

Variety	Class	Pedigree	Year	Area (%)
Kanred	HRWW*	Selection from Crimean	1917	19**
Tenmarq	HRWW	Marquis/P-1066	1932	37
Kawvale	SRWW	Selection from Indiana Swamp	1932	6
Comanche	HRWW	Oro/Tenmarq	1942	21
Pawnee	HRWW	Kawvale/Tenmarq	1942	39
Wichita	HRWW	Early Blackhull/Tenmarq	1944	25
Kiowa	HRWW	Chiefkan//Oro/Tenmarq	1950	13
Ponca	HRWW	Kawvale/Marquillo//Kawvale/Tenmarq	1951	14
Bison	HRWW	Chiefkan//Oro/Tenmarq	1956	27
Kaw/Kaw 61	HRWW	Oro//Mediterranean/Hope/Early Blackhull/Tenmarq	1960/65	16
Ottawa	HRWW	Mediterranean/Hope//Pawnee/Oro/Illinois no. 1// Comanche	1960	9
Parker	HRWW	Quivira/Kanred/Hard Federation//Prelude/Kanred/ Kawvale/ Marquillo//Kawvale/Tenmarq	1966	9
Parker 76	HRWW	Parker/Agent	1976	
Shawnee	HRWW	Selection from Ottawa	1967	1
Eagle	HRWW	Selection from Scout	1970	23
Cloud	HRWW	Scout/Agent	1973	1
Kirwin	HRWW	Parker/Bison	1973	—
Sage	HRWW	Agent/Scout	1973	15

*HRWW = hard red winter wheat, SRWW = soft red winter wheat, HWWW = hard white winter wheat.
** Data compiled from Kansas Agricultural Statistics Service reports.

Mennonites were well-suited to Kansas, and often enabled them to successfully grow a crop when other settlers' crops failed.

Two important introductions of 'Turkey'-type wheats were made by M.A. Carleton, a graduate (B.S. 1887, M.S. 1893) and former faculty member (1893-94) of K-State. Carleton, a cerealist and plant explorer for the U.S. Department of Agriculture, introduced 'Crimean' and 'Kharkof' hard red winter wheats from Russia in 1900. 'Crimean' became the parent of the first improved wheat varieties developed by K-State. 'Kharkof', being hardier than 'Turkey', extended production of hard red winter wheat throughout Kansas and into more northern states.

The fourth important introduction was 'Norin 10' and other semi-dwarf wheats by S.Cecil Salmon, also a graduate (M.S. 1913) and former professor (1913-31) at K-State. The short, stocky wheats were collected by Salmon while serving as a crop consultant with the U.S. Army of Occupation in Japan in 1946. Similar lines were used by CIMMYT in Mexico to create the varieties that started the Green Revolution in developing countries and are in the pedigrees of more than 95% of the varieties grown in Kansas today.

Wheat Improvement by Evaluation

Early researchers at Kansas State Agricultural College (KSAC; now K-State) faced the same uncertainties with wheat as settlers did. The types of

Variety	Class	Pedigree	Year	Area (%)
Trison	HRWW	Triumph/Bison	1973	2
Larned	HRWW	Ottawa/ Scout	1976	12
Newton	HRWW	Pitic 62/Chris sib//Sonora 64/Klein Rendidor/Scout	1977	41
Arkan	HRWW	Sage/Arthur	1982	15
Dodge	HRWW	KS73H530 (Newton sib)/ KS76HN1978-1 (Arkan sib)	1986	—
Norkan	HRWW	Plainsman V/(KS76H3705) Larned/Eagle//Sage	1986	—
Karl/Karl 92	HRWW	Plainsman V/Kaw/Atlas 50// Parker/Agent	1988/92	24
Ike	HRWW	Dular/Eagle//Cheney/Larned/Colt	1993	11
Jagger	HRWW	KS82W418/Stephens	1994	45
2137	HRWW	W2440/W9488A//2163	1995	23
Betty	HWWW	KS82W418/Stephens	1998	—
Heyne	HWWW	KS82W422/SWM754308/KS831182/KS82W422	1998	—
Trego	HWWW	KS87H325/Rio Blanco	1999	2
Lakin	HWWW	KS89H130/Arlin	2000	—
Stanton	HRWW	PI220350/KS87H57//TAM200/KS87H66/ KS87H325	2000	1
2145	HRWW	HBA142A/HBZ621A//Abilene	2001	2
Overley	HRWW	U1275-1-4-2-2/Heyne sib//Jagger	2003	15
Danby	HWWW	Trego/Betty sib	2005	—

wheat that were adapted to the state, preparation of the soil, fertility requirements, the optimum date and rate of seeding, and control of the major diseases and insects were all unknown.

Research on wheat at K-State was started by J.S. Hougham, the first Professor of Agricultural Science. Spring wheat sown by him in March 1868 on land bequeathed to K-State when it was formed in 1863 yielded 20 bu/acre of "first class grain." Winter wheat planted in September 1868 also gave a good harvest, but six varieties sown in October were destroyed by freezes in February and March.

Progress was slow during the early years because the new college lacked facilities for research. The problem was partly remedied when Manhattan Township and the Kansas Legislature approved funds for land and equipment.

F.E. Miller became Professor of Agriculture and Farm Superintendent in 1873. He initiated research on variety evaluations, soil preparation, crop rotations, and fertilizers for wheat and was the first scientist to emphasize grain quality as well as yield.

Miller was replaced in 1874 by E.M. Shelton, who focused on mixed farming of crops and livestock, but also conducted considerable experimentation with wheat. In addition to testing numerous varieties, Shelton evaluated wheat for pasture; rotations; use of manure, salt, and plaster (gypsum) as fertilizers; and started a 1-acre plot of continuous winter wheat to measure the long-term fertility of the soil. Although wheat was well established in the state, failed crops during 1885, 1886, and 1887, primarily from winterkilling, prompted Shelton to advance *The Argument for Wheat-raising in Kansas* (KSAC Bulletin 7, 1889).

The soft red winter wheats 'Little May', 'Big May', 'Red May', and 'Zimmerman', which Shelton considered to be "local names for one and the same variety" (KSAC Bulletin 7), were named by K-State as its standard varieties in 1889. When C.C. Georgeson replaced Shelton in 1890, he substituted 'Currell', another soft red winter wheat, for general cropping (KSAC Bulletin 33, 1892).

Appreciation of the merits of 'Turkey' hard red winter wheat came slowly. A number of varieties known as 'Russian', 'Red Russian', and 'Turkey' had been tested without distinction by K-State during the 1880s. On October 6, 1890, Georgeson received and planted a variety labeled 'Turkey' (Steck.) (KSAC Bulletin 20, 1891). This variety was no better than its predecessors the first year, yielding only 14.94 bu/acre. By 1896, after six years of testing, however, Georgeson described the variety as "rapidly coming to the front as a heavy yielder" and "perhaps the hardiest wheat of any we have tested" (KSAC Bulletin 59). This was the first official report of the superiority of 'Turkey' hard red winter wheat over several years. In 1898, 'Turkey' became K-State's standard hard red winter wheat and 'Zimmerman' continued as its standard soft white wheat (KAES Press Bulletin 1).

Establishment of the Hays Branch Experiment Station in 1901 expanded research with wheat to an area that was more representative of the major production regions of Kansas than the Manhattan location was. Early work at Hays emphasized evaluation of 'Kharkof' and 'Turkey', their cultural requirements, and seed production. The station later became an important source of new varieties for western Kansas.

In addition to evaluating introduced types, the Manhattan and Hays stations promoted wheat production by increasing seed supplies of the best varieties, particularly 'Kharkof'. The KSAC Press Bulletin No. 134 in 1909 announced that sufficient seed of improved varieties was available to plant one-half of the acreage in the state and "the problem of wheat improvement in Kansas will have been solved."

Recognition of the value of 'Turkey'-type wheat and distribution of improved seed helped to make Kansas the "Wheat State." By 1919, when the first official survey was taken, 'Turkey'-type wheat, about half of it 'Kharkof', occupied more than 82% of the 11.6 million acres of the crop in the state. But the need to improve wheat did not end. New opportunities and technologies, new races of pests, and the necessity of being competitive mandated continuing genetic improvement of wheat by selection and hybridization.

Wheat Improvement by Selection

The first improved variety released by K-State was developed by H. Fuller Roberts, a Professor of Botany. Roberts planted 554 rows of wheat, each of them from one spike of the variety 'Crimean', in 1906. Selections were replanted in rows from 1907 to 1910 and in field plots from 1911 onward. Seed of the best line was distributed to 1,500 farmers for testing in 1914 and released by K-State as the variety 'Kanred' in 1917 (Table 2). The new variety was earlier in maturity, hardier, and more productive than 'Crimean' or 'Turkey'.

The only soft red winter wheat released by K-State also resulted from selection. 'Kawvale' was selected from 'Indiana Swamp' by John H. Parker, Professor of Agronomy from 1917 to 1938 and the first trained plant breeder in the department. It had high yield and resistance to leaf rust, and was intended for production in southeastern Kansas.

Parker came to K-State with degrees from Minnesota and Cornell, and later earned the Ph.D. from Cambridge. In addition to heading the small grains program, Parker was also in charge of corn improvement for many years. Parker was both a prolific developer of new wheat cultivars and an inspiring teacher.

A typical tribute was paid to Parker by Paul C. Mangelsdorf in his book, *Corn: Its origin, eEvolution and Improvement* (1974). In it, Mangelsdorf states that he had the "good fortune" to serve as Parker's assistant for four years and credits him for recommendations that started his career in corn genetics and evolution.

'Kaw 61', a hard red winter wheat, was a repurification of 'Kaw' by Elmer G. Heyne, Professor of Agronomy from 1947 to 1982. Heyne also selected 'Shawnee' for improved baking properties from 'Ottawa' and released it in 1967.

Heyne, who started at K-State as a USDA agronomist in 1938, assumed responsibility for the wheat program in 1946. His degrees were from Nebraska, K-State, and Minnesota. Heyne developed 10 wheat cultivars, one barley cultivar, six oat cultivars, three corn lines, and four sorghum lines during his career at K-State. His last wheat cultivar, 'Newton', occupied more than 41 percent of the Kansas wheat acreage when he retired in 1982. Heyne also initiated development of hard white winter wheat, a new class that is becoming popular in the Great Plains.

Heyne had a scholarly approach to plant breeding and was major professor for 60 students. He started and endowed the departmental Parker Memorial Library and initiated and edited the *Annual Wheat Newsletter* until his retirement. He was also editor of the second edition of the ASA/CSSA/SSSA monograph, *Wheat and wheat improvement* (1987).

Awards received by Heyne included fellow of ASA, CSSA, and AAAS; the ASA Agronomic Achievement Award; the CSSA DeKalb-Pfizer Crop Science Distinguished Career Award; and the University of Minnesota Outstanding Achievement Award.

The variety 'Eagle' was selected from 1,800 spikes of 'Scout' in a project begun in 1962 by R.D. Livers, leader of the Hays wheat program from 1962 to 1979. The new variety had exceptional breadmaking properties (Table 3).

Another high-quality variety, 'Karl 92', was selected from 'Karl' by Rollie G. Sears, leader of the Manhattan wheat program from 1982 to 2000. 'Karl 92' had higher yield and better disease resistance than its parent variety.

Sears joined the department in 1980 and succeeded Heyne as leader of the wheat improvement program in 1982. Sears had a B.S. degree from Montana State and M.S. and Ph.D. degrees from Oregon State.

Elmer G. Heyne with Newton wheat, 1982.

Wheat Improvement by Hybridization

Hybridization of wheat at K-State started in 1899, before the rediscovery of Mendel's Laws of Inheritance. Press bulletin No. 1 from the Farm Department announced that 3,000 crosses were made that summer and the progeny would be planted in the autumn. No record was found of the results of the experiment.

The first variety developed by hybridization was 'Tenmarq', from a cross between P-1066 (a selection from

'Crimean') and 'Marquis' (a Canadian hard red spring wheat) (Table 2). The cross was made by M.N. Levine, an assistant in Plant Pathology, under the direction of Parker in 1917, and the initial selection of the new variety was done in 1921. 'Tenmarq' was noted for early maturity, high yield, and excellent quality (Table 3).

Many other well-known varieties – 'Comanche', 'Pawnee', 'Wichita', 'Ponca', 'Kiowa', and 'Bison' – originated from Parker's program (Table 2). 'Comanche', which came from a cross in 1928, had high yield and test weight and good resistance to many diseases. 'Pawnee', also from a cross in 1928, was selected at the University of Nebraska; it had many excellent characteristics and was highly popular because of its wide adaptation.

Parker resigned from K-State in 1938 to become director of the Kansas Wheat Improvement Association. He became the founding director of the Malting Barley Improvement Association in 1945, a position that he held until his death in 1956.

Louis P. Reitz, a native of Belle Plaine, succeeded Parker in 1939. Reitz had degrees from K-State and Nebraska and later obtained the Ph.D. from Minnesota. Several of the varieties that originated in Parker's program were selected and released by Reitz, including 'Wichita', which was intended to replace the variety 'Early Blackhull' because of its good yield and quality (Table 2). The wheat cultivars 'Comanche' and 'Pawnee' also were released during Reitz's tenure.

Reitz resigned from K-State in 1946 to become the USDA coordinator of the wheat improvement programs in the 11 southern Great Plains states. He was named director of the USDA national wheat improvement program in 1955. Reitz received the K-State Distinguished Service in Agriculture Award in 1979.

Two important varieties were developed by A.F. Swanson at the Hays Branch Experiment Station during the 1950s (Table 2). 'Kiowa', from a cross made by Parker in 1938, was released in 1950 because of its high yield and excellent adaptation to western Kansas. 'Bison' came from the same cross and was selected by Swanson for improved bread-baking quality.

Table 3. Grain quality traits of wheat varieties released by Kansas State University, relative to 'Turkey' hard red winter wheat.*

	Quality trait						
Variety	**Flour yield (%)**	**Flour protein (%)**	**Absorption (%)**	**Mixing time (min)**	**Loaf volume (mL)**	**Crumb grain score**	**Quality index**
Turkey	72	11.5	56	2.4	935	6.3	14.7
Tenmarq	75	12.0	56	2.7	943	8.0	18.6
Comanche	74	12.0	58	3.1	917	7.0	18.5
Pawnee	73	11.4	55	2.0	928	6.8	13.8
Wichita	76	11.2	54	2.2	946	7.2	15.3
Bison	74	11.7	56	2.9	985	7.7	24.0
Eagle	75	12.3	58	4.6	922	8.0	23.9
Newton	72	10.9	55	3.3	980	7.7	21.7
Karl	75	11.9	58	5.1	1003	8.0	28.1

*Adapted from Cox, T.S., M.D. Shogren, R.G. Sears, T.J. Martin, and L.C. Bolte. 1989. Genetic improvement in milling and baking quality of hard red winter wheat cultivars, 1919 to 1988. *Crop Science* 29:626-631.

The Joe Jagger family with Gerry Posler (L) and Rollie Sears (R) in a foundation field of Jagger wheat.

Eight varieties were developed by hybridization by Heyne during his career (Table 2). 'Ponca' came from a cross by Parker in 1935, and was resistant to Hessian fly and had excellent baking properties. 'Kaw', from a cross in 1941, was resistant to leaf rust and bunt and had stable grain quality under adverse conditions. The cross for 'Ottawa' was made in 1943, and the variety was released for its excellent resistance to Hessian fly and soil-borne mosaic virus. 'Parker' originated from a series of crosses began in 1920; it matured early and was resistant to Hessian fly and leaf rust. Seed of 'Parker'/'Agent' from Colorado State University was backcrossed to 'Parker' in 1967, and a single spike was increased and released as 'Parker 76' for resistance to leaf rust and Hessian fly. 'Cloud' also came from a composite of lines from a cross at Colorado State University that were screened for resistance to leaf and stem rusts. 'Trison' was developed for early maturity and enhanced dough and baking properties. The last variety released by Heyne, 'Newton', came from a single plant selected out of 6,400 lines of a cross by Pioneer Hi-Bred International. The variety was the first widely successful semi-dwarf wheat in Kansas.

Development of hard white winter wheat for Kansas was initiated by Heyne in the early 1970s. Much of the wheat improvement at Manhattan and most of the program at Hays now emphasize hard white winter wheat.

Several excellent varieties were released by Livers at Hays, in addition to 'Eagle', during the 1970s (Table 2). 'Kirwin' resulted from crosses that began in 1958, and was selected in 1964 for resistance to Hessian fly and high test weight. 'Sage' came from crosses in 1964, and was selected in 1969 for high yield and resistance to leaf rust. Another variety, 'Larned', came from a series of crosses from 1963 through 1966 to transfer resistance to Hessian fly from 'Ottawa' to a 'Scout'-type wheat.

Crosses for 'Arkan', 'Dodge', and 'Norkan' were made by Livers during 1970-71 and 1976-77. All of the varieties were selected and released by Livers' successor, T. Joe Martin, leader of the Hays wheat program from 1979 to the present (Table 2).

New wheat varieties begin with hand crosses made in the greenhouse.

'Arkan' had outstanding resistance to leaf rust and was intended primarily for southeastern and south central Kansas. Both 'Dodge' and 'Norkan' had excellent disease resistance and were adapted to western and northern areas of the state, respectively.

Two additional hard red winter wheats and two hard white winter wheats were developed by Martin (Table 2). 'Ike' was from a last cross made in 1982-83 and had high yield, disease resistance, and quality. 'Stanton' came from a final cross in 1988-89, and combined outstanding performance with resistance to Russian wheat aphid. The two hard white winter wheats, 'Trego' and 'Lakin', from crosses in 1988 and 1989, respectively, were recommended for production in western Kansas. 'Trego' had particularly exceptional yields under dryland conditions, and resisted preharvest sprouting, a problem of white wheat.

Two varieties that occupied significant acreage, 'Karl' and 'Jagger', were released by Sears during 1988 and 1994, respectively (Table 2). 'Karl', from a cross made by Heyne in 1977, had superior breadbaking quality and was adapted to eastern and central Kansas. 'Jagger' was developed from a cross in 1984 and became popular across the state because of its high yield, disease resistance, and quality. Another release by Sears, '2137', was selected from lines donated by Pioneer Hi-Bred International; it produced high yields and resisted many diseases.

The first hard white winter wheat cultivars developed at K-State, 'Betty' and 'Heyne', also came from Sears' program. 'Betty' was selected from a field of 'Jagger' in 1991 and released for production in western Kansas. Another white wheat, 'Heyne', had excellent disease resistance and was recommended for central and south-central Kansas.

Several of the cultivars released by Sears, particularly 'Karl'/'Karl 92' and 'Jagger', were highly popular with Kansas farmers. Sears was a fellow of ASA and CSSA and received the K-State Graduate Research Award. He resigned in 2000 to become a wheat breeder at Agri-Pro.

The hard red winter variety '2145' was selected from Pioneer Hi-Bred International lines by Sears in

1994. It was released by Sears' successor, Alan K. Fritz, primarily for production in central Kansas.

Fritz assumed responsibility for the wheat improvement program in 2000. Fritz had a B.S. from Nebraska, and obtained M.S. and Ph.D. degrees from K-State, with Sears as his major professor.

Fritz's program includes both hard red and hard white winter wheats, with emphasis on stress tolerance, disease resistance, and quality. He released the cultivar 'Overley' in 2003 from a cross made by Sears in 1994.

'Overley' produced high yields in central Kansas and also represented an improvement in seed size. Martin released the hard white wheat 'Danby' in 2005. It was well adapted to western Kansas and represented a significant improvement in tolerance to preharvest sprouting.

Other Contributors to Wheat Improvement at K-State

Development of new varieties is a team effort at K-State. Many scientists and agencies other than those mentioned here are essential to the program. Agronomists test the varieties, increase the seed, and develop improved production practices. Plant pathologists screen experimental lines for disease resistance, and entomologists screen for insect resistance. Cereal chemists evaluate the milling and baking quality. Scientists from the U.S. Department of Agriculture contribute greatly to the program, and cooperate in development and release of new varieties. The Kansas Crop Improvement Association increases and distributes seed to growers and provides funds for the wheat program. Additional funding has been furnished by the Kansas Wheat Commission, USDA, and other agencies.

Primarily adapted from: A History of Wheat Improvement at Kansas State University by Gary M. Paulsen, AES Keeping Up With Research, SRL 136. March 2003. Contribution no. 03-301-S from the Kansas Agricultural Experiment Station.

Harvesting wheat varieties with a plot combine.

Harvesting grain sorghum plots at the Hesston Experiment Field, 2003.

Sorghum Improvement

Mitch Tuinstra

Grain sorghum is often described as a "wonder crop" of semi-arid and arid agriculture. It is prized by producers because it is so tolerant of hot and dry conditions. Given these characteristics, it is not surprising that sorghum is the number one summer crop in Kansas in most years.

The history of sorghum introduction into the United States, and the success of subsequent crop improvement efforts through variety selection and plant breeding, is an amazing story, particularly when we consider that most sorghum landraces introduced to the United States from Africa or India will not even flower or produce grain during the summer growing season; most varieties from these growing areas are day-length sensitive. Despite these challenges with crop adaptation, photoperiod-insensitive varieties from Egypt were identified and successfully introduced into California in 1874. White and Brown Durra were some of the first grain sorghum varieties introduced to the United States. Although both varieties were introduced at the same time, the 'White Durra' variety won popularity with producers, and production soon expanded to the Central Great Plains region. 'White Durra', also known as Egyptian rice corn, was popular in Kansas as early as the 1880s. Following the successful introduction of 'White Durra', several more grain-type varieties were introduced into the United States between 1876 and 1910. These varieties included Red and White Kafir, 'Giant Yellow Milo', 'Blackhull Kafir', 'Shallu', 'Pink Kafir', 'Feterita', and 'Hegari'. The germplasm represented in these varieties provided the basic building blocks for early efforts in sorghum variety development.

After the successful introduction of numerous varieties, considerable effort was made to characterize the performance of these varieties in the diverse growing environments represented in Kansas. As early as 1900, H.M. Cottrell *et al.* published an Experiment Station bulletin (No. 93) describing the field performance characteristics and feed quality attributes of Kafir-Corn. More detailed sorghum performance studies were described by Claude C. Cunningham and R. Kenney in 1917 (KAES Bulletin No. 218) and Hilmer H. Laude and A.F. Swanson in 1933 and 1934 (KAES Bulletins No. 265 and No. 266). These studies generally showed that the kafir varieties had greater yield potential and better adaptation in the eastern and central parts of Kansas and the milo varieties performed better in the drier areas to the west.

In the years after sorghum was introduced into the United States, most sorghum varieties were rather tall (2–3 m) and were harvested by hand. With the development of mechanized farming equipment in the 1920s and 1930s, considerable effort was made to develop or adapt sorghum varieties for use in mechanized production and harvesting. Public and private sorghum researchers and sorghum producers in Texas, Oklahoma, and Kansas identified and selected sorghum varieties with shorter stature and more erect culms. Sorghum breeding activities were initiated in the Department of Agronomy at K-State at this time. John H. Parker and Elmer G. Heyne, with the state, as well as Francis L. Barnett and Dale Weibel, with the USDA, began by making selections within sorghum varieties, and later they planned crosses for population development in sorghum. These early efforts focused on development of forage sorghum varieties, as well as on improving plant type and yield in the grain sorghum varieties. 'Atlas', a famous and widely grown forage variety, was developed and released in 1928.

Sorghum improvement efforts gained momentum when A. Jack Casady was hired by the USDA in the 1950s, with the mandate to develop a grain sorghum breeding program at Manhattan. The intended focus of the program was to develop new combine-type sorghum varieties, in collaboration with sorghum breeders stationed at Hays and Colby, Kansas, and Lincoln, Nebraska. A fundamental shift in technology in sorghum cultivar development occurred at this time. In the late 1940s, J.C. Stephens and R.F. Holland with the Agricultural Experiment Station in Texas discovered a cytoplasmic male-sterility system in sorghum, based on differences in milo and kafir cytoplasm. Male-sterile lines were developed and used to produce F1 hybrid sorghum varieties for testing in 1954. The first hybrid varieties were sold to farmers in 1956, and these hybrids rapidly replaced traditional inbred varieties. By 1960, nearly all of the grain sorghum acreage in the United States was planted with hybrid varieties. Because of

Newton Ochanda making sorghum crosses, 2006.

this change, sorghum crop improvement programs around the country began focusing on development of new parent lines that could be used to produce hybrid varieties.

Casady and his collaborators released 29 sorghum parent lines (KS1-KS29) between 1958 and 1968. This set of material represented both seed parents and pollinator parents with good drought-tolerance characteristics. Some of the most valuable lines in this set of material were a few yellow-endosperm seed parents derived from crosses involving Short Kaura. Because of the interest of the private seed industry in this material, Casady released another set of 10 seed parents (KS45-KS54) with yellow endosperm characteristics in 1972. These lines were widely used in the private seed industry for production of hybrids and in breeding programs. KS55 was released as a grain sorghum pollinator parent in 1973. Casady also released seven hybrid forage sorghum seed parents (KS58-KS64) in 1977, before retiring in 1978.

Dan Rodgers was hired by the state in 1978 to continue the sorghum breeding effort. Rodgers released one forage sorghum seed parent and six forage sorghum pollinators in 1985. This release also included three grain-type pollinators. These lines (KS67-KS83) were derived from populations initiated by Casady. Rodgers also developed and released seven grain sorghum populations (KP7B, KP8B, KP9B, KP10R, KP11R, KP12B, and KP13B). The primary purpose of this release was to improve and diversify the pollinator and seed-parent germplasm pools of sorghum for traits important to producers in Kansas, especially drought and heat tolerance. Shortly after starting his research program for the state, Rodgers accepted a sorghum breeding position with Pioneer Hi-Bred International in Texas. Tragically, he was killed in a car accident after starting his new job in the private seed industry.

Paula Bramel-Cox was hired by the state in 1985 to continue sorghum breeding efforts in Manhattan. Bramel-Cox directed the sorghum program from 1985 to 1996. The main emphasis of her research program was sorghum germplasm enhancement and population improvement. In 1990, the program released two bulks of seed with Biotype E greenbug resistance, KS Bulks 30-31. She also released two chinch bug resistant lines, KS94 and KS95, to address the continuing problem of chinch bug infestation in sorghum in east-central Nebraska, Kansas, and Oklahoma. Bramel-Cox left K-State in 1995 to become head sorghum geneticist and germplasm curator at the ICRISAT Center in India.

Mitch Tuinstra was hired in 1997 to continue the sorghum breeding and genetic research program in the Department of Agronomy. The program released a Biotype I greenbug-resistant line, KS97, and an elite pollinator parent, KS98, in 2000 from populations initiated by Bramel-Cox. Because of changes in university policy, these were the last publicly released sorghum lines from the program.

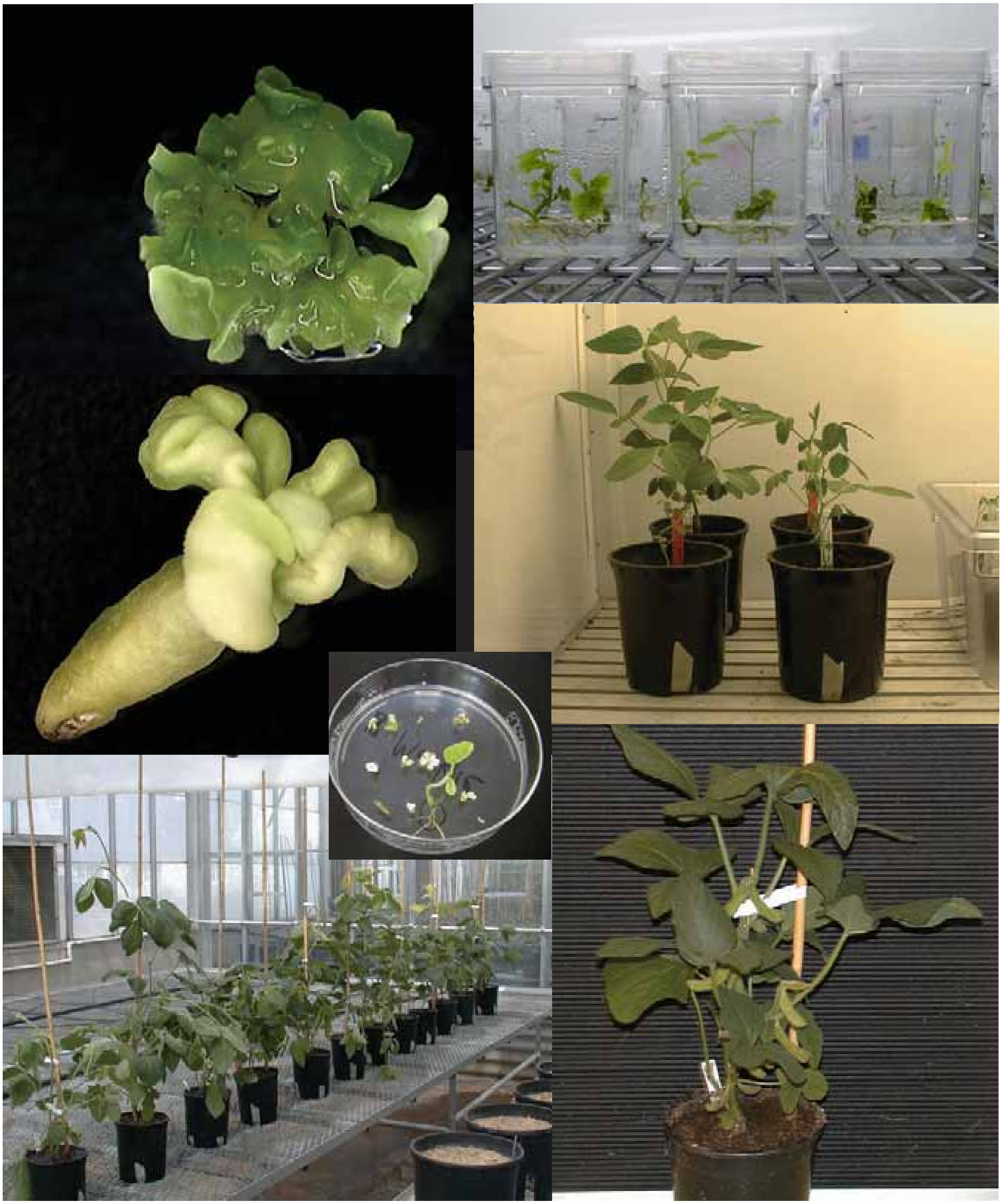
Around the turn of the century, the University initiated changes in policy regarding development and protection of intellectual property, including development and release of parent lines and varieties. These changes were associated with an increased emphasis on intellectual property protection in the seed industries, especially as it related to development and commercialization of genetically modified organisms and traits. A new mechanism was needed for release and exchange of sorghum parent lines and germplasms among public and private research institutions. Tuinstra worked with representatives of public and private research programs to develop a series of Material Transfer Agreements that would govern the exchange and use of genetic materials. These agreements preserved free exchange and use of breeding materials among public institutions. Release of parent lines to the private seed industry is now governed by research and commercialization agreements.

The main focus of research in Tuinstra's program is development of parent lines that produce high-yielding, drought-tolerant hybrids. Three grain sorghum parent lines have been released since 2000. Line 00MN7645 was released in 2003 and represented a new type of staygreen, drought-tolerant, pollinator parent. This line represents a new baseline for pollinator-parent development. Some of the first food-grade sorghum parent lines, 01MN1589 and 01MN7951, were released in 2004 by the Manhattan program. Grain harvested from hybrids produced using these line can be used to make high-quality human food products from sorghum flour.

As we look to the future of sorghum and the sorghum breeding program at K-State, we see a crop that faces challenges for acreage from several crops, including corn and soybean, which have tremendous public and private research investments in plant breeding and biotechnology. Will sorghum continue to play an important role in dryland agriculture systems in the United States? As long as sorghum is one of the most drought-tolerant crops available to farmers in Kansas, we will continue to see this crop flourish across the state.

The following is a tribute to sorghum from the Kafir-Corn Carnival celebrated in Butler County, Kansas, in 1911. It describes the reasons why sorghum is such an important crop in the Central Great Plains:

> *"Another day has passed and still no rain. Another follows and still another until it seems that the skies have turned to brass and the fountains of heaven have dried up. Indian Corn for so many years called King, wearies of his crown, rolls, twists, shrivels, and dries beneath the pitiless rays of the burning July sun. The meadows turn brown—the farmer turns pale—the debtor avoids the severity of his creditor—gloom, despondency, and hard times like a dark mantle are about to settle over the landscape that looked so promising and fair in the early days of June."*
>
> *"But lo! Again the scene shifts. The mantle is lifted. Kafir Corn, the Queen of the Kansas prairies has, during these days of heat and drought, of burning and scorching wind, been contentedly biding her time. Until drenched by the autumn rains—soon to be converted into real gold and silver; and confidence, peace, happiness and prosperity reign throughout the land."*
>
> –Manley Arnold, 1911



Soybean improvement currently includes incorporation of novel traits through genetic engineering. These photos depict steps in the tissue culture process to develop mature transgenic plants from engineered soybean tissue.

Soybean Improvement

William T. Schapaugh

In 1889 and 1890, E.M. Shelton, H.M. Cottrell, W.M Shelton, and C.C. Georgeson introduced the soybean into Kansas as a drought-resisting plant. Seed of the first soybean variety reported to be grown on the College farm was obtained from T.W. Wood & Sons, Richmond, Virginia. Growth was reported to be vigorous through the season, but the plants were killed by frost before maturity. Four soybean varieties were tested on the College farm in 1890 to learn something of their value for this country and climate. One variety was obtained from Peter Henderson & Co., one was from home-grown seed raised on the farm in 1889, and two others were imported directly from Japan. Three of the varieties were yellow-seeded, similar to the type of soybean produced today in Kansas for protein meal and oil. One of the varieties was named Edamame. The word Edamame means "Beans on Branches." Edamame was described as a large-seeded, early maturing variety with greenish-yellow seed. Today, the term Edamame refers to a class of large-seeded soybeans that are harvested and eaten as a green vegetable.

The first planting of soybean in the United States is believed to be on a farm in Georgia in 1765. From 1804 to 1890, scientific literature in the United States occasionally referenced the exceptional qualities of soybean. One difficulty confronting agronomists at the time was that most varieties evaluated in the northern and western United States were adapted to more southern latitudes, and did not mature properly. Hence, the seed-fill period was cut short, and the yields were low. The Japanese varieties tested by E. Shelton, Cottrell, W. Shelton, and Georgeson were early in maturity to try to address this problem. The growing season in 1890 was characterized by drought during July and August, and an uncommonly early killing frost September 12th. Despite the weather, the beans did remarkably well. The work in 1890 was summarized by the statement, "Certain early varieties of the Japanese Soy bean promise to be of much value for this country as heavy producers of a highly nitrogenous feed."

After 1890, the interest in soybean production showed a marked increase. The research focus initially centered on adaptation, crop production, and utilization. The first Agricultural Experiment Station bulletin in the United States devoted entirely to soybean was Bulletin No. 92, *A new Drought-Resisting Crop–Soy Beans*, published in March 1900, and authored by H.M. Cottrell, D.H. Otis, and J.G. Haney with the Experiment Station of the Kansas State Agricultural College. This bulletin served as a soybean production handbook, providing details on the soybean plant, varieties to grow, sources of seed, planting recommendations, cultivating, harvesting, yield potential, economic value, feeding value, and faults of the crop.

Two faults were noted in the report. The college sent out small one- and two-quart lots of seed for farmers to try. Most of the farmers planting these small lots reported that the beans came up well, but that while the plants were still young, the entire patch was eaten by rabbits. To address this fault, the College refused to sell less than one bushel of beans for planting. The other observed fault was that when the beans became ripe, they shelled or shattered badly. In the coming years, plant breeding would do little for the rabbit problem, but genetic improvement of shattering resistance was a high priority for the early soybean breeders.

By 1900, the college had raised soybeans for a decade. From this experience, the recommendation from the agronomists to Kansas crop growers was to "Plant five acres or more of soy beans this spring (1900) and give them a trial." Cottrell, Otis, and Haney followed Bulletin No. 92 with Bulletin No. 96 (1900), which discussed inoculating soybean seed with bacteria to produce nitrogen-fixing nodules on the soybean roots, and Bulletin 100 (1901), which summarized the good and bad experiences that 292 farmers in 75 Kansas counties had with producing soybean during the 1900 growing season. One hundred and thirty-five farmers wrote that the soybean is a profitable crop, 68 had a favorable opinion but need further trial, 33 reported unfavorably, and 30 thought the crop a total failure. The others did not express an opinion.

It would be decades before the Kansas Agricultural Experiment Station (KAES) would hire a faculty member to specialize in soybean breeding, but breeding soybean varieties was reported in 1902 to commence by Botanist H.F. Roberts and Assistant Botanist L.F. Paull. Although the main work of the Botanical Department was wheat and corn-breeding, the botanists did extend their activities to include soybeans, with the object of improving their value as a grain crop; yield, earliness, and non-shattering qualities were the factors to which attention was chiefly directed. For several years, selections were made by this research team, and by 1906, a non-shattering selection was being increased for general planting. Roberts, Paull, and Assistant Botanist G.F. Freeman also initiated basic studies in soybean genetics, examining heredity and variation in hybrids and the distribution of parental characteristics in off-spring, that continued until at least 1908. Throughout the 1920s and 1930s, KAES agronomists continued to evaluate varieties of soybean for both hay and seed yield. Selections were made and evaluated with the goal of improving various agronomic characteristics, but it is not clear if these breeding efforts led to the release of any new soybean varieties to farmers.

Although soybeans continued to serve as an important forage crop for several decades, the acceptance of soybean meal as a part of poultry and livestock rations in the 1930s greatly increased demand for soybean products and soybean acreage in Kansas and the United States. In 1930, 27,000 acres were planted to soybeans in Kansas. By 1952, Kansas farmers planted more than half a million acres. Total planted area exceeded 1 million acres in 1973 and 2 million acres in 1987, and 3.2 million acres of soybeans are estimated to be planted in 2006. From the 1930s into the 1950s, Agronomist James W. Zahnley was responsible for evaluation of soybean varieties and experimental selections for yield of hay and seed. Mass selection and pure line breeding were conducted by KAES faculty in the 1930s; Kansas Selections 83 and 85 ranked first in seed production, along with soybean varieties ‘Pinpu’ and ‘Illini’, in field trials. Many of the selections under evaluation were recently imported varieties received from the United States Department of Agriculture (USDA), collected by W.J. Morse on trips to the Orient.

It was during the career of Zahnley that KAES began to work with the USDA in soybean breeding. In 1936, the U.S. Regional Soybean Laboratory was established in Illinois as a cooperative project between the USDA and the twelve Agricultural Experiment Stations of the north-central states, of which Kansas was a part. Work of the Regional Soybean Laboratory was directed toward the breeding of improved soybean varieties for industrial use. To provide an accurate and rapid method of evaluating new strains developed through the cooperative work, Uniform Soybean Variety and Strain tests were established in the spring of 1939. Entries in these tests were organized by maturity groups, so that strains of the proper maturity could be evaluated together in areas of adaptation. In 1942, this work was expanded to include twelve of the southern states. Kansas began participating in the Uniform Testing Program in 1943, under the leadership of Zahnley. Zahnley evaluated the strains in maturity groups III and IV at one or two locations in Kansas each year from 1943 to 1953. Manhattan and Thayer, Kansas, served as the primary test locations over this period, but testing was also conducted at other sites, such as Mound Valley.

In the 1950s and 1960s, participation in the Uniform Tests grew. In 1953, Verlin Peterson at Thayer and L.C. Jones at Mound Valley joined Zahnley in conducting evaluations. When Zahnley retired in 1954, J.W. Schmidt provided leadership for the Uniform Testing program for a few years until E.L. Mader, who joined the Agronomy faculty in 1948, assumed responsibility for the program. For more than 30 years, KAES agronomists: F.E. Davidson, R.N. Ford, L.B. Hertz, J.D. Ives, L.C. Jones, K. Kelly, G. Kilgore, J. Lawless, E.L. Mader, L.J. Meyer, V. Peterson, O.G. Russ, J.W. Schmidt, and J.W. Zahnley contributed to soybean variety development by evaluating experimental soybean strains at experiment fields and experiment stations located at Colby, Columbus, Manhattan, Mound Valley, Newton, Ottawa, Parsons, Powhattan, and Thayer.

The contributions to soybean breeding in the United States and Kansas through the participation of KAES scientists in the Uniform Testing program cannot be underestimated. Most of the experimental soybean strains under evaluation during this time were developed by USDA breeders located in Indiana, Illinois, and Mississippi. Resources available to these breeders were not sufficient to evaluate the agronomic characteristics of these strains over broad geographic areas. Thus, the Uniform Testing program was created, and leaders like Zahnley, Peterson, and Mader enabled farmers in Kansas to benefit from these breeding efforts. Release decisions of new varieties were based, in part, on their agronomic performance in Kansas environments. The KAES joined in the release of appropriate varieties and received parent seed for increase so new varieties could be offered to farmers quickly. And when a new soybean variety was released, the KAES agronomists shared the Kansas performance data with farmers as they considered the appropriate varieties to plant.

In December 1967, Cecil Nickell was hired by Ray Olson as an assistant professor in the Department of Agronomy. He initiated a soybean breeding and genetics program and taught two plant breeding courses. Initially, considerable time was spent determining the major problems associated with soybeans in Kansas and determining the goals for the new breeding project. The overall goal was to develop high-yielding, disease-resistant, adapted soybean varieties for Kansas.

The major disease pressure came from *Phytophthora* root rot and charcoal rot. Therefore, research focused on water use of soybeans and improved selection efficiency in soybean breeding in stress environments. It became obvious that the selection environment had to change if progress in developing soybean varieties was to occur. Nickell spent the next ten years testing and developing soybean varieties under irrigation. Early testing was done under irrigation. Before release, testing of potential varieties was done in stress environments. Disease resistance and high yield were the main criteria of selection. Nickell became a full participant in the USDA regional program, collaborating with USDA and state breeders in the evaluation of experimental material and in annual planning workshops.


Screening experimental soybean lines for resistance to iron deficiency.

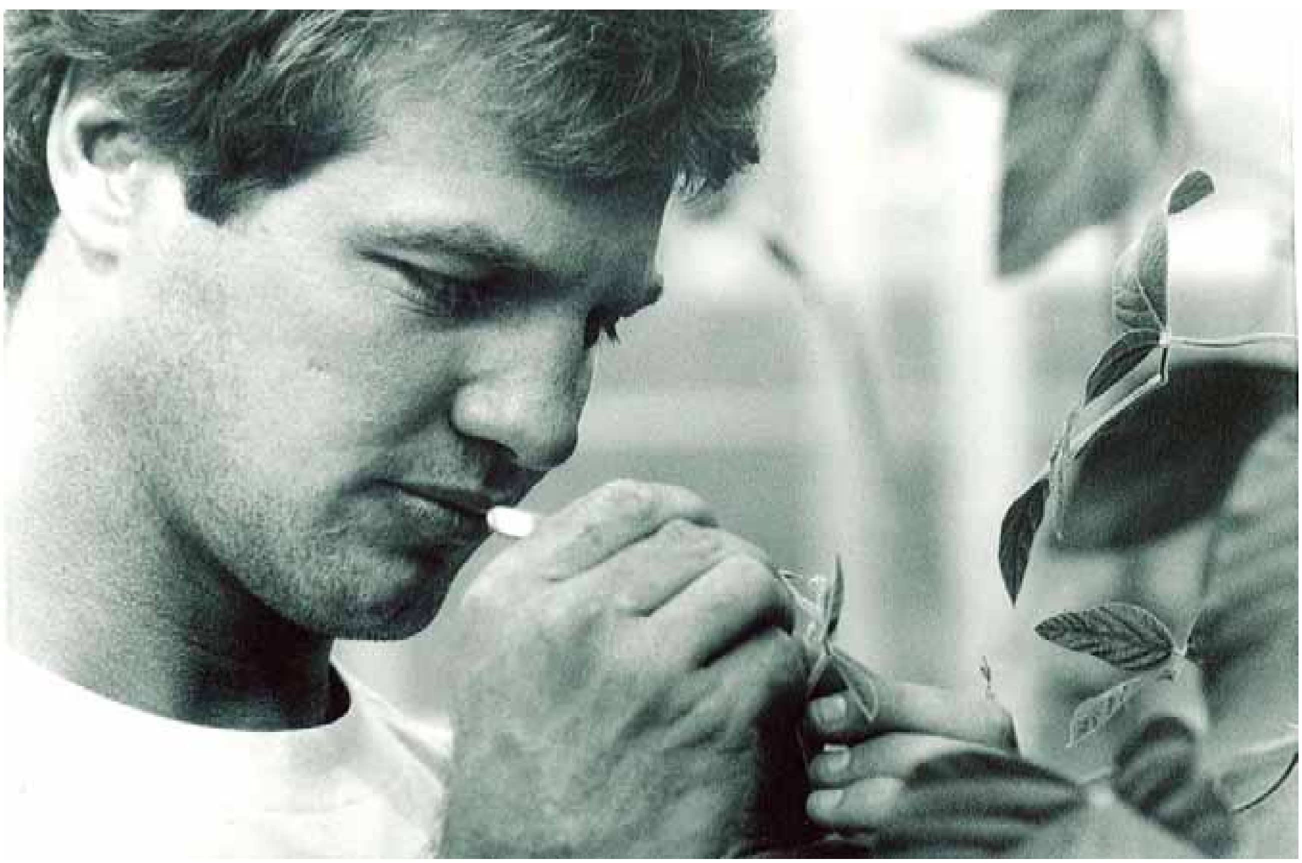
Mader and Nickell cooperated in the development and documented release of the first soybean variety, 'Columbus', from the Station. 'Columbus' originated from a selection Mader made from a population received from A. Probst, who was the USDA breeder located at Purdue University. Mader and Nickell evaluated the selection in Kansas, followed by evaluation in the Uniform Soybean Variety and Strain tests. 'Columbus' performed well and was released in 1971. Nickell followed the release of 'Columbus' with releases of six other maturity-group IV varieties from 1974 To 1981 ('Pomona', 'DeSoto', 'Sparks', 'Crawford', and 'Douglas')(Table 1). Extension activities also served as a major focus of Nickell's project. Considerable time was spent promoting soybean production in Kansas. Extension meetings were held throughout the state by Peterson (known as Mr. Soybean in Kansas). Dryland soybean acreage was concentrated in the eastern third of Kansas. In the late 1970s, however, irrigated soybean acreage expanded westward in the state.

Shortly after Nickell joined the Agronomy Department, Fred Schwenk was hired in 1969 by the Plant Pathology Department to direct the soybean pathology lab (SPL). His work began on virus problems of soybeans: soybean mosaic virus, bean pod mottle virus, tobacco ringspot virus, and tobacco streak virus. The SPL characterized the effects on the plants; the seed-borne nature of some of those viruses; and the link between bean pod mottle virus and a condition known as green-stem (in which the stem remains green long after the leaves have fallen in the fall) that was a problem confronting soybean breeders and the industry.

To address soybean breeding objectives, Agronomy and Plant Pathology programs shared greenhouse and lab space, equipment, and technical assistance. Cooperative field experiments were conducted, and the team worked together at Agronomy field days. Most important, this breeding team shared ideas. An interdepartmental (Agronomy, Plant Pathology, and, occasionally, Entomology) survey of soybean growing conditions in the state was conducted on an approximately annual basis. The survey was used to determine research priorities. This cooperation was touted by college administrators as a model of interdepartmental collaboration.

Over time, and especially in the southeastern part of the state, and under irrigation throughout the state, fungal diseases increased and were considered more important. The SPL then focused primarily on the diseases *Phytophthora* root rot, caused by *Phytophthora megasperma* var. *sojae* (*Pms*), and Charcoal rot, caused by *Macrophomina phaseolina* (*Mp*). The Agronomy and Plant Pathology programs worked together to identify races of *Pms* prevalent in Kansas and to screen new soybean lines for response. Race 4 of that pathogen, which overcame 'Clark 63' resistance, was first identified and isolated from irrigated soybeans in central Kansas. They used existing screening mechanisms developed elsewhere, but SPL researchers also developed a way to use motile spores (zoospores) to screen for resistance. This zoospore injection method greatly enhanced the efficiency of screening breeding lines for resistance to *Pms*. Varieties 'DeSoto', 'Sparks', 'Crawford', and 'Douglas' all possessed resistance to *Pms*. In January 1979, Nickell resigned his position and was hired as an associate professor of soybean breeding and genetics at the University of Illinois.

Nickell was replaced in 1979 by W.T. Schapaugh, Jr. Within a few weeks of Schapaugh's appointment, soybean research and extension leaders, most notably Peterson, Schwenk, and Wilkins, provided Schapaugh a first-hand look at the soybean industry in Kansas with visits to farming operations, tours of experiment station facilities, and meetings



Graduate student Troy Weeks making a soybean cross, 1986.

with farmers and Experiment Station faculty and staff. It was clear that the KAES and K-State stakeholders were proud of the soybean breeding activities, and planned to build upon the strengths of the program. Many positive and long-term relationships grew from these initial meetings.

Schapaugh immediately benefited from the strong interdepartmental variety development program in place. Research activities focused on stress tolerance and variety by environment interactions, with environments represented by different cropping systems and productivity levels. *Pms* studies were initiated with Schwenk. The breeding program would continue to place a great deal of emphasis on the development of maturity group IV varieties, but expanded to include development of group V varieties for southeastern Kansas, and group III varieties for northern and western Kansas (Table 1). Additional tests sites were established. Some of these sites were provided by K-State experimental field and branch experiment stations, but many farmers stepped forward to provide suitable testing environments around the state. Two of these farmers, Dale Roberds (Pittsburg, Kansas), and Vernon Egbert (McCune, Kansas) have provided one or more field testing sites for the Soybean Breeding Program each year for more than 25 years.

Funding from the Kansas Soybean Commission (KSC) enabled the program to expand. Schapaugh's arrival closely coincided with the establishment of the KSC, which was organized in 1978. This "check-off" program provided farmers a mechanism to invest in research, education, and marketing programs to enhance the soybean industry. For nearly 30 years, the KSC has been a strong supporter of soybean breeding research activities in the Department of Agronomy at K-State by funding applied and basic research in breeding and genetics, supporting staff and graduate student salaries, and assisting with purchases of major equipment items and facilities. Significant long-term funding also has been provided by the Kansas Crop Improvement Association to support soybean genetics and variety development.

By the early 1980s, attention began to focus less on *Pms* and more on the disease Charcoal rot (*Mp*). Breeding for resistance to *Pms* had incorporated both general and specific types of disease resistance into adapted soybean varieties that provided excellent protection from yield losses due to the disease.

Time and effort spent studying *Mp* attempted to quantify infection and to mimic infection under greenhouse and controlled environment-chamber conditions, as a prelude to developing a screening mechanism. Largely through the work of graduate student C.A.S. Pearson, it was determined that *Mp* growing in culture media in the laboratory had several growth patterns, depending upon the crop (e.g., soybean, corn, sorghum), supporting the idea that the fungus, which has a very wide host range worldwide, is composed of multiple strains. This became important in developing a strategy for control. Agronomic trials evaluated the interaction of variety maturity and drought stress on colonization of *Mp*. Other trials characterized the influence of cultural practices and crop rotation on disease development and severity. Because of its sporadic appearance under natural conditions and the difficulty in developing a useful and repeatable inoculation system, no reliable screening system was developed, and no true sources of genetic resistance were identified. But much was learned about the biology of the pathogen and ways to minimize losses through variety selection and cropping systems.

Later, SPL researchers used techniques from the then-emerging field of cell and tissue culture (biotechnology) to try to develop new approaches to disease control. They developed the first techniques to culture soybean somatic (leaf) cells, but none of these led to any disease control. Methods of cell and protoplast isolation developed by the SPL were useful to researchers in other states, which ultimately contributed to the type of activities conducted by plant transformationist Harold Trick.

Trick joined the Plant Pathology Department in 1998, as an assistant professor, to study plant tissue culture, transformation, and molecular biology of wheat, soybean, and maize. Trick established collaborative work on several soybean projects. In work with S. Muthukrishnan (Biochemistry) and Schapaugh, plant resistance genes were over-expressed in soybean to examine if transgenic plants had increased resistance to *Mp*, the cause of Charcoal rot, and soybean cyst nematode (SCN). Unfortunately, they did not, but in another SCN-resistance collaboration with T. Todd (Plant Pathology), M. Herman (Biology), and J. Roe (Biology) a novel approach to knock out the expression of essential genes in nematodes by genetically engineering soybean plants has reduced SCN reproduction 80%, compared with susceptible controls. In collaboration with X. Wang (Univ. of Missouri), R. Welti (Biology) and Schapaugh, transgenic soybean plants with down-regulated phospholipase D in soybean seeds are currently under evaluation in greenhouse and field experiments. Down-regulation of this enzyme in the seed may increase seed quality or oil quality during storage.

In the late 1980s, the soybean cyst nematode arrived in Kansas and rapidly spread throughout the soybean-producing areas of the state. A multi-disciplinary research team was formed to provide relief to the local and state soybean industry from this pest. Todd, a Nematologist who joined the Plant Pathology Department in 1982, provided leadership in evaluating breeding lines for response to SCN, and characterizing the race and population density of SCN in Kansas soils.

An aggressive breeding program was started by Schapaugh and Todd that screened as many as 10,000 experimental varieties per year for resistance to SCN. Agronomists such as Jim Long, from the Southeast Agriculture Research and Extension Center, assisted with the agronomic evaluation of experimental soybean varieties, and initiated long-term crop rotation studies that demonstrated that the use of varieties resistant to the cyst nematode greatly decreased damage by the nematode. A long-term study of the effects of resistance-gene deployment on the virulence structure of diverse SCN populations revealed that selection of virulent populations cannot be avoided by rotating different sources of resistance, but that some sources of resistance were more stable than others. On the basis of this information, resistance-based management practices were incorporated into management recommendations.

'KS5292' was the first maturity group-V, SCN-resistant variety released by KAES. 'KS5292', and most of the releases since 1981, were named using the letters "KS" followed by a 4-digit number. The first number indicated the maturity group, the second number the relative position in that maturity group, and the last two numbers specified the year of release. So, 'KS5292' indicated an early group V variety released in 1992. Additional SCN-resistant varieties were released in 2002, 2004, and 2006. Through 2006, the sources of SCN resistance used to develop all of the K-State varieties were unique to the primary resistance source used by private breeding programs, and provided Kansas soybean producers an efficient tool to better manage the nematode.

The history of soybean breeding is not complete without mentioning the development of intellectual property rights. Before 1970, most of the soybean varieties used in commercial production were developed by the public sector in the cooperative program between the USDA and state Agricultural Experiment Stations. In 1970, the Plant Variety Protection Act (PVPA) was signed into law, and later amended in 1994. The primary purpose of the PVPA is to encourage the development of novel varieties, and protect the developer's investment. A Certificate of Protection is awarded to an owner of a variety after an examination shows that it is new, distinct from other varieties, and genetically uniform and stable through successive generations. The owner of a U.S.-protected variety has exclusive rights to multiply and market the seed of that variety. The term of protection is 20 years for most crops. Two exemptions to the protection provided include: 1) a research exemption to allow the use for breeding to develop a new variety; and 2) a farmer's exemption to allow the saving of seed for the sole use of replanting the farmer's land.

The PVPA stimulated significant private investment in soybean variety development. In 1973, 15 private entries were evaluated in the Kansas Soybean Variety Performance Tests. By 1983, 102 private entries were evaluated in the trials. As the number of private programs grew and competition increased, companies began to explore alternatives to PVP that would enhance the intellectual property protection available for varieties.

In the 1980s, technology use agreements, or licenses, began to shape the current state of soybean variety protection. License agreements specified how the seed of a variety could be used. The protection offered by the developer of a soybean variety was further strengthened in 1985, when the Patent Office Board of Appeals and Interference ruled that utility patents could be granted for plant material. Technology use agreements and utility patents enhanced the legal protection offered to the developer of a variety, and further enhanced private-sector investment in soybean breeding. Through these mechanisms, access of varieties for breeding became restricted, and planting of farmer-saved seed became prohibited for most commercial varieties.

One significant outcome of this private-sector investment was the development of Roundup Ready® (RR) soybeans. Through genetic engineering, researchers with Monsanto developed a soybean variety that could tolerate high rates of Roundup®, a non-selective herbicide used to kill unwanted grasses and weeds. Commercial production of the first genetically modified (GMO) Roundup Ready® soybean varieties occurred in 1996. RR varieties were rapidly adopted by farmers and, by 2005, more than 90% of the soybean acreage in Kansas was planted to RR varieties.

By the late 1990s, about 90% of the soybean acreage in Kansas was planted to private varieties from more than 30 seed companies. As the transition from public to private varieties occurred, the Soybean Breeding Program focused on research and development activities that complemented the private breeding effort, and on training graduate students.

One new area of emphasis was the development of special-use varieties for identity-preserved and value-added markets. Since 2001, three types of special-purpose varieties have been released. Two large-seeded, yellow hila, high-protein types have been released for the production of soymilk or tofu. Several small-seeded, yellow hila varieties have been released for export markets to Japan for production of natto. Three high-protein varieties have been released for production of high-protein feed, or blended with low-protein beans to meet specific protein standards. When the KAES began releasing special-use varieties, an "sp" designation was added to the variety name to indicate special purpose. This naming convention was also applied to SCN-resistant varieties by adding an "N" to the variety name, and an "RR" to the Roundup resistant varieties.

Evolution of intellectual property protection for soybean varieties, and the development of Roundup Ready® soybeans, influenced the way K-State varieties were released. Into the early 2000s, K-State and most other public varieties were released to farmers through a seed certification program. In Kansas, parent seed was increased by the Agronomy Department's Foundation Seed Program and allocated to Certified Seed Growers who increased and sold seed to farmers for grain production. Oversight for the certification program is the responsibility of the Kansas Crop Improvement Association. As conventional (Non-GMO) and public varieties declined in acreage, the KAES moved to non-exclusive licenses to transfer parent seed of Non-GMO K-State genetics to appropriate seed producers.

Although K-State and other public varieties fell to a low level of production after the advent of RR technology, we were confident the K-State genetics could offer competitive advantage for soybean producers in our region. For those varieties to be grown, it became apparent that incorporating farmer-preferred technology, such as Monsanto's Roundup Ready® trait, would be necessary. In 1997, K-State signed a research agreement with Monsanto that provided access to RR genetics and enabled the breeding program to develop RR varieties. In 2004, the Kansas State University Research Foundation signed a commercialization agreement with Monsanto to license K-State-developed RR varieties to seed producers. The first two RR varieties developed at K-State ('KS4404RR' and 'KS4704RR') were released in 2004, and two additional varieties ('KS3406RR' and 'KS5306RR') were released in 2006. Upon release, these varieties were provided through license agreements to companies with RR commercialization agreements, with permission granted to use the brand "Wildcat Genetics" when selling the product by variety name, or to sell the product by branding without specifying the variety name.

The past several years, breeding for insect resistance has focused on the soybean stem borer and soybean aphid. The soybean stem borer is a small, long-horned beetle that attacks soybeans. Serious damage has been most common in south-central Kansas, but since first reported in 1985, the insect can be readily found in the western two thirds of Kansas. Schapaugh has worked with Entomologists P.E. Sloderbeck, L.L. Buschman, and R.A. Higgins to reduce the economic impact of this pest through genetic resistance. Thus far, consistent differences among varieties in infestation or plant damage have not been found, but efforts continue to identify a suitable source of host plant resistance.

The soybean aphid (SBA), native of China and Japan, was first identified in the United States during the summer of 2000. By August and September of 2002, small numbers of aphids were confirmed in five eastern Kansas counties. Because the aphid had caused severe damage in some areas of the United States, a cooperative program was established with Entomology faculty (J.C. Reese, C.M. Smith, and Higgins) to screen soybean germplasm for sources of resistance to the soybean aphid. By phenotypic screening of experimental lines for SBA resistance, four highly resistant K-State lines were identified. A germplasm release of the most resistant of these lines is scheduled for the summer of 2006.

Our graduate students, undergraduate students, and staff working with the Soybean Breeding and Genetics Program have been one of our most valuable assets. Students pursuing advanced degrees have directed most of the basic and applied research conducted by the program. Since 1967, 30 graduate students have completed advanced degrees with the Soybean Breeding and Genetics Program, and now provide leadership in academic and private settings. Over this period, 18 students completed their M.S., and 12 students completed their Ph.D. requirements. Twenty were from the United States and 10 were international students, from Argentina, Brazil, Chile, China, Jamaica, Pakistan, Poland, Togo, Tunisia, and Turkey. These students are employed by universities in Alabama, Illinois, Kansas, and South Dakota; by private seed companies including Monsanto, Pioneer, and Terral; international universities and research centers; and in other public and private settings. They serve in various capacities, including as plant breeders, technicians, researchers, agronomists, extension agents, teachers, and lawyers.

As many as 10 undergraduate students are hired each semester to provide much of the labor to assist with packeting seed, threshing plants, harvesting plants, maintaining the greenhouse, and the numerous other jobs that must be completed to run an efficient program. More than 80 undergraduates have contributed to the program during the past 30 years. Several of these students have pursued advanced degrees in Agronomy or Plant Breeding and Genetics. Five completed advanced degrees with the Soybean Breeding and Genetics Program.

The first full-time staff member who had responsibility exclusively to soybean breeding and genetics was hired under the tenure of Schapaugh. In 1979, D.S. Harris served as a full-time research assistant while pursuing her M.S. degree. When Harris completed her degree in 1982, C.J. Coble assumed responsibility for that position. Coble also worked toward an advanced degree, and completed her M.S. degree in 1988. Shortly before Coble left to take another position, R. Dille was hired in 1987 as a research assistant. Dille had been working with project as an undergraduate before earning a B.S. degree in Agronomy. Dille continues to serve as an Assistant Agronomist with the soybean breeding project.

Many essential contributions made to the Soybean Breeding Program by K-State faculty and staff are not mentioned here. Agronomists have provided support for evaluation of experimental varieties at testing locations around the state, have assisted with research projects, and have served on Graduate Student committees. Support staff have maintained test plots, equipment, and greenhouses. The Foundation Seed program has been responsible for the increase and maintenance of all K-State soybean releases.

Table 1. Kansas Agricultural Experiment Station Soybean Releases

Year of release	Name	Pedigree	Maturity group
1971	Columbus	[C1069/(Lincoln/Ogden)]/Clark	late IV
1974	Pomona	[Harosoy/(Lincoln/Ogden)]/C1265 [Harosoy/(Lincoln/Ogden)]	mid IV
1977	Crawford	Williams/Columbus	late IV
1979	DeSoto	[Wayne/(Clark/Adams)]/Columbus	mid IV
1980	Douglas	Williams/Calland	late IV
1981	Sparks	Williams/Calland	early IV
1990	KS4390	K1022/Essex	early IV
1992	KS5292	Essex/Forrest	early V
1994	KS4694	Sherman/Toano	mid IV
1994	KS3494	Harper/Asgrow 3127	early III
1995	KS4895	Sherman/Bay	late IV
1995	Magellan	Sherman/Harper	early IV
1997	KS4997	Pioneer 5482/Asgrow A3127	late IV
2001	KS5001sp	Hutcheson/SS201	early V
2001	KS5201sp	Camp/Sherman	early V
2002	KS4202	KS4694/C1842	early IV
2002	KS4602N	Delsoy4710/KS4694	mid IV
2002	KS5502N	Hartwig/KS4895	mid V
2002	KS4302sp	Hutcheson/Nattosan	early IV
2002	KS4402sp	Hutcheson/Barc 6	mid IV
2002	KS4702sp	Saturn/Jack	late IV
2002	KS5202sp	Hutcheson/BARC 9	early V
2003	KS4102sp	Flyer/BARC 6	early IV
2003	KS4303sp	Jack/Mercury	early IV
2003	KS5003sp	KS5292/Mercury	early V
2004	KS5004N	KS5292/SC91-2007	early V
2004	KS4404RR	$K1235^2$//$Resnik^2$/40-3-2	mid IV
2004	KS4704RR	$KS4895^2$//$Resnik^2$/40-3-2	late IV
2005	KS5005sp	Saturn/SS1386-5-2	early V

Corn Breeding

Clyde E. Wassom

Introduction

Corn has been an important crop in Kansas since the mid to late 1800s. Corn in Kansas, published by the Kansas State Board of Agriculture in September 1929 as report number 191, lists corn production statistics from 1860 through 1928. This publication provides many interesting details of growing corn in Kansas through 1928. It includes information about the varieties of corn grown, soil conditions, environmental effects, etc. Production in the early years, 1860-1867, ranged from 5.6 to 8.5 million bushels from 170,000 to 211,000 or more acres. By 1895, corn was grown on 8,394,871 acres. Several open-pollinated varieties were used, and yields ranged from 40.38 bushels per acre in 1877 to 2.77 bushels in 1913. In 1930, corn acreage was 7.1 million, with an average yield of 12.5 bushels per acre. Acreage had declined markedly to 1.7 million in 1970, but yield had increased to 64 bushels per acre. In 2005, Kansas producers planted 3.65 million acres of corn, with 3.45 million harvested for grain and an average yield of 135 bushels per acre.

Early work

The varieties of corn grown in Kansas during the late 1800s and early 1900s were mainly those introduced by farmers coming from other states of the United States or were selected and developed from the open-pollinated sources farmers were growing in Kansas. A detailed discussion of these varieties is given on pages 29 through 53 of the 1929 report number 191 of the Kansas State Board of Agriculture. The 1929 publication also presents yield comparisons of several varieties, including Pride of Saline, Boone County, Commercial, Freed, Kansas Sunflower, Midland, and Reid. It is interesting to note that Pride of Saline ranked among the highest yielding varieties in 600 tests from 1911 to 1926. Samples of all these varieties were still available for use in the breeding program until the state corn breeding project closed in 1992.

In 1910, A. M. Ten Eyck, at the Fort Hays Branch Experiment Station, began conducting some of the first yield tests, including the more productive varieties being grown at that time. John H. Parker, the first plant breeder in the Agronomy Department, concentrated his efforts on wheat, but his early responsibilities also included the early corn breeding work. In 1921, Paul C. Mangelsdorf, a student of Parker, completed a thesis entitled Corn Breeding in Kansas, which summarized the corn breeding research in Kansas up to that time. After receiving his diploma from Kansas State College in June 1921, Mangelsdorf was appointed as a graduate assistant at the University of Connecticut under Donald F. Jones, one of the early pioneers of the development of hybrid corn. Later, in 1974, Mangelsdorf was the author of a book entitled *Corn, Its Origin, Evolution and Improvement*. In the preface of that book, he referred to his work at K-State in 1921 and stated "that Dr. Parker practically turned over to me the experimental work on corn."

The first attempts to improve corn yields in Kansas, as in other states, focused on breeding for improved performance of the open-pollinated varieties. The methods used included mass selection, ear-to-row selection, and varietal hybridization. Some advances were made, but the results were inconsistent; consequently, efforts in Kansas, and throughout the Corn Belt, were focused on developing inbred lines to take advantage of the expressed hybrid vigor, the yield increase that occurred when two inbred lines were crossed to produce an F_1 hybrid.

The USDA Corn Breeding Program in Kansas

The United States Department of Agriculture began corn breeding efforts at several state experiment stations in the Corn Belt in the 1920s. A M. Brunson was the first USDA corn breeder in the Agronomy Department at the Kansas Agricultural Experiment Station. He began his work in 1926, and was the project leader through the 1937 crop year, when he was transferred to Purdue University, at Lafayette, Indiana. He contributed a section of the 1929 KSBA report number 191, pages 73 to 80, in which he summarized the progress to 1929. Some interesting points he made were:

> *"Corn is the most important crop in the United States, whether judged from the standpoint of acreage, total production, or value of the crop. Even in Kansas, which is predominantly a wheat state, more bushels of corn than of wheat have been produced in seventeen of the twenty-eight years, 1900-1927 inclusive."*
>
> –A.M. Brunson, 1929

In summary, Brunson indicated that several methods had been proposed to increase the inherent productivity of corn, but were abandoned. He stated the new method of hybridizing selected inbred lines was being tested extensively and that it held much promise for the future. The efforts of the USDA program in Kansas under Brunson's direction concentrated on the development of high-combining inbred lines. The open-pollinated varieties, which had been widely grown in the state, provided much of the source material from which many Kansas inbred lines were developed. Some yellow inbred lines released from that work were 'K126', 'K148', 'K151', 'K201', and 'K201G'. Pride of Saline was the source of many of the white inbred lines, including 'K41', 'K55', and 'K64'.

R.W Jugenheimer was the project leader for the USDA corn breeding program from 1938 until 1943. During this time, a number of hybrids and their inbred parents were released by the Kansas station. World War II interrupted the program at Kansas State College, as well as many other locations. E.G. Heyne apparently conducted the work from 1943 through 1945 and authored the 1944 and 1945 annual reports for the corn breeding project.

After he left the corn breeding position at K-State, Jugenheimer was the author of two important references on corn breeding. The first was a report entitled "Hybrid maize breeding and seed production," presented to the Food and Agriculture Organization of the United Nations in Rome, Italy, in 1958. The second reference was a book, *Corn Improvement, Seed Production and Uses*, published in 1976, which was more detailed in scope. Both publications provided important information about corn breeding and both included references to the work he did in Kansas.

L.A. Tatum was the corn breeding project leader of the Kansas USDA program from 1946 to 1956. During these years, the emphasis continued to be the development of superior inbred lines with high combining ability. In addition to his work on the Kansas project, an important contribution of Tatum was a classic paper he co-authored with G.F. Sprague, entitled "General versus specific combining ability in single crosses of corn," published in 1942 in the *Journal of the American Society of Agronomy* (34:923-932). W.R. Findley joined the Kansas corn breeding program in 1955, but he did not become the project leader until Tatum left in 1956. Findley left Kansas in 1960 to join the ARS program at the OARDC campus at Wooster, Ohio, where he served until his retirement in 1985. Gene Scott was also employed on the program until the USDA project was closed in 1961.

It is of interest to note that the Kansas USDA program not only made significant contributions to corn breeding, but also served to stimulate graduates to pursue advanced degrees. Jugenheimer completed his Ph.D. degree under the direction of Sprague, the USDA corn breeder in the Agronomy Department at Iowa State College in Ames, Iowa. Tatum also received his degree from Iowa State College, with Sprague as his major adviser. Some others who received part or all of their training at K-State were John Lonnquist, corn breeder at Nebraska and later at Wisconsin; Bill Kerr, alfalfa breeder at the University of Nebraska; and Scott, who received his Ph.D. degree at K-State and was moved to the corn breeding position at Mississippi State University upon the completion of the program here.

By the late 1950s, much of the development of inbred lines and the production of high-yielding hybrids had shifted to commercial companies, and many USDA corn breeding programs were curtailed or eliminated; including the program at K-State, which was terminated in 1961. Findley and Scott were transferred to USDA corn breeding programs at the Ohio and Mississippi stations, respectively.

The breeding emphasis during the early years was to develop corn inbred lines that could be used in high-yielding hybrid combinations for corn production in the areas of Kansas most suited for growing corn.

The State Corn Breeding Program

After the USDA project was discontinued in 1962, a state corn breeding program led by C.E. Wassom was initiated in the Agronomy Department at K-State. The search for genotypes of corn tolerant to the environmental stresses that limit corn production in Kansas was an important part of the newly organized state corn breeding project. By the 1960s, the greatest acreage dedicated to corn production in Kansas was found where irrigation was available and in northeast Kansas, where sufficient rainfall normally occurred for growing corn. Consequently, field studies were established at the Ashland Agronomy

Farm, Manhattan, Kansas, where moisture regimes could be controlled by use of irrigation to simulate moisture stresses that occur under natural conditions. At about the same time, a cooperative program was initiated with CIMMYT (the International Center for the Improvement of Maize and Wheat) to develop a "team training" program for graduate students. This provided the opportunity to use CIMMYT facilities in Mexico for controlled water treatment in an area where very little rainfall occurred. As a consequence of this program, it was possible to combine the study of research efforts in the areas of genetics, breeding, physiology, and plant pathology. Because many of the graduate students supported by CIMMYT were from other countries, it was possible to evaluate corn genotypes in several environments, including areas of little or no rainfall.

Significant yield losses in Kansas also result from insects, including the southwestern corn borer, fall armyworm, and European corn borer. A series of experiments were established at the Sandyland Experiment Field near St. John, Kansas, in which several genetically different sources of corn were planted and evaluated for their responses to southwestern corn borer and fall armyworm damage. The effort was designed to identify genetic resistance to the insects involved, and was conducted with the assistance of R. Painter of the K-State Entomology Department. There were differences in response, but the use of natural infestation for screening purposes was not reliable enough to identify significant levels of resistance. A more intense selection program was needed that used artificial rearing and infestation techniques, like those of Mississippi State University.

Another major emphasis of the state corn breeding program was the improvement of yield potential of white corn hybrids. This work was supported in part by grants from the Quaker Oats Company. The breeding approach involved the development of new white inbred lines to be used in hybrid combinations. Potential for the improvement of protein quality in corn became a reality with the report from Purdue University in 1963, that incorporating the opaque 2 gene into corn resulted in increases of two essential amino acid–lysine and tryptophan because the o_2 gene interferes with the synthesis of zein, an endosperm protein. The backcross procedure was used to insert the opaque 2 gene into several Kansas white inbred lines to improve protein quality. In addition, some of the best high-combining yellow inbred lines were converted to white endosperm by using a system of backcrosses. Several of these converted inbred lines and some inbreds with the opaque 2 gene were released, including 'K301', 'K302', 'K303', 'K304', 'K305', and 'K306'.

In addition, the effect of several plant traits were researched, including root size and structure, leaf area, tassels, etc., and the effect of these traits under stress and no-stress conditions upon corn yield. Effects of physiological factors and pathogens were also involved. Selection procedures were evaluated to develop the most efficient means of identifying superior genotypes. Results of these studies were included in numerous theses and publications from the program. Because of budget limitations and research program prioritizations, the state corn breeding project was closed after the retirement of Wassom in 1992.

Canola Breeding

Mike Stamm

Background

Canola is an oilseed crop that produces high quality, edible oil used in margarine, salad dressings, shortenings, vegetable oil, and several industrial applications. Canola research started in the Great Plains region in the late 1980s. Before that, industrial rapeseed was investigated as an alternative crop, but demand was limited and interest was low. The lack of success was a result of few adapted cultivars (only European cultivars were grown) and a lack of management recommendations and general knowledge for growing the crop in the region. Local markets were unable to establish, and crop insurance was not available at the time. In addition, because rapeseed was relatively new to the United States, few chemicals were available for weed control.

The Program

In 1992, through a special grant appropriation by the USDA, a regional canola breeding program was established at K-State to determine the potential for developing canola varieties adapted to the Great Plains. Anne Rogers was hired as the program's first breeder. In 1993, Charlie Rife was hired, and remained project leader until 2005. During this time, canola-quality cultivars were selected and identified that showed significant improvements over previously tested cultivars. Two germplasm lines, KS3579 (1996) and KS1701 (1997), were developed and released to facilitate improvements in winter hardiness of public and private germplasm. Four cultivars—'Plainsman' (1998), 'Wichita' (1999), 'Abilene' (2002), and 'Sumner' (2003)—have been released. Sumner is a line possessing tolerance to carryover of sulfonylurea herbicide, a class of herbicides commonly used in wheat production that often limit canola crop rotation options. These lines have proven adaptive to the Great Plains environment and are considered benchmarks for canola varieties in the Great Plains region. In 2005, Oklahoma State University and K-State provided joint funding to support the canola breeding program, and Michael Stamm was hired. Oversight of the breeding program is currently provided by a steering committee consisting of research and extension faculty from K-State and

Charlie Rife (L) discussing merits of Plainsman canola with producers, circa 2002.

Oklahoma State University. An external advisory committee consisting of researchers from both universities, industry personnel, and canola growers, has been given the authority to provide expertise and guidance for the breeding program.

The Research

One of the major contributions of the K-State breeding program to canola research is the National Winter Canola Variety Trial (NWCVT), established in 1994. This variety trial includes released cultivars that have not been extensively tested in the United States and advanced experimental lines in the final stages of field testing. The NWCVT also improves the visibility of winter canola production across the United States and provides growers with yield and agronomic data on cultivars available for planting on their farming operations. The trial has grown from 12 locations in 6 states in 1994–95 to 45 locations in 23 states in 2005–06. The 2005–06 NWCVT includes 13 released cultivars and 22 experimental lines from eight different breeding programs, including two in Europe. Data obtained from this trial have assisted various breeding programs in making decisions on the release of experimental lines and hybrids.

Over the past 14 years, significant progress has been achieved in increasing winter hardiness in the germplasm developed for the Great Plains region. Additional cultivars are being evaluated that possess even greater levels of winter hardiness, improved yield potential, tolerance to sulfonylurea herbicide carryover, and tolerance to direct application of imidazolinone and glyphosate herbicides. In addition, established studies are looking at cultural practices such as planting date, fertility, cropping systems, and crop rotations. Current agronomic-trait evaluations include screening for shatter resistance, stand establishment, grazing potential, reduced plant height, early maturity, and heat tolerance at flowering. The research conducted by K-State and Oklahoma State remains the cornerstone for canola research in the southern Great Plains, and has received respect both nationally and internationally.

Most of the funding for canola research at K-State and Oklahoma State has been provided through grants awarded by the U.S. Department of Agriculture. Additional funding for germplasm evaluation or special research projects has been provided by the Kansas Department of Commerce, the Kansas Crop Improvement Association, the Crucifer Crop Germplasm Committee, the K-State Agronomy Department, and the K-State Plant Biotech Center. Private companies such as Aventis and Monsanto also contribute to research conducted by the program.

Canola is gaining broader interest among farmers in crop rotations with winter wheat, particularly in south-central and southwestern Kansas and Oklahoma. As acreages continue to increase, local markets and crushing facilities are being established. Canola acreage in the southern Great Plains increased from 270 acres in 2002–2003 to 3,000 acres in 2003–2004. Between 7,500 and 10,000 acres were planted during the 2004–2005 season. An estimated 60,000 acres were planted in Kansas and Oklahoma in the fall of 2005, with the potential of doubling in 2006. In addition, the Risk Management Agency is issuing test policies, and the availability of crop insurance will be routine in the near future. The combination of interested producers seeking alternative crops, the significantly high demand for bio-diesel, and the continued improvement of adaptable germplasm guarantees a bright future for canola production on the southern Great Plains.

Personnel

Breeders

Anne Rogers	1992–1993
Charlie Rife	1993–2005
Michael Stamm	2005–present

Assistant Scientist

Cynthia La Barge	1996–present

Alfalfa Breeding

Gerry L. Posler, Donald L. Stuteville, and Paul C. St. Amand

Alfalfa has been grown in Kansas since the very early settlers began crop and livestock production. E.M. Shelton reported in Kansas Agricultural Experiment Station (KAES) Bulletin 2 (1888) that alfalfa investigations had been conducted since 1875, twelve years before the KAES was established. Alfalfa acreage increased to a peak of more than 1.3 million in 1914, declined to about 400,000 by 1937, then increased again to about 1 million by 1950, and has been fairly stable since that time, ranging between 800,000 and 1.2 million acres.

Seed for early plantings in Kansas came from the southwestern United States, probably New Mexico and California. Many of these early seedings were successful, and alfalfa became better adapted to Kansas growing conditions through natural selection.

Before 1898, there were no named varieties of alfalfa in the United States, although 'Grimm' was imported into Minnesota in 1857 and 'Ladak' was imported from northern India by the USDA in 1910.

In KAES Bulletin 155 (1908), AES Director C. W. Burkett stated:

> *"Alfalfa is the imperial forage of Kansas … while not as large [acreage] as corn or wheat, it is the most remarkable [crop] because of its quality and the riches that follow in its wake [N production in crop rotations]."*

Alfalfa Breeding/Genetics personnel have included:

Clarence Grandfield (USDA)	1928–1954
Edgar (Ted) Sorensen (USDA)	1955–1990
William (Bill) Rooney	1992–1995
Daniel Skinner (USDA)	1990–1996
Paul St. Amand	1997–2004

George F. Freeman (Botanist) reported in KAES Bulletin 155 (1908) that "breeding of this forage plant is just beginning to receive the serious attention of the [U.S.] experiment stations and the USDA in the states of the West and Southwest and we are now past the time of introduction and must improve the crop by plant breeding." He further noted that breeding objectives should include: 1) hardiness and vigor, 2) drouth resistance, 3) disease resistance, 4) leafiness, 5) upright growth habit, and 6) high seed production.

During most of its history, the Kansas alfalfa breeding program was a joint effort of USDA geneticists/breeders and state-employed cooperators, primarily in entomology, plant pathology, and dairy science. Some faculty members who made extended, significant contributions to the program were Don Stuteville, Plant Pathology; Ernst Horber, Entomology; and Earle Bartley, Dairy Science. Throughout its existance, the Kansas alfalfa breeding program primarily stressed development of varieties and germplasms with multiple pest resistance for increased forage yield and quality. Early efforts were to add resistance to bacterial wilt and to improve winter hardiness and adaptation, followed by adding resistance to several important insects and diseases to develop and release varieties and germplasms with multiple pest resistance for improved forage yield and quality.

The alfalfa breeding team for more than 30 years: Ernst Horber (Entomology), Don Stuteville (Plant Pathology), and Ted Sorensen (USDA/Agronomy).

Most recently, under the direction of Rooney, Skinner, and St. Amand, the focus of the program was to utilize biotechnology and marker-assisted selection to identify genes for specific disease resistance and to develop germplasms with multiple pest resistance. St. Amand and his students studied spring blackstem and determined that pathologic races of *Cercospora medicaginus* do not exist on alfalfa, allowing breeders to screen for resistance with any local isolate. They also developed a standardized testing methodology for resistance to this fungus. This group participated in the first QTL study of the genetically complex autotetraploid alfalfa. In a series of studies with transgenes, it was determined that single escaped or feral alfalfa plants growing at considerable distances from alfalfa fields can contribute to medium- or long-range gene spread, and they concluded that studies of transgene fitness, hybridization, and competitive advantage should be conducted on all alfalfa transgenes before release into the environment. With colleagues, they developed and served as curators of "AlfaGenes," the alfalfa portion of the Plant Genome Data Base.

Because of financial constraints and research priorities, the alfalfa breeding program was closed in 2004.

Varieties

KANSAS COMMON – This variety traces to imported seed from Chile into California in 1850 and then introduced for early plantings in Kansas. A.L. Clapp reported that the original foundation seed came from a field on the W.J. Sayre farm in Chase County, Kansas, and was certified by KCIA from 1923-1969. C.O. Grandfield reported in KAES B-346 (1951) that "Kansas Common has been perhaps the most widely grown Common alfalfa in the U.S. … adapted over all the southeast U.S. except the Coastal regions."

BUFFALO (1945) – Grandfield reported in C 226 (1945) that this variety originated from an old strain of Kansas Common, known to have been grown in Kansas before 1907. The superiority of this strain was brought to the attention of Agronomy Department Head L.E. Call in the early 1920s by W.J. Sayer, a farmer formerly from Chase County, Kansas. Seed was planted on the Agronomy Farm in 1922 and developed through several years of close breeding in isolated blocks at the Garden City Station and selection for wilt resistance and other agronomic traits.

CODY (1959) – This variety resulted from recombining several selections from Buffalo, and was the only variety resistant to spotted alfalfa aphid at that time.

KANZA (1970) – This variety had resistance to bacterial wilt, spotted alfalfa aphid, and pea aphid, plus tolerance to frost.

RILEY (1977) – Riley is an 8-clone synthetic variety developed through phenotypic recurrent selection. Its parentage traces to 'Cherokee' (5), 'Kanza' (1), polycross progenies of 'Buffalo' (1), and 'Williamsburg' (1), providing high resistance to anthracnose, pea aphid, spotted alfalfa aphid, and bacterial wilt; moderate resistance to summer black stem and downy mildew; and tolerance to potato leafhopper.

After the release of 'Riley', the primary focus of the program was to develop and release germplasms with multiple pest resistance to an increasing number of insects and diseases.

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Grass Breeding

Gerry L. Posler and Walt H. Fick

The Department of Agronomy at K-State has a long history of native grass breeding, beginning with A.E. Aldous in the 1930s. One of Aldous' students and successor at K-State, K.L. Anderson, was responsible for a number of native grass releases. Anderson and F.L. Barnett trained a number of students in grass breeding. The cultivars developed were primarily for range reseeding, pasture plantings, revegetation of disturbed areas, waterways, soil stabilization, hay production, and wildlife food and habitat. The cultivars developed were generally a joint release by the Kansas Agricultural Experiment Station (KAES) and the USDA. Many of these cultivars are still used today and are seeded extensively in the Conservation Reserve Program (CRP). Additional information about these cultivars is available on the websites of the USDA-NRCS Plant Materials center (PMC) at Manhattan, Kansas, and the Native Seed Network. In addition to these native grass cultivars, cultivars of forage sorghum and sudangrass were developed by crop breeders in agronomy, including J.H. Parker, R.C. Pickett, A.J. Casaday, and Barnett. Some cultivars were developed from strains originally selected by producers in Kansas. Several of these cultivars were widely grown, seed was certified by KCIA for many years, and some are still grown and certified at the present time.

'Kansas Orange' sorgo was selected from the group of Orange sorgos originally introduced into Kansas and has been known since 1880. It was recognized by the KAES in 1888 as one of the sorgos best suited for making sugar. 'Early Sumac' sorgo, an early-maturing variety with sweet, juicy stalks, was developed from 'Standard Sumac' at the Hays Branch Experiment Station. Seed of 'Kansas Orange' and 'Early Sumac' sorgos was first certified by KCIA in 1924 (Clapp, 1970).

'Atlas' sorgo was a pedigree selection from a field cross between 'Sourless' sorgo and 'Blackhull' kafir found by I.N. Farr of Stockton, Kansas. The selection made by J.H. Parker was named 'Atlas';

Foundation seed increase block of switchgrass at USDA-SCS-PMC, Manhattan, Kansas.

Table 1. Grass Cultivars Released by K-State Agronomy.

Cultivar	Year of Release	Joint Release With
‘El Reno’ sideoats grama	1944	USDA-SCS
‘Blackwell’ switchgrass	1944	USDA-SCS
‘Kaw’ big bluestem	1950	USDA-SCS
‘Kanlow’ switchgrass	1963	USDA-SCS; USDA-ARS
‘Osage’ indiangrass	1966	USDA-SCS; USDA-ARS
‘Aldous’ little bluestem	1966	USDA-SCS; USDA-ARS
‘Barton’ western wheatgrass	1970	USDA-SCS; USDA-ARS
‘Bend’ sand lovegrass	1971	USDA-SCS; USDA-ARS
‘Pete’ eastern gamagrass	1988	USDA-SCS; USDA-ARS; and Okla. Agric. Exp. Sta.

seed was certified by KCIA and distributed to Kansas farmers in 1928 (Clapp, 1970). ‘Atlas’ sorgo has sweet, juicy, sturdy stalks; leafy plants; and a white kafir-like seed. It is still grown widely in Kansas today.

Sudangrass was introduced into the United States by USDA in 1909 and into Kansas about 1913; it soon was grown in every county. ‘Wheeler’ sudangrass was developed by Carl Wheeler, Bridgeport, Kansas, a producer and President of KCIA in 1917–18. Wheeler was noted for fine stems and low prussic acid content. Seed was first sold by Wheeler in 1915 (Pickett) and first certified by KCIA in 1922 (Clapp). ‘Greenleaf’ sudangrass traces to a cross between ‘Leoti-Sudan 2’ and ‘Leoti Sudan 4,’ made by J.R. Quinby at Texas A & M University and selected at the KAES. Greenleaf was noted for high resistance to leaf diseases; superior leafiness, tillering, and vigor; and low prussic acid content. Seed was first certified by KCIA in 1952 (Clapp).

‘Achenbach’ smooth bromegrass was developed from a strain grown on the Achenbach Brothers farm in Washington County, Kansas, as early as the late 1890s. It is a typical southern-type bromegrass and is a heavy producer of both forage and seed. ‘Achenbach’ resulted from the first documented breeding of smooth bromegrass, a single cycle of mass selection for “the tallest, best filled, lightest colored plants” done by two Achenbach brothers in the early 1900s (Vogel). It was named by KAES in 1944. Seed was first certified by KCIA in 1932, but much ‘Achenbach’ was sold over a period of many years as “common” smooth bromegrass.

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Crop Production and Crop Ecology

Richard L. Vanderlip

Crop production can be considered applied crop ecology because, to maximize production, the aim is to do the best job possible of fitting the crop to the environment in which it is growing. Much of the early work in the department was exactly this—trying to determine the best practices for producing crops in the extremely diverse and variable Kansas environments. See the section on Experiment Fields (p.151) to get more details about the early Cooperative Experiments conducted on farmer's fields throughout Kansas by H.J.C. Umberger. In 1923, the first experiment fields in the Agronomy Department were initiated in southeastern Kansas because that area was not represented by the four branch experiment stations in central and western Kansas or by the Manhattan location. Much of the crop production research has been conducted on the Experiment Fields from that time through the present.

In the Kansas Agricultural Experiment Station Director's Report for 1913, Agronomy faculty included Cecil Salmon, Ralph Kenney, and R.K. Bonnett in crops and C.C. Cunningham and B.S. Wilson in cooperative experiments. The report also included a map of Kansas, which showed Cooperative Experiments in all but 21 counties. The experiments included variety tests for sorghum, corn, and wheat; fertilizer tests on wheat, oat, and alfalfa; field selection of corn and sorghum; and testing of miscellaneous crops such as Sudangrass, sweet clover, lespedeza (Japan clover), cowpea, Spanish peanut, and Mexican bean. Publications included *Corn*, *Alfalfa in Kansas*, *Kafir in Field and Feed Lot*, *Seed Corn for Kansas*, and *Sweet Clover*. The introductory paragraph on "Crop Experiments" follows:

> *"Crop Experiments. Studies have been continued with the small-grain cereal crops and with corn and forage crops in an endeavor to produce better and higher-yielding varieties for growing under the soil and climatic conditions existing in Kansas. A few pure strains of wheat are proving of superior value and have been distributed this year for trial with farmers in different parts of the state, to determine their yielding value compared with standard varieties. One of these strains has given an average yield at Manhattan during the past three years of 4.8 bushels more than the standard Turkey wheat."*

Beginning in 1914, the Director's reports were Biennial, and for the next several years similar reports were found. In the 1918–19 Biennial Report, C.W. Mullen was listed as an Assistant Prof. of Farm Crops, and he later became Associate Dean of the College of Agriculture and advised all incoming freshman students. J.W. Zahnley joined the department in 1915 and, although he is best known for his

Sorghum dessication study, 1972.

work in weed control (see the section Weed Science, p. 113), he is also mentioned as working with specialty crops, particularly evaluation of soybeans for both hay and seed (see the section on Soybean Improvement, p. 81). In the 1932 Biennial Report, Zahnley is listed as leader for the 'Miscellaneous Legumes for Forage' project with work on ". . . clovers, vetches, sainfoin, crotalaria, sweetclover, lespedeza, and the nonlegumes Pyrethrum and Ephedra . . ."

In 1919, H.H. Laude was hired to direct the Cooperative Experiments. He held this title until 1931. Like many of the early crop agronomists, he had a broad program of crop production, ecology, and physiology research (see the section on Crop Physiology, p. 105). Early publications were: *Adapted Crop Varieties for Kansas* (1925), *Cotton in Kansas* (1925), *Growing Flax in Kansas* (1927), *Blackhull Wheat in Kansas* (1925), *Sorghum Production in Kansas* (1933), *Varieties of Sorghum in Kansas* (1933), *Do We Properly Appreciate the Sorghums?* (1938), and *Barley Production in Kansas* (1933). In 1940, Laude initiated a project entitled "Crop-weather Studies," in which he attempted to relate crop growth and yield to environmental variables of air temperature, humidity, precipitation, and soil temperature. Smith (1981) described him as ". . . a recognized leader in crop ecology investigations and utilization of statistics."

E.L. Mader joined the Agronomy Department in 1948, and not only continued the soybean variety testing and soybean breeding (see the section on Soybean Improvement, p. 81) but also did most of the soybean production research for more than two decades. Mader's date-of-planting, maturity-group, and row-spacing studies provided the basis for recommendations for many years. Subsequent soybean breeders, C.D. Nickel and W.T. Schapaugh also continued crop production research.

Laude was replaced by A.W. Pauli, crop physiologist (1951) and F.C. Stickler, crop ecologist (1954). Stickler and Pauli worked closely together, and most of their numerous publications carry both their names. Stickler worked on production and ecology of wheat, corn, and sorghum. Much of the practical crop production research on grain sorghum in the United States between 1954 and 1964 was conducted by Fred Stickler and his students. He was instrumental in utilizing yield components to evaluate production practices and characterize sorghum hybrids. Current research articles on grain sorghum nearly always include citations having Stickler as one author.

John Deere started an agronomic research program in 1964, and both Stickler and Pauli were part of that newly formed group. Stickler was replaced by R. L. Vanderlip in 1964. Vanderlip continued work on corn and grain sorghum, with primary emphasis on grain sorghum. Much of his graduate students' early work was on growth and development of grain sorghum, and resulted in the publication *How a Grain Sorghum Plant Develops*, patterned after the Iowa State corn publication. This work provided a broad range of field data which, in 1974, Vanderlip used in a sabbatical at the Blackland Conservation Research Center in Temple, Texas, working with J.T. Ritchie and G.F. Arkin in developing the sorghum plant growth model, SORKAM. Subsequent work was a combination of field experiments and simulation projects. Much of this was directly or indirectly aimed at using long-term weather records to evaluate sorghum replanting decisions. This led to identification of weaknesses in the model and work on determining tiller number, grain number, and development of a grain-fill concept, which results in grain size (weight) being a consequence rather than an input. Problems modeling plant phenology led to discovery that very little variability exists in duration of grain fill (measured in thermal time) among current hybrids. This resulted in a USDA Special Grant in 1997 to look for genetic variability in grain fill duration (see the section on Sorghum Improvement, p. 77). Vanderlip retired in 2003.

Steve Welch, systems modeler, joined the Agronomy Department in 1990. His early work was with parameter estimation, model validation, and mathematical modeling of morphological plant growth. In the last several years, Welch has turned his attention to modeling the control pathways in Aribidopsis, and working on incorporating basic genetic and biochemical information into models.

In 2004, Scott Staggenborg transferred from the Northeast Area Agronomist position to an on-campus position in cropping systems. He has developed a broad field research program that includes studies of precision agriculture techniques, rotational effects in cropping systems, and alternative crops.

Crop Physiology

Gary M. Paulsen

Hilmer H. Laude, who was appointed to the K-State faculty in 1920, is generally considered the first crop physiologist in the Department of Agronomy. He had previously served as an assistant in crops in the department from 1911 to 1913. Laude had a B.S. from K-State, M.S. from Texas A&M, and Ph.D. from the University of Chicago.

Laude's initial charge was cooperative experiments. The position involved a range of crops, including alfalfa, corn, sorhgum, and wheat. He focused on wheat during later years and, in a 1951 *K-Stater* article, was described as "K-State's Number One wheat man."

Much of Laude's research on wheat concerned drought and high-temperature stress. Many of his students' theses were on plant stress, and a landmark paper by Laude in the journal *Science* in 1939 reported on diurnal changes in crop resistance to high temperature. Laude was also noted for applying statistics to agronomic research.

Laude became a fellow of the American Society of Agronomy (ASA) in 1942 and received the K-State Distinguished Graduate Faculty Award for 1955-56. He also served as historian for ASA, authored a review of the Society's first 50 years in 1957, and edited a comprehensive history of the society in 1962. Laude retired from K-State in 1959.

A son of Laude, Horton, became a professor of agronomy at California after majoring in agronomy for his B.S. at K-State. He was only the second student at K-State (and the first to accept the award) to be a Rhodes scholar at Oxford.

Arland W. Pauli was appointed as a temporary research assistant in agronomy in 1951 after receiving the B.S. from Missouri that same year. He received the M.S. in 1952 and Ph.D. in 1957 from K-State, with H.H. Laude as his major professor. Pauli succeeded Laude as station physiologist when Laude later retired.

Most of Pauli's research was in two areas: cold injury to wheat and growth and development of sorghum. His investigations of cold injury to wheat concerned the roles of proteins and carbohydrates and the effect on crown tissue. His extensive investigations on sorghum were mostly in cooperation with Fred Stickler, the station crop ecologist. Their studies included caryopsis development, effects of leaf area and leaf removal, and involvement of gibberellic acid. Pauli resigned from K-State to accept a position as agronomist with the John Deere Corporation in 1964.

Gary M. Paulsen, a graduate of Wisconsin, joined the department as crop physiologist in 1965. His research emphasized wheat, particularly nitrogen nutrition, agronomic requirements and preharvest sprouting of hard white wheat, and high-temperature injury. Some 80 graduate students received M.S. and Ph.D. degrees with him.

Paulsen was a fellow of ASA, Crop Science Society of America (CSSA), and American Association for the Advancement of Science (AAAS), and served as an associate editor of *Agronomy Journal* and associate editor and technical editor of *Crop Science*.

Considerable leadership for construction of the Throckmorton Plant Sciences Center was provided by Paulsen. He was a member of the building committee for Phase I, which was completed in 1981. For Phase II, which was completed in 1994, he was the chair of the interdepartmental program committee, chair of the departmental building committee, and liaison among the three departments, architects, and contractors. One of his most cherished awards was from the departments of Agronomy; Horticulture, Forestry, and Recreation Resources; and Plant Pathology for "outstanding leadership and tireless effort during planning, construction, and equipping Phase I and Phase II of the Throckmorton Plant Sciences Center." Paulsen retired in 2003.

Mary Beth Kirkham, a graduate of Wellesley and Wisconsin, became a member of the Evapotranspiration Laboratory in 1980. Her primary efforts were in drought physiology of crops and phytoremediation of soils contaminated with heavy metals. Her work in these areas continued after the laboratory closed in 1994.

Research by Kirkham utilized split roots to demonstrate the importance of water potential in hydraulic lift, use of chelates to facilitate uptake of heavy metals from sludge-treated soil, and effects of elevated carbon dioxide on soil-plant-water relations. Her work was published in more than 200 scientific papers.

Kirkham served on the editorial boards of *Agronomy Journal*, *Soil Science*, *Crop Science*, and many other journals. She is also a fellow of ASA, Soil Science Society of America (SSSA), CSSA, and AAAS and received numerous K-State awards for her accomplishments.

P.V.V. Prasad was appointed crop physiologist in the department in 2005. His B.S. and M.S. were from Andhra Pradesh Agricultural University, and his Ph.D. was from Reading (UK). His major interests are in crop responses to abiotic and biotic stresses, best management practices for maximizing crop yields, and growth models to evaluate the influence of stresses and management practices on yields.

Forage Management and Utilization

Gerry L. Posler and John O. Fritz

In the early 1970s, F.L. Barnett shifted his research efforts from grass breeding to forage management and quality studies. He conducted variety and management trials of cool-season grasses and summer annual forages.

In late 1974, G.L. Posler was hired in a new position, primarily teaching, but also with responsibility for non-rangeland forage research. He initiated research trials, primarily in eastern Kansas, to evaluate yield and quality of cool-season grasses and grass-legume mixtures. He also evaluated yield and quality of summer annual forages, irrigated alfalfa, and wheat pasture in trials located primarily in south-central and southwestern Kansas. Later, he and his graduate students evaluated effects of organic acid treatments on silage quality of sorghums, effects of glandular hairs on alfalfa quality, and effects of grazing legume-grass mixtures with sheep. With colleagues, Posler developed a computerized tool for planning year-round forage systems (FMUP) that was modified by teaching and extension personnel in several other states to teach students the concepts of planning year-round forage systems and to assist producers in developing site-specific year-round forage systems. Posler cooperated extensively with several faculty in other departments in his research and teaching efforts, including E.E. Bartley and G. Ward (Dairy Science); K K. Bolsen, L.H. Harbers, D.R. Ames, D. Blasi, and L. Corah (Animal Science); R. Higgins (Entomology); O. Buller (Agricultural Economics), and F.L. Barnett, J.L. Moyer, E.L. Sorensen [USDA]; G.L. Kilgore, S.C. Fransen, and J.P. Shroyer (Agronomy).

Posler and his students established and equipped a forage-quality analysis laboratory to determine crude protein (CP), fiber (ADF and NDF), and *in vitro* digestibility contents of various forage crops; they also conducted *in vivo* forage digestibility studies using fistulated animals provided by colleagues in Dairy Science.

In 1990, when Posler became Agronomy Department Head, J. O. Fritz was hired. Fritz conducted research evaluating post-harvest losses of alfalfa hay. This research revealed the changes that occur to the nonstructural carbohydrate and protein content of alfalfa hay during storage as conventional bales. With graduate student W. Coblentz, Fritz developed and tested a system to produce laboratory-scale alfalfa hay bales. In addition, Fritz and colleagues from K-State conducted research on the rumen degradability of proteins in alfalfa, modeled yields of forage sorghums in Kansas by using the simulation

Bill Hall conducting analyses in the forage quality lab, 2004.

model SORKAM, and were the first to regenerate plants of eastern gamagrass from tissue culture callus. With colleagues from the USDA and University of Nebraska, Fritz conducted research enabling the prediction of the development and quality of big bluestem and switchgrass. With the cooperation of P. Ohlenbusch and G. Kilgore, Fritz directed the development of the KansasGrazer computer program designed to aid cattle producers in planning forage systems and determining proper stocking rates.

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Range Management

Clenton E. Owensby and Walter H. Fick

Personnel

R.K. Bonnett	1919
C.W. Mullen	1920
R.L. Hensel	1920–1924
A.E. Aldous	1926 –1938
K.L. Anderson	1938–1967
C.E. Owensby	1967– present
W.H. Fick	1978–present
AS&I Partners–Ed Smith, Bob Cochran	

Research Facilities

Casement Pastures (owned and operated by Dan Casement)	1919–1948
Aldous Plots	1921–present
Donaldson Pastures	1950–1998
Rannells Flint Hills Prairie	1989–Present

Research History (Major Projects)

Work in the range management area began in 1919 on the Casement Pastures northeast of Manhattan by R.K. Bonnett, listed as a Crops Specialist, studying the impact of time of burning on tallgrass prairie yield and species composition. In 1920, C.W. Mullen, also listed as a Crop Specialist, continued that work. R. L. Hensel was appointed in late 1920 to head the Pasture Investigations Project, took over the work on the range burning research, and authored the first refereed publication in the range area (R.L. Hensel, 1923. "Effect of burning on vegetation in Kansas pastures," *Journal of Agricultural Research*.). Hensel's tenure in the department was short, and A.E. Aldous replaced him in 1926. Aldous expanded the range research program tremendously. The first work on grazing effects was initiated early in his tenure, on the Casement pastures. He did pioneering work in forage nutritive value; food reserves in weedy forb and brush species and native warm-season grasses; fertilization; the range grass breeding project, which he initiated; weed and brush control; haying date and height; and grazing systems.

Since Alfred E. Aldous initiated studies with prescribed burning in the 1920s, K-State has gained worldwide recognition for this research.

Site where Clenton Owensby and colleagues evaluated effects on rangeland from elevated CO_2, one aspect of global warming.

Upon Aldous' death in 1938, Kling L. Anderson was appointed to head the Pasture Investigations Project. Anderson continued Aldous' work with grazing management and range burning, and greatly expanded the grass breeding work. In 1946, legislator Wayne Rogler of Matfield Green, Kansas, introduced a bill to acquire research area. After its passage, in 1948 the university acquired the "Donaldson Pastures and range", an 1152-acre area five miles northwest of the campus. During the next two years, the research infrastructure was put in place. The area was fenced into nine 44-acre pastures for stocker grazing research. The rest was fenced into larger pastures and dedicated to winter nutrition studies for spring-calving cows. Ed Smith, of Animal Sciences and Industry, and Anderson shared the research design and implementation, with Smith collecting the livestock data and Anderson the botanical information. The original treatments included: determining the effect of heavy, moderate, and light stocking rates on unburned bluestem range, a comparison of deferred rotation grazing with season-long grazing, and comparisons of the effects of early spring, mid spring, and late spring burning with an unburned pasture. Those studies continued until 1967, when Anderson had to take medical retirement.

Clenton Owensby replaced Anderson. The original research projects at the Donaldson Pastures were terminated, and over the next three years all units were stocked season long at a moderate rate and burned in the late spring to equalize the productivity and species composition on the area. The original moderately stocked unburned pasture and the late-spring burned pasture were continued until 1991, when an accidental fire from off the area burned the unburned pasture. That ended a 41-year comparison of burned and unburned bluestem pastures. That study, along with the Aldous Burn Plots study (initiated in 1926 and continuing to the present) represents the longest-term burning research in the world. In 1970, two new projects were initiated for stocker cattle at the Donaldson site: a comparison of intensive early stocking with season-long stocking, and aerial nitrogen fertilization of burned and unburned bluestem range at 0, 40, and 80 lb N/acre. Those studies were four years in duration, and after a two-year period of equalization, a stocking rate study for intensive early stocking comparing 2, 2.5, and 3 times the season-long rate on burned bluestem range was initiated. Bob Cochran replaced Smith as the Animal Sciences and Industry research partner. That study continued for six years. The next study on the Donaldson site was a comparison of rotation of late-season rest with year-long continuous stocking. That study lasted for six years and was the last cooperative study with the Animal Sciences and Industry Department on the Donaldson Pastures.

In 1978, Walter H. Fick was hired, primarily to expand the range management course offerings and to conduct research on rangeland brush and weed control. His initial research demonstrated the superiority of picloram over 2,4-D amine for fall musk thistle control under dry and/or cold environmental conditions. This work contributed to the labeling of picloram for musk thistle control. Most of Fick's research has been conducted on private land, although experiments were conducted on the Donaldson Pastures, Rannells Flint Hills Prairie, the Konza Prairie, and Fort Riley. Over the years, Fick worked closely with private industry to screen herbicides and aid expansion of labels for brush and weed control. Triclopyr and metsulfuron were shown to provide control of *sericea lespedeza*. Fick recently contributed to the database supporting the labeling of aminopyralid for noxious and invasive weed control. In addition to his work on musk thistle and *sericea lesepdeza*, Fick developed recommendations for chemical control of Russian olive, osage orange, elm, blackberry, multiflora rose, Baldwin ironweed, roughleaf dogwood, lanceleaf ragweed, smooth sumac, buckbrush, and saltcedar.

Graduate students of Fick have studied brush control and associated botanical changes after tebuthiuron application; defoliation effects on big bluestem production, forage quality, and carbohydrate reserves; prescribed burning impacts and chemical control of roughleaf dogwood; nonstructural carbohydrate reserves of blackberry and multiflora rose; defoliation, burning, and nitrogen fertilization effects on Caucasian bluestem production, quality, and vigor; smooth sumac and roughleaf dogwood response to different burning frequencies; integrated control of *sericea lespedeza*; nitrogen dynamics, production, and quality of some eastern gamagrass-legume mixtures; establishment of eastern gamagrass with pre-germination seed treatments; soil quality and vegetation comparisons between native range and conservation reserve program plantings; and ecology of *sericea lespedeza* in the Kansas Flint Hills. Fick advises students in the distance M.S. program with range/forage interest. These students are studying smooth brome response to fertility, integrated control of roughleaf dogwood by using herbicides and prescribed burning, impact of herbicides and fire on *sericea lespedeza* seed banks, and vegetation and livestock response to patch burning of tallgrass prairie.

In 1989, work was initiated one mile north of the campus in a native bluestem pasture operated by Animal Sciences and Industry on the effects of elevated CO_2 on nitrogen-fertilized and unfertilized tallgrass prairie. That study, funded by the Department of Energy, was nine years in duration.

Also in 1989, a 2105-acre area was bequeathed to the Kansas State University Foundation by Lou R. Adams and Helen R. Sampson for the sole use and benefit of the range research program, with the specific condition that the area may never be sold, conveyed, or assigned by the grantee, and that the property may be only used for research uses, which will be limited to those that do not alter the condition of the property and preserve it in its existing condition. To restore the Rannells holdings to their original extent, Section 4 was purchased to extend the area to 2745 acres. The Hilas Bay and Emma Browning Rannells Flint Hills Prairie Preserve is located immediately south of Manhattan, Kansas, adjacent to K-177. In 1999, an additional 160 acres was purchased, making the area 2904 acres. The area was fenced into sixteen ~80-acre units, eight 160-acre units, and one 240-acre unit. Livestock water is supplied by ponds, solar pumps, and undeveloped springs. There are three new sets of working pens and livestock weighing and handling facilities on the area. A headquarters building was erected in the spring of 1994 and a horse barn in 1997. Eleven ponds were constructed in the winters of 1993 through 1996 to provide reliable water for the research pastures. In 2004–05, one section that was fenced originally with high-tensile electric fencing was refenced with barbed wire. During the winter of 2005–06, the other electric fenced section was refenced with barbed wire.

Table 1. Research Projects on the Rannells Flint Hills Prairie Preserve

Heifer Wormer Trial	1990	Larry Corah
Implant Trial	1993–1995	Bob Brant, Clenton Owensby, and Todd Milton
Grazing Distribution under IES and SLS	1993–1995	Brent Brock, Clenton Owensby, Lynnette Lewis and Lisa Auen
Ironweed Control	1996–2005	Walter Fick
Soil Classification	1995–1997	Bill Weimueller and Mickey Ransom
Project BigFoot (NASA)	1998–2004	John Briggs, Alan Knapp, and Clenton Owensby
Greater Prairie Chicken Population Study	1998–1999	Jack Cully, Robert Robel, and May Wong
Rotation of IES + LSG with IES and SLS	1997–2006	Clenton Owensby, Lisa Auen, and William Lamb
Carbon and Water Vapor Fluxes on Grazed and Ungrazed Tallgrass Prairie (DOE – AmeriFlux – NIGEC)	1997–2007	Clenton Owensby, Jay Ham, and Alan Knapp
Rotation of IES + LSG with SLS only	2001–2007	Clenton Owensby, Lisa Auen, and John Murphy
Soil Carbon Sequestration on Heavily Grazed Tallgrass Prairie (USDA – CASMGS)	2002–2006	Clenton Owensby, Jay Ham, and Lisa Auen
Isotopic Air Sampling in a Tallgrass Prairie to Partition Net Ecosystem CO2 Exchange (DOE)	2002–2007	James Ehleringer (Utah), Clenton Owensby, and Jay Ham
Integration of Carbon Fluxes Across the Great Plains Region Using Remote Sensing and Ground-Based Flux Systems (EROS – SDSU – KSU)	2003–2005	Tagir Gilmanov, Clenton Owensby, and Jay Ham
Greater Prairie Chicken Female Choice and Testosterone (KWP)	2003–2006	Brett Sandercock and Jacqueline Nooker
Scintillometer Estimates of Energy Fluxes Compared to Eddy Correlation Measurements	2005–2006	Nate Brunsell (KU), J.M. Ham, and C.E. Owensby
Growth Dynamics and Photosynthetic Responses to Season of Herbage Removal of Tallgrass Prairie	2005–2007	J.T. Murphy, C.E. Owensby, J.M. Ham, and L.M. Auen
Monitoring Pond Evaporation, Runoff, Infiltration, and Livestock Consumption of Grazed Tallgrass Prairie	2005–2006	J. Deusterhaus, J.M. Ham, and C.E. Owensby

Weed Science

Kassim Al-Katib

The weed science program at Kansas State University currently provides diverse expertise and training with a complementary balance in basic and applied sciences that contributes to the fine quality of the program. Current laboratory, greenhouse, and field research addresses the common goal of developing and implementing integrated weed management systems that are economically feasible and environmentally compatible. Basic and applied research in weed physiology and ecology, with emphasis on herbicide-plant interactions, herbicide-resistant weeds, weed population dynamics, risk and management of herbicide-resistant crops, integrated weed management, and cultural practices to reduce herbicide runoff have been conducted and continue to be a major focus of the overall research program.

The breadth of the weed science program in the last few years also was widened by offering more courses in weed science, including one undergraduate and three graduate courses. These courses are Weed Science, Integrated Weed Management, Advanced Weed Ecology, and Herbicide Interactions. The number of weed science graduate students has increased from 2 or 3 students in 1990 to about 10 students in 2006. Because much of the research in weed science is conducted by graduate students as part of their thesis or dissertation, the increase in graduate student numbers has greatly increased research output and strengthened the weed science program. In addition, funds obtained through competitive grants and industry were used to hire a postdoctoral research associate and an assistant scientist to expand the research base and provide continuity to the weed science program.

The current success of the weed science research and teaching program was built on a long history of outstanding weed research at K-State. The history of weed science at K-State started in 1895, when A.S. Hitchcock at the Kansas Agricultural Experiment Station published six series of bulletins describing the fruits, seeds, and seedlings of all important weeds in Kansas. These bulletins also described the distribution of various weeds in Kansas.

Field bindweed was, and continues to be, a major weed problem in Kansas. Therefore, early weed science research at K-State was mainly focused on field bindweed. The first experiment on control of field bindweed in Kansas, and probably in the United States, was conducted by A.M. Ten Eyck in 1907 on a farm near Victoria, in Ellis County. In 1919, J.W. Zahnley was hired as a Professor of Agronomy, with research and teaching assignments in weed science. In 1928, Zahnley started the first research in the United States on sodium chlorate as an herbicide to control weeds. His publications on this subject created worldwide interest in sodium chlorate. In addition, Zahnley conducted the early research on use of 2,4-D herbicide to control broadleaf weeds in wheat. Over the years, Zahnley developed an active research and teaching program in weed science, with strong interest in field bindweed and other dryland

James W. Zahnley in bindweed control plots, 1927.

Student employee mapping weed populations for variable-rate application research, 2003.

weeds. He trained several graduate students, including Oliver Russ, who was hired later as a weed scientist in the Department of Agronomy.

In 1954, Laurel Anderson was hired to replace Zahnley. At that time, there was great interest in chemical weed control, which led to the expansion of the weed science program at K-State. Anderson was conducting a broad range of research activities and, when he left in 1965, the department hired three scientists to replace him—Kurt Feltner, Erick Nilson, and Oliver Russ. All three scientists had research and graduate-student training responsibilities except Feltner, who had additional teaching responsibilities. Feltner left the department in 1972, and Stan Ehler assumed Feltner's teaching responsibilities, whereas Russ assumed the research responsibilities. Because of the strong demand for more courses in weed science, and also strong interest in herbicide/environment interactions, the Department of Agronomy hired Loren Moshier in 1977 to teach undergraduate and graduate courses and conduct research in herbicide/environment interactions. Moshier taught three courses until he left the department in 1994.

The weed science program went through a major restructuring in 1990. After Russ retired, his position was redirected to weed ecology, and Michael Hoark was hired to fill the position in 1991. He established an active program to study weed population dynamics and weed/crop competition. In 1996, the weed science program was further strengthened by hiring Kassim Al-Khatib as a weed physiologist. He established an outstanding weed physiology program that is internationally recognized, with an emphasis on herbicide-resistant plants and herbicide/plant/environment interactions. In 1998, Horak left the department and in 1999 was replaced by Anita Dille. She has established a strong research and teaching program in weed ecology. Dille's research also uses precision agriculture to manage spatial weed variability in Kansas farms. Components of integrated weed management can be linked to site-specific weed management through mapping and evaluating variability in soil properties, adjusting weed-control practices according to those properties, mapping weed populations, and targeting control practices to where weed populations occur.

An important strength of the weed science program is the cooperation that exists in terms of sharing equipment, instruments, labor, and space within laboratory, greenhouse, and field-research facilities. The weed science program has benefited greatly from establishing weed physiology and weed ecology laboratories that are equipped with several modern instruments. Good laboratory field facilities and equipment strengthened the basic research component of the weeds group, and have helped attract quality graduate students. Both Dille and Al-Khatib conduct research across the state. This allows more targeted research on problems specific to certain regions, and facilitates evaluation and comparisons of weed interference, weed management practices, and herbicide performance in different environments.

Soil Classification and Soil Survey

Orville W. Bidwell and Michel D. Ransom

Much of the history of soil genesis, classification, survey, and mineralogy in the Department of Agronomy involves participation in an overall program for soil survey in Kansas, which is now known as the Cooperative Soil Survey. The combined careers of the two authors of this section span more than 50 years. The Soil Survey of the United States, and of the Kansas Agricultural Experiment Station (KAES) herein described, is based on the concept of a soil as a natural body. It assumes that "the soil" exists in a natural position on the landscape, so that when isolated, described, and mapped areally, its response to various practices can be measured and predicted.

Kansas Legislature's First Soil Survey Funding for 1911–1912

Kansas' first soil survey was in 1902, of the Wichita area, and seven others were completed by the USDA Bureau of Soils before the state of Kansas authorized funding in 1911. March 10 of that year, by House Bill 494, the Kansas Legislature appropriated $10,000 for the biennium. The funds were sufficient only to employ assistants to work cooperatively with USDA leaders.

The KAES members who participated in 1911 were C.S. Myasza and H.C. Lint in Reno County and Ray Throckmorton in Shawnee County. Shawnee, Cherokee, Reno, Greenwood, and Jewell counties were completed. Reports as Kansas bulletins were printed for Shawnee, Cherokee, Reno, and Jewell counties.

Ray I. Throckmorton

Ray Iams Throckmorton, (1886-1979) a graduate of Pennsylvania State College, was employed to do soil survey work in Kansas beginning July 1, 1911. The salary was $40 per month plus expenses. He took the job with the understanding "that he would not be required to teach." The first winter of his employment, however, he was asked to substitute for a teacher on sabbatical leave. "Throckmorton consented, and developed into one of the most popular, competent, and devoted teachers of the institution," Dean Leland Call recalled. "Throck," as he was affectionately known, worked in Shawnee, Cherokee, and Jewell counties in 1911 and 1912. He held other positions in the Agronomy Department before being Department Head from 1926 to 1946.

Although his professional specialty was soil survey, records of the American Soil Survey Association that existed from 1922 to 1936 show that he attended annual meetings only in 1925, 1927, and 1930. He presented no papers and served on one committee, Kansas representative on the Excursion Arrangement Committee for the First International Soils Congress, 1927. Instead, he participated in the affairs of the American Society of Agronomy, for which he served as President in 1934. From 1946 to 1952, he was Dean and Director of Agriculture. In retirement, he taught one section of beginning Soils through the spring semester of 1957. Throckmorton's early soil-survey knowledge and experience, however, combined with Harold Myers's skill, noticeably affected the development of the state's soil-survey program after WWII.

Kansas Legislature Revokes Soil-Survey Support

Some Kansans, unhappy to have soil surveys disclose poor land quality, convinced the 1913 Legislature to discontinue state soil survey activity by including the following in Senate Bill No. 812, Section 7:

> *"That Chapter 22 of the Session Laws of 1911 being an act entitled 'an act authorizing the Kansas State Agricultural College to make a soil survey of the state and making an appropriation therefor' be and the same is hereby repealed."* Approved March 12, 1913.

Although the state of Kansas' soil-survey support was of short duration, Call wrote that it enabled the KAES to help complete the survey of five counties and employed Throckmorton, who became a successful teacher, researcher, and administrator of the institution.

Kansas's First Soil Chemical Analyses

In 1899, the KAES council authorized the Department of Chemistry to analyze typical soils of the state. Shortly after the work began, the chemistry building burned, May 31, 1900. Work did not begin again until 1909, according to J.T. Willard's Foreword for KAES Bulletin 199. By then, the Bureau of Soils of the United States Department of Agriculture had made soil surveys of Allen, Sedgwick, Butler, Brown, Riley, Russell, Finney, and Gray counties, from which the soil samples were obtained.

Charles O. Swanson (1869-1946) was in charge of collecting and analyzing the samples, and preparing Bulletin 199. (Swanson later became esteemed head of the Flour and Feed Milling Department.) Charles E. Millar (1885-1955) of the Agronomy Department did most of the chemical analyses, except for samples earlier analyzed by H.C. McLean. Millar resigned December 1915 to accept a position at Michigan State College, where he retired in 1950 as head of the Soils Department.

Legislature Resumes Soil-Survey Funding, 1926–1932 Only

The Kansas Legislature resumed soil-survey funding in 1926, with annual appropriations of $5,000. Coincidentally, 1926 was the year former soil surveyor Throckmorton became head of the Agronomy Department. Cooperative work with the Bureau of Soils ended in 1932, when funding ceased due to universal financial conditions. Soil surveys were completed for the counties of Clay, Labette, Doniphan, Wilson, Crawford, Johnson, Woodson, Neosho, Marion, Bourbon, Kingman, and Allen.

Clay County party leader, James Thorp, advanced in the USDA hierarchy to become a regional soil correlator and Great Plains Principal Soil Correlator of the Soil Survey Division, and when the Division merged with the Soil Conservation Service (SCS), he became Great Plains Principal Soil Correlator of SCS. Thorp became known as an international loess authority.

1946–1949, Era of Transition

Spirited soil activity took place in the Agronomy Department after World War II. Military veterans who filled the classrooms overworked the few experienced professors. Soils members Myers (1906–1992) and John Clifford “Cliff” Hide (1905–1962) were joined at the War’s end in 1946 by Harold Jones (1916–1987) and Floyd Smith (1920–1994) and in 1947 by Raymond Verlin Olson (1921–1985). Long-time Soils Professor William Harold Metzger died July 1942, at the approximate age of 42. Hide departed for Montana in March 1946.

Claude Fly’s Impact on the Kansas Soil Survey

Claude Fly (1905–1991) was located in the Kansas State College Agronomy Department during his tenure as State Soil Scientist of the Soil Conservation Service from 1947 to 1952. He was housed there, rather than in the State SCS office in Salina, to be closely associated with soils members of the department. From 1950 to his departure, he was assigned by Agronomy Department Head Myers to 307 East Waters Hall, with C. Harry Atkinson and Orville Bidwell. In addition to supervising a number of field soil scientists, he is remembered for giving soils leadership to inexperienced K-State faculty.

Funding Resumed in 1946

Kansas resumed soil-survey funding of $5,000 annually from 1946 to 1950 and $10,000 annually after 1950. The acknowledged purpose was to supply soil information for developing irrigation districts. Until 1952, as in the past, the Kansas Legislature funded the soil survey directly. In 1952 and thereafter, funding was included as an applied research item in the KAES budget. This change may have been made by Dean Throckmorton to avoid future legislative revocation, as a recalcitrant Legislature had done to him in 1913.

State soil-survey funds were used for three separate projects from 1946 through 1949: (1) funding the state’s share of the county reconnaissance maps and reports project with the Soil Conservation Service; (2) partial funding of a cooperative irrigation survey with the Bureau of Reclamation; and (3) providing field-party members for the Saline County Soil Survey.

Saline County Survey

The Saline County survey party, led by Arvid Cline of the Soil Survey Division of the Bureau of Plant Industry, Soils, and Agricultural Engineering (BPI), also consisted of State of Kansas and Soil Conservation Service (SCS) surveyors. Field work completed in early 1950 was published in 1959. The Saline County report was the last Kansas report to have colored planimetric soil maps prepared using a plane table. Later Kansas soil survey reports used aerial photographs as the base map.

Paul Brown worked on the Saline survey as a state employee from March 1946 to March 1947, and as a USDA employee to May 1948, when he was appointed to the Hays Branch Experiment Station. Darold Dodge worked for the state during the summer of 1947 and from March to May 17, 1948, when he transferred to the SCS.

Irrigation Projects Soil Surveys

Formation of irrigation districts in Osborne and Republic counties demanded soil surveys to delineate the irrigable soils. The USDA Division of Soil Survey of the BPI and the KAES agreed to conduct the needed soil survey. To head the cooperative project in 1948 or 1949, the BPI transferred Cuthbert Harry "Shorty" Atkinson (1906–1993) from New York State to be a joint employee with Kansas Agricultural Experiment Station. Whereas the BPI increased Atkinson's salary over time, the KAES never increased its share of about $3,000. In addition to Atkinson, the Soil Survey Division employed William Badgley, a 1951 Kansas State College geology graduate. Coordinators of the cooperative project were James Madison, Denver, Bureau of Reclamation, and William Johnson, Lincoln, Nebraska, BPI. The state employed Robert Bohannon, James Killian, and Wayne Fowler in 1951. Fowler later was Executive Secretary of the Kansas Crop Improvement Association before taking a job with Dekalb.

Soil Survey Activity after the 1951 Flood

The winter after the 1951 flood, the SCS assigned soil scientists, using the state symbolization, to map flood-affected lands of the Kansas River Valley from Junction City to Kansas City. N.L. Sodman was transferred from out of state to re-map Geary County flooded lands for the soil survey report in preparation. Emergency federal subsidies were provided for plowing to a depth of three feet of deposits of a specified sandy texture and thickness. Soil surveys were needed to delineate the damaged areas. A farmer at Manhattan's east edge found that deep plowing so improved 1952 crop yields that in the winter of 1952-l953 he deep-plowed adjacent stratified deposits that had not qualified for government subsidy. The reason deep plowing improved other flooded lands was because it disrupted intermittent thin bands, characteristic of flood deposits, that restricted vertical root proliferation.

To determine whether Big Blue and Delaware Rivers dams were to be used for flood control or irrigation, Atkinson's field party was transferred in 1952 from the Kansas-Bostwick Irrigation District to the Kansas River valley. Its mandate was to determine irrigable soils on the north side of the river from Wamego to Lawrence. Myers transferred Bidwell from his work in Geary and Brown counties to hasten completion of the project. Aerial photographs, at a scale of 13 inches to the mile, were used in place of the regular photographs at 4 inches to the mile. The survey revealed too few acres of irrigable soils that had a suitable cost/benefit ratio for irrigation. Tuttle Creek and Perry dam sites becoming the jurisdiction of the Corps of Engineers did not deter the bureau engineers from seeking other sites. In the 1960s, they hesitated a long time before acknowledging that Saline River valley soils were too saline and clayey to irrigate from the Wilson Dam in Russell County.

Role of the Soil Conservation Service

The Soil Conservation Act of 1935, one of Franklin Roosevelt's several "New Deal" measures, authorized formation of the Soil Conservation Service (SCS). Hugh Hammond Bennett (1881–1960), ardent foe of water erosion, was appointed its head. Differences with other USDA agricultural agencies soon appeared as the SCS began flexing its muscle and implementing its mandate. A striking difference between the SCS and the Soil Survey Division of BPI was including degree of slope and amount of erosion in the mapping symbols. But the biggest change was authorizing federal expenditures to establish soil conservation districts. The districts provided technical assistance to develop farm plans and to install conservation measures such as gradient and level terraces, grass waterways, and farm ponds.

Because of suffering inestimable damage by wind erosion, Kansas welcomed federal assistance with open arms. Seemingly unceasing devastating winds had caused land values to plummet, lowered farm owners self esteem, and created economic havoc to the entire state, in addition to affected agricultural communities. The Kansas Cooperative Extension Service readily approved of the new organization, assigning Extension Specialists Luther Willoughby (1889–1957), Reuben Lind (1901–1991), and Harold Harper (1907–1992) to assist in organizing county soil conservation districts. By 1950, all counties except Shawnee had a soil conservation district.

Kansas' rapid pace, on the other hand, created an urgent need for farm-planning and soil-classification personnel. To fill the positions, the Agronomy Department created a Soil Conservation Curriculum with new courses, Soil Conservation I for eastern Kansas and Soil Conservation II for western Kansas. For a time, Missouri and Oklahoma personnel filled a disproportionate number of early positions.

Kansas State Soil Scientists

From 1936 to 1946, Alvin Goke, stationed in Salina, was in charge of the eastern Kansas detailed soil legend, according to Wesley Barker. It is unclear whether Goke's title then was State Soil Scientist or Area Soil Scientist. Nicholas Holowaychuk, returning from an exciting military intelligence position as a Russian interpreter, was State Soil Scientist from July 1946 to June 1947 and was stationed in the K-State Agronomy department. Holowaychuk never discussed with fellow student Bidwell why he left Kansas to take graduate work at Ohio State University. There he received the doctorate in 1950 or 1951 and remained to head the University's soil survey program.

Claude Fly, like his predecessor, Holowaychuk, was housed in the Agronomy Department. He remained State Soil Scientist until 1952, when he accepted an overseas assignment with the Morrison-Knutson Engineering firm, designing an irrigation system near Kabul, Afghanistan. Area soil scientists, Henry Otsuki and Richard Jackson, administered the state program until Arthur Nelson became State Soil Scientist in 1953, retiring in December 1965. Charles W. McBee was State Soil Scientist from 1966 to 1981. William Roth held that position from 1981 to 1988, and Richard Schlepp from 1988 to 2001. Cleveland Watts assumed the position after the retirement of Schlepp, and currently holds the title of State Soil Scientist and MLRA Office Leader.

Are Farm-Planning Soil Surveys Suitable for Publication?

During World War II, soil mapping for farm planning progressed rapidly in districts whose soil scientists were not subject to military conscription. It ceased in districts lacking soil scientists. By 1949, a number had been completely mapped. Could the farm-planning soil information be compiled and recorded for others to use? That question faced the leadership of the Soil Conservation Service, the Kansas Agricultural Experiment Station, and the Division of Soil Survey. In 1949, those organizations, probably at Myers' behest, agreed to publish the soil maps in a report format.

The Soil Conservation Service would provide the completed soil field sheets, the Division of Soil Survey would correlate the soils according to the national system, and KAES would provide a part-time individual to do whatever was necessary in terms of fieldwork and manuscript preparation for a conventional publication. By 1949, mapping was complete in the counties of Geary, Brown, Ellsworth, Franklin, and Wilson. Of those, Geary County, mapped by Ralph Dunmire (1910–1980), and Brown County, mapped by Robert Eikleberry (1912–1982), were selected for the pilot program. First, however, the KAES needed to come up with a soil classification specialist.

Orville Bidwell Selected for State Soil Surveyor Position

The Department Head of Agronomy was faced with the responsibility of providing the individual to work with the Soil Conservation Service and the Soil Survey Division of BPI. Filling the new position was only one of many things Myers had on his mind when he attended the American Society of Agronomy annual meeting at Milwaukee, Wisconsin, October 24–28, 1949. Immediate Past President of the Soil Science Society of America, Myers was "going through the chairs" to become President of the American Society of Agronomy.

Orville Bidwell, about to receive a Ph.D. degree at Ohio State University December 16, 1949, attended this annual meeting for the sole purpose of getting a job. Because the Agronomy Society had no career placement service in those days, job applicants not only had to learn of available jobs, but also had to identify the individual to contact among the sea of strange faces. Bidwell tried to talk to Myers at the meeting but found him difficult to contact. When seen, he either was a scheduled speaker or tied up in Society business meetings. With time running out, it looked like the timid applicant would be unable to contact him. On the last day, he saw Myers race down the grand stairway from the floor above, stop, hesitate for a moment and turn to retrace his steps. Sensing an opportunity, Bidwell rushed to the stairs, and called, asking if Kansas was looking for a soil surveyor. Answering in the affirmative, Myers came down the stairs and pointed out nearby chairs where he proceeded to interview the candidate. To his question about soil-survey experience, Bidwell responded that he'd spent three summers in the field for the Ohio Agricultural Experiment Station, two in Clark County and one in Fairfield County. Myers said he'd like the new individual to be a mediator between two individuals with deep-seated differences, one a member of the SCS, the other of the BPI. Myers said he planned to place the three in the same office to improve relationships. Bidwell admitted that he was not an arbitrator. After several more questions, Myers told him to submit his application.

Returning home, Bidwell prepared applications for Kansas, Illinois, and Purdue. When the Kansas job offer arrived after Thanksgiving, Bidwell, believing he was most suited for the Illinois job, inquired if Illinois had made a decision. When the reply was "not yet," he decided to take the Kansas offer. Accepting the Kansas job meant working alone in a broad new program with limited funds and relying on cooperating national agricultural agencies for information and assistance. In contrast, the Illinois job would have consisted of operating a laboratory in one of the foremost state programs that consisted of five full-time soil scientists. Bidwell learned later that Kansas was able to make the first offer because Myers had known his advisor, J. Boyd Page, when both were at Missouri.

Bidwell knew nothing about the Kansas State College of Agriculture and Applied Sciences other than seeing and admiring Myers at national meetings and reading A.T. Perkins' controversial soil-phosphorous work. Myers had told him that Kansas winters were sunnier than Ohio's. Bidwell's advisor, Boyd Page, who drove through Manhattan on US Routes 24-40 to his former home in Utah, said Manhattan was a lovely community with lots of trees. Bidwell arrived in Manhattan on January 25, 1950, to take the new position Myers had crafted of half-time teaching and half-time research. An appendectomy in early January delayed his arrival several weeks. The position consisted of full time teaching the second semester, with summer and fall semesters devoted to revision and publication of completed Soil Conservation Service farm-planning soil maps.

Pleistocene Sediments Emphasized

Following his arrival in Manhattan, Myers urged Bidwell to accompany SCS State Soil Scientist Fly on field reviews whenever possible. He arranged to have Bidwell spend a week traversing from Jewell to Cherokee counties with James Thorp and William Johnson of Lincoln, Nebraska, and John Frye, Kansas State Geologist, from Lawrence.

The purpose of the week-long field study was to compare interpretations of Kansas geomorphic landscapes, with particular attention given to loess identification, and particle size and thickness variation with distance from suspected sources. Hearing Thorp and Frye discuss their versions of a given geomorphic position was a memorable learning experience, indeed, for the neophyte. Thorp, then Principal Soil Correlator of the Great Plains States, had led the Clay County survey in 1926. In the interim, he had become nationally renowned as a loess authority. Frye shortly before had published, with Ada Swineford (1917–1992), a Kansas Geologic Survey bulletin on some characteristics of Kansas Pleistocene deposits.

Frye in 1951 led the Kansas segment of the "Friends of the Pleistocene" field tour that entered Kansas in Marshall County. The tour progressed eastward through Nemaha, Brown, and Doniphan counties, examining Kansan glacial till and out wash variation and red Sioux quartzite erratics the ice had picked up at Pipestone, Minnesota. Of particular interest to the forty tour members was Frye's identification and designation of Bignell, Peoria, and Loveland loess exposed on the bluffs of the Missouri valley at Iowa Point in Doniphan County.

Consulting Work by Bidwell

Unmentioned in the position discussion was extra consulting either for other university researchers or for personal reimbursement. Shortly after Bidwell arrived, agricultural economists who had worked with Fly and Holowaychuk called for assistance. Merton Otto (1899–1982) requested help to correlate Geary County farm sale prices with soil quality. Later, Wilfred Pine (1912v1995) sought information for a northeast Kansas land study. A visit by Kansas highway department engineers seeking causes of deterioration of concrete highways led to a long association with John D. McNeal, Head of the Planning Department.

Shortly after arriving in Kansas, Bidwell received a request from the Defense Department, asking for soil surveys to plan several Atlas missile sites in Kansas. In response to the request, he sent County Reconnaissance Soil Maps of designated counties, one of which was Pottawatomie, where a missile base was to be constructed at the north edge of Wamego. The Wamego site was completed in 1961 and abandoned in 1965. As remembered, there were two other Kansas sites, one at Glasco in Cloud County, and another in central Kansas.

Range scientist Kling Anderson, who with Fly had developed a pioneering range-site concept, was the agronomist most interested in soil classification. When Kling, Jerry Tomanek of Fort Hays State College, and Wayne Huffine (1920–1991) and Jack Harlan (1917–1998) of Oklahoma A and M developed a summer range course at the K.S. Adams ranch, Foraker, Oklahoma, Bidwell was asked to teach the soils portion. This continued for many years, with Anderson and also with his successor, Clenton Owensby.

Robert Bohannon took a week of Bidwell's time to take Cherokee, Bates, Summit, and Dennis soil samples in Crawford County for his Ph.D. research at the University of Illinois. Other work involved helping Tom Shackelford, University Grounds Superintendent, when he sought red soil for the base paths of the University's baseball field.

Telephone consultations were frequent, especially in the 1960s and 1970s. One of special interest related to the siting of an Oscar Mayer pork-processing plant at Wamego in the mid 1960s. When eastern Kansas hog feeders disclosed the need for a local market, the Oscar Mayer Co. indicated interest in locating a plant on the Newman terrace of the Kansas River valley, north edge of Wamego. During the early stages of land acquisition, an Omaha attorney inquired by phone if the soils could absorb 30 inches of wastewater in addition to normal rainfall. When told the silty clay was too slowly permeable to fully accept 30 inches of natural precipitation, the caller remarked that Oscar Mayer would withdraw its bid.

Bidwell's Teaching Program

For several years, teaching consisted of two sections of Soil Conservation I, in addition to the Soil Development and Classification lecture and two laboratory/field classes. Bidwell's Soil Development and Classification course evolved from Throckmorton's Soil Survey course that Metzger renamed Development and Classification of Soils**.** Establishing a strong Soil Development and Classification position apparently was important to Myers. His emphasis may have stemmed from a deep-seated interest occurring when he taught the course in the early 1930s and again in 1946. Olson, Fly, Atkinson, and Johnson provided amiable assistance to Bidwell, who was cutting his teeth on prairie soils. Bidwell's mandate, in turn, was to extend the knowledge to students, agronomy research and extension colleagues, and farmers.

Over time, Bidwell's teaching responsibility included courses other than Development and Classification and a curriculum other than agronomy. From 1950 through 1952, Bidwell taught Soil Conservation in Eastern Kansas. When Olson, teacher of Soil Physics, became Agronomy Department Head and brought Art Hobbs back from Oklahoma, Hobbs took the conservation course and re-titled it Soil Management. Bidwell was assigned Soil Physics from 1953 to about 1959 or 1960, when Hyde Jacobs asked to teach the course. In the mid 1950s, Olson suggested a graduate course, Soil Genesis, be taught every other year. The course never had more than six students and occasionally none. In Bidwell's courses, information on Northeastern Kansas Pleistocene geology that Frye provided in 1950 and 1951 proved beneficial for class field trips for more than 30 years, many in cooperation with the University of Kansas and Highland Community College. The Soil Morphology class was created for participants on the Soil Judging Team in about 1966.

There were many reasons for decreased agricultural enrollment during the 1950s. One of the most apparent was that entering students were not taking necessary college preparatory courses such as Chemistry and Mathematics needed for beginning soils and changing agricultural curricula. Some high school students did not take the courses because they were not offered in small high schools, others decided to enroll without taking college preparatory courses. Students were choosing Animal Husbandry rather than Agronomy because its prerequisites were less rigorous and did not require Chemistry. The department's teaching faculty spent many hours debating whether Chemistry should be a requirement for soils. One member said Soils could be taught without Chemistry. Because Agronomy numbers were so few, C. Peairs Wilson, Director of Resident Instruction, appointed Bidwell to the University's recruiting team in the late 1950s.

While at the University of Wisconsin on sabbatical leave the fall semester of 1962, Bidwell developed the concept that students with farming experience have an inherent advantage in the agriculture sector over those lacking it. Why not spread this word among high school advisors, many of whom recommend engineering to the more qualified students? Returning in January 1963, Bidwell proposed the idea to Duane Acker, new Director of Resident Instruction. "Let's go after the prepared students that had been selecting other curricula such as engineering, rather than lowering our standards to gain numbers from the unqualified reservoir," he told the Director. Acker accepted the idea and proposed a "Science Seminar." High-school science teachers within a radius of 50 miles of Manhattan were invited to bring outstanding students to a series of science seminars by outstanding K-State faculty members, who received an honorarium. The seminars were held once a month on Saturday morning for four months during the 1963-1964 and 1964-1965 school years. As remembered, two of the invited speakers were biologist Thad Pittenger and physicist Basil Curnutte. A determination of where the 30 to 40 motivated students ended up was never made, and there seemed to be no noticeable affect on subsequent agricultural enrollment.

Not long after coming to Manhattan in 1966, Carroll Hess scheduled a retreat at Rock Springs for teaching faculty. One purpose was to study in depth the entire resident teaching program, including a change in title of the College of Agriculture. When the agricultural faculty failed to accept Charles Hall's and Bidwell's proposal to include "Natural Resources," as part of the College of Agriculture's title, Hess appointed an *ad hoc* committee to consider a Natural Resource Inter-disciplinary Curriculum. The committee consisted of Wilfred Pine, Agricultural Economics, chairman; Ray Keen, Horticulture; Jacobs, Owensby, and Bidwell, Agronomy; and Harry Manges, Agricultural Engineering. The new curriculum was to be known as Natural Resource Conservation, later Natural Resource Management, and was designed to recruit students whose interest in the environment had been stimulated by Rachel Carson's *Silent Spring* in 1962. A sizable number of students interested in the environmental cause elected the Soils option of the curriculum. From 1966 to 1984, the 150 students in the Soils option was a source of soils team members.

In addition to the College of Agriculture mandate of increasing student numbers with options in Economics and Soils and Range Science was a Horticulture proposal to develop a sub-curriculum in Parks and Recreational Areas Management. For a time, the committee's major work was preparing proposals for new courses and a job description for Director Hess to use for a new position, filled later by Ben Mahaffey. Hess instructed Bidwell to create the Soil Morphology class for soils team applicants so the College of Agriculture and Department of Agronomy could receive the student credit hours.

In the middle 1970s, department head Jacobs advised Bidwell to cease reviewing soil-survey manuscripts to develop and teach a course for land-use planning. Teaching tenths were increased from five to six as a result. Bidwell consulted Robert Ealy and Vernon Deines, heads of Landscape Architecture and Regional and Community Planning, for ideas and developed "Soil Interpretation for Land-Use Planning" for their students. Parks and Recreation Areas Management students also elected the course.

Although increased student numbers enabled Agronomy Department Head Jacobs to add range scientist, Walter Fick, to the department in 1978, the Soils option was not popular with all Agronomists. Roscoe Ellis (1920–1982), Professor of Soil Chemistry, claimed that the Soils option recruited students at the expense of the Agronomy Department. Among the 150 Soils option students, several became attorneys specializing in environmental issues. Daniel Robison was the first K-State student to receive a Marshall Scholarship in 1984. He was the fourth agriculture student, and the first soil science student, in the 30-year history of the Marshall award program. Robison obtained the Ph.D. degree at Reading University, Reading, England. Elissa Levine, a native of New York City, came to K-State because of her interest in conservation and the environment. In 2001, she was with the NASA/GODDARD Space Flight Center.

To accompany the Natural Resource curriculum, Bidwell proposed in 1970 the formation of a Natural Resource Conservation Club, in conjunction with the national Soil Conservation Society of America. Starting out as its advisor, he became co-advisor from 1971 to 1982. Mahaffey, first co-advisor, recommended the name change to Natural Resource Management. The NRM Club won first-place awards for Ag-Science Day displays in 1979, 1980, and 1981.

Research Program and Soil Survey Activities of Bidwell

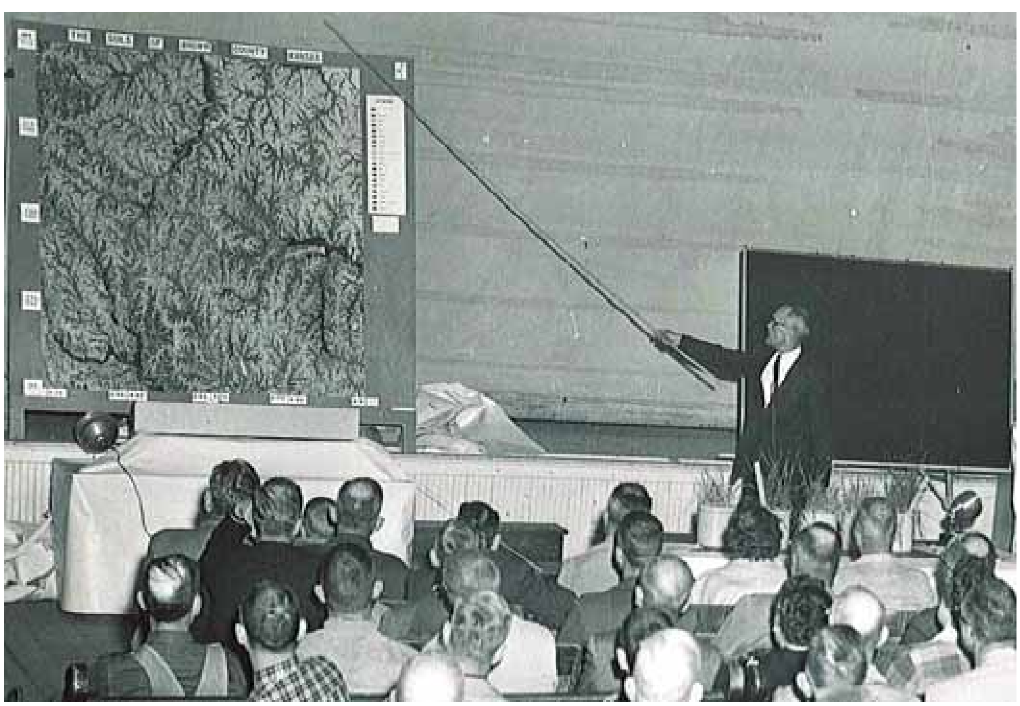
Of the five counties slated for soil survey revision and publication, Geary was the first selected because of its proximity to Manhattan. Bidwell's first experience in Geary County was the field review in June 1950. The purpose of the review was for William Johnson, USDA Soil Survey Division correlator, to evaluate soil mapping consistency and field-sheet quality for correlation in the national system and for publication suitability. Participants, in addition to Johnson, were Dunmire, who made the survey; Fly, Dunmire's superior and State Soil Scientist of the SCS; and Bidwell. Bidwell spent the rest of the 1950 field season examining, describing, and recording soil information in conformance with Johnson's critical recommendation. The major task consisted of distinguishing between the series Crete, Irwin, Ladysmith, and Dwight; Shellabarger and Farnum; and Sutphen and Solomon. Some series names were changed in the 1998 revision.

A Brown County review similar to that of Geary County was made in 1951. In addition to Johnson, Fly, and Bidwell, Eikleberry, who made the survey, also participated. The rest of 1951 Bidwell spent becoming familiar with the Brown County soils and distinguishing the relationships of loessial textures and thickness with distance from the Missouri River. Affected soils were Monona, Marshall, Sharpsburg, and Grundy. Robert Hanna distinguished the textural variation in his 1955 Soil Science Society of America Proceedings article. Some soil series names were changed in the 1998 update.

Bidwell found remarkable similarities among the loessial soils in Geary and Brown counties. Brown County's loess thinned and became more clayey with distance from the Missouri River. Geary County's loess thinned similarly with distance from the Republican River, but the distance was much shorter, and the changes more drastic.

Bidwell spent the field seasons of 1953 through 1957 working intermittently in Brown County, while compiling the Geary County report. Brown County field notes were lost and fieldwork discontinued after the August 25, 1957, East Waters Hall fire. Destroyed also were the Geary County field notes and all but one copy of the Geary County soil-survey manuscript.

When Bidwell joined the Kansas State Agronomy Department, he unknowingly became an official member of NCR-3, the North Central Regional Soil Survey Committee. Authorized by the North Central Region directors, its purpose was to advance knowledge of the region's soils and foster working relationships among the twelve cooperating states. The



Orville W. Bidwell aquaints producers with the Brown County soil survey, April 1961.

date of origin of NCR-3 is not known to the authors. K-State participation is believed to have begun in 1947, when Myers attended a North Central Regional meeting at Des Moines. In 1948 and in June 1950, he attended similar meetings at Lincoln and Lansing. Bidwell first participated with the committee at the 1950 meeting.

In 1959, forty-seven SCS soil scientists were working in Kansas. By 1964, fieldwork had been completed in fourteen counties, and ten counties had been published and their reports distributed, according to State Conservationist Morrie Bolline in March 20, 1965, *Kansas Farmer*. At that time, thirty-eight soil scientists were mapping soils at an annual cost of $300,000.

The major outcome of the accelerated soil-survey program was the published soil survey reports. In addition to the copies the SCS provided to each (county) conservation district, 4500 copies were allotted to the Kansas Extension Service by the U.S. Senators and Representatives. When the Saline, Brown, and Geary County reports arrived almost simultaneously in 1959 at Umberger Hall, the Extension Service's distribution center, Director Harold Jones instructed Bohannon, Soils Extension Specialist, "to put the reports in user's hands." Jones knew the value of the reports because ten years previously he had used soil survey reports in Soils courses he taught in the Department of Agronomy.

Acting Vice-President for Agriculture Floyd Smith appointed Bidwell as Acting Head and Chairman of the Search Committee when Olson relinquished the leadership of the Agronomy Department in June 1970. Bidwell served as Acting Head until Jacobs was selected for the permanent position in the fall of 1971.

During a three-month study in Nigeria in 1971, Bidwell found that Nigerian soils have six textural classes: Sand, Slightly Clayey Sand, Clayey Sand, Very Clayey Sand, Sandy Clay, and Clay. The soils are very hard when dry. Bidwell gave a pessimistic final report to the USAID office in the spring of 1971:

> *"Prospects of significant increases in crop yields are extremely poor based on the inherently low fertility and the extreme hardness during the dry season, Silt normally is the mineral source of plant nutrients. With no silt, mineral nutrients must come from slowly weathering sands and clays. Large supplements such as animal waste and imported commercial fertilizers brought long distances usually over poor roads are unlikely."*
>
> *"Man's only course is to continue the current practice of shifting cultivation, whereby a system of long-time fallow utilizes deeply penetrating and proliferating roots of natural vegetation to pick up plant nutrient elements near weathering rock. The natural woody vegetation then transports and stores the nutrients in the form of organic matter to the upper layers of the soil for use of shallow-rooted annual crops."* O.W. Bidwell

Bidwell's other research activities involved working with interpretive soil-mapping symbols and numerical soil taxonomy. He published a paper with Francis Hole of the University of Wisconsin that used numerical methods for the classification of soils by using a computer.

Perhaps Bidwell's greatest achievement was the recognition of Harney silt loam as the State Soil of Kansas. This effort was started by Bidwell in approximately 1984. At the urging of Bidwell, the Kansas Association of Professional Soil Classifiers (KAPSC) passed a resolution, at their annual meeting in 1985, seeking a state soil. A number of different soils were proposed, and several were nominated at the KAPSC meeting. After a poll of all KAPSC members, Harney was selected. Over the next five or six years, Bidwell worked tirelessly with the Kansas Association of Professional Soil Classifiers to obtain public support for the recognition. He wrote letters to newspapers, testified in the Legislature, called Legislators, and made many public speeches about the importance of recognizing the importance of soils. The effort culminated March 30, 1990, when both the House and the Senate passed a resolution, Senate Bill 96, that adopted Harney silt loam as the State Soil of Kansas. On April 12, 1990, Governor Mike Hayden signed S.B. 96 into law, with seventeen supporters, including Bidwell, being present for the signing.

Bidwell's Retirement

Orville Bidwell retired June 1984, after 34 years of service to K-State. From 1950 to 1984, he taught 800+ students, advised 150 undergraduates, coached 89 members of the Soil Judging Team, and chaired 18 M.S. and 8 Ph.D. graduate committees. He started the Agronomy Newsletter in Spring 1982, and edited five editions through 1986. In 1992, along with

Ted Walter, he started a series of monthly Agronomy Retirees Luncheons.

At Bidwell's retirement, the O.W. Bidwell Soil-Judging Team Fund was established in the K-State Foundation to support travel by Soil Judging Teams to regional and national contests. Bidwell and his first wife, Rose, and his second wife, Avis, gave generously to the fund. Many friends and relatives made additional contributions to the fund after the passing of Rose on December 6, 2001. Memorial contributions were also made to the fund by family members and friends after the death of Bidwell on June 5, 2006.

Michel D. Ransom Assumes Bidwell's Faculty Position

After the retirement of Bidwell, Michel D. "Mickey" Ransom was selected to assume Bidwell's position. He started June 18, 1984. He received both his B.S. in Agronomy (Soil Science) in 1974 and M.S. in Soil Science in 1976 from the University of Arkansas. He worked for USDA-SCS as a field soil scientist in Arkansas for two years before returning to graduate school at The Ohio State University, where he completed his Ph.D. in Soil Genesis, Classification, and Mineralogy in 1984.

Ransom changed the name of Bidwell's Soil Development and Classification course to Soil Genesis and Classification. Bidwell's Soil Genesis course was changed to Advanced Soil Genesis and Classification. In addition, Ransom added a new course, Soil Mineralogy. Ransom continued Bidwell's emphasis on teaching soil science through soil-judging-team activities. His soil-judging teams have competed in 22 regional and 13 national contests, including 11 of the last 12 national contests.

Ransom developed a soil genesis and mineralogy research laboratory that includes facilities for routine soil characterization, including particle size distribution, pH, calcium carbonate content, organic carbon content, extractable acidity, extractable bases, and electrical conductivity. In 1985, he obtained equipment needed for soil thin-section preparation and analysis, including diamond saws, grinders, and a petrographic microscope with photographic attachments, and acquired an x-ray diffractometer for mineralogical analyses of soils, sediments, and clays.

Ransom's research program focuses on soil classification and genesis, with an emphasis on soil micromorphology. His research projects have included (1) processes of soil genesis, including clay translocation and pedogenic carbonate accumulation, in soils of western Kansas, (2) geomorphic relationships and parent material stratigraphy in the Bluestem Hills, (3) using a soil survey geographic database within a geographic information system for land use planning, and (4) cooperative work with Richard Vanderlip that developed a productivity index for irrigated crop lands in Kansas. His research program supports the soil survey program in Kansas by providing soil characterization analyses. In addition, Ransom has worked with USDA-NRCS to recognize that many soils in Kansas have formed from multiple parent materials and have a complex genesis.

One of Ransom's primary contributions to the soil survey program involved the digitization of all soil survey information in Kansas. Along with H.L. "Sy" Seyler and M. Duane Nellis (now Provost at K-State), he started a program in 1990 that digitized all soil survey information in Kansas for use in a state-wide geographic information system (GIS). This project was done cooperatively by the departments of Agronomy and Geography. It was funded by USDA-NRCS, the Kansas GIS Policy Board, and the Kansas Water Office. The work was completed in the Geographic Information Systems/Spatial Analysis Laboratory of the Geography Department. As a result of this project, Kansas was one of the first states to have all of their soil survey information available for use within a GIS. The project was a model for the development by NRCS of a nationwide GIS system for soil survey information.

Since 2000, Ransom has also served as Assistant Head for Teaching, coordinating the teaching and undergraduate advising programs in the department. He has served as Chair and Board Representative of the Pedology Division of the Soil Science Society of America. Ransom is a Fellow of American Society of Agronomy and the Soil Science Society of America. He also served as President of the Faculty Senate of Kansas State University in 2000–01.

Soil Chemistry

Gary M. Pierzynski

The current disciplines of soil chemistry and soil fertility developed from similar research topics, and were indistinguishable in the early years of soil science. Such research was originally performed in the Chemical Department, and subsequently the Chemistry Department, at K State. The Department of Agronomy was created in 1906, and for some time there were faculty in both departments working with soils, although it is unclear whether there were clearly delineated duties or interests.

A brief mention of soils is made in the bulletin entitled *Agricultural Research at KSAC Before 1887.* The report indicates that a study commissioned by the Kansas State Board of Agriculture in 1875 was designed to study the chemical properties of farm soils. Samples were collected from nearly all counties with cultivated land. William K. Kedzie reported that the organic matter content and other measurements had been made, but that it would take some time to process all of the samples.

Julius T. Willard, the namesake for Willard Hall on campus, was head of the Department of Chemistry from 1897 to 1918. During that time, he also served as the director and vice-director of the Kansas Experiment Station. He published bulletins and articles on fertilizers and their use, analysis of registered fertilizers, ammonia and nitric acid in atmospheric waters, and fertilizers on sorghum.

C.O. Swanson, also a member of the Department of Chemistry at first, wrote several reports on commercial fertilizers, and one report entitled *Chemical Analysis of Some Kansas Soils* in 1914. The forward of this bulletin indicates that the authorization for this study was made in 1899, but that the work was suspended from 1900 to 1909 because the chemical laboratory was destroyed by fire. This bulletin also indicates that Leland E. Call read the manuscript before publication. Swanson was responsible for the chemistry of soils and crops until approximately 1920 when he went on leave, eventually to return for an extended career in milling science.

Contributions to soil chemistry from the Department of Chemistry continued into the 1940s with the publication of a series of papers on phosphorus adsorption by soils in the *Soil Science Society of America Proceedings* by Alfred Perkins and Herbert H King. King is namesake for King Hall on campus.

Early soil fertility work out of the Department of Agronomy appeared in 1918 in a bulletin entitled *Soil Fertility*. The authors were L.E. Call and R. I. Throckmorton. They provided a fairly extensive discussion of soil chemical properties and fertilizers, along with yield data from studies initiated in 1911. The bulletin also provided information on average yields for a number of crops as far back as 1865, and cites the State Board of Agriculture as the source of the data.

Surprisingly few bulletins dealing with soils were produced between 1918 and 1932, when a second soil fertility bulletin was authored by Throckmorton and F.L. Duley. This bulletin has a greatly expanded description of soils, compared with the 1918 publication. Throckmorton and Duley also published a bulletin entitled *Twenty Years of Soil Fertility Investigations* in 1935. The study described in that publication was initiated in 1909 by W.J. Jardine and Call, continued from 1913 to 1925 by Throckmorton, and continued by Duley from 1925 to 1930.

Two faculty members with expertise in soil chemistry and fertility were hired in the 1940s, Ray Olson in 1947 and Roscoe Ellis, Jr. in 1948. Olson was head of the Department of Agronomy from 1952 to 1970, and his early work focused on the establishment of soil testing programs around the state. Ellis was perhaps the first faculty member to be specifically called a soil chemist. He was instrumental in identifying and resolving zinc deficiencies in fields that had been leveled for purposes of flood or furrow irrigation. Ellis also performed some of the earliest environmental soils work in the department, with experimentation on metal phytotoxicity from historic zinc and lead mining in Kansas. Ellis was highly respected across the state, and was editor of the *Soil Science Society of America Journal* for a time. After his untimely death in 1982, the Roscoe Ellis Memorial Lectureship and Scholarship were established. The Ellis Lecture has attracted many of the nations top soil scientists to campus, and the scholarship is the premier scholarship awarded each year to a graduate student in soil science.

A. Paul Schwab replaced Ellis and served on the faculty from 1983 to 1999. Schwab initially worked on inorganic soil chemistry, but eventually worked on organic compounds as well, most notably atrazine and petroleum hydrocarbons. Schwab greatly expanded the environmental aspects of soil science research, and became an internationally known expert in petroleum-contaminated soils. He established strong collaborative efforts with faculty from the College of Engineering. Schwab resigned to take a faculty position at Purdue University.

With the resignation of Schwab, Gary Pierzynski assumed the role of inorganic soil chemist, and assumed the graduate-level soil chemistry teaching. He also had developed a research program in soil fertility. Pierzynski continued the environmental interests by developing a large research program in remediation of metal-contaminated soils. He received a patent on a remediation technology, is first author on a popular textbook entitled *Soils and Environmental Quality*, and has served as editor of the *Journal of Environmental Quality* since 2002. He continued strong collaborative efforts with faculty from the College of Engineering. At this writing, Pierzynski is serving as Interim Head of the department.

Kang Xia joined the department in 1998 to conduct research on soil organic chemistry. She was developing a research program with environmental interests before her resignation in 2001 to take a faculty position at the University of Georgia. She developed an undergraduate soil chemistry course that has since been taught by Pierzynski. For a brief period, the department had the good fortune of having two soil chemists. Xia's position was not refilled due to budget constraints.

Field Day demonstration of GPS equipment for field mapping and precision application of nutrients, 1974.

Soil Fertility

David A. Whitney and Larry S. Murphy

Soil fertility investigations have been conducted by scientists throughout the history of the Agronomy Department. Research involving soil fertility is reported in Kansas Agricultural Experiment Station bulletins published before the designation of an Agronomy Department. Throughout the history of the Agronomy Department, soil fertility research, teaching, and extension activities have had a strong interdisciplinary approach, working with other disciplines within and outside the department. Soil fertility investigations have been conducted by on-campus, experiment-field, and branch-station scientists; extension specialists and agents; and farmer cooperators. This review of soil fertility history is divided into 20-year periods, with only a few of the research findings highlighted for each period. No attempt was made to identify all research and extension activities in each period.

1906–1926

Maintaining soil organic matter was recognized by early scientists as critical for optimum crop production. L.E. Call and R.I. Throckmorton (1918), in an experiment station bulletin entitled *Soil Fertility,* stress erosion control and crop rotations including green manure crops to maintain soil organic matter. They also stress the use of barnyard manure. To determine the value of manure as a light topdressing on wheat, work was started in 1913, in cooperation with a number of farmers in eastern and central Kansas. Over the next four years, 105 tests were conducted, showing an average of about a 30% yield increase with manure application.

Additional research trials during this era established the need for phosphatic fertilizers on many shale- and sandstone-derived soils of the eastern part of Kansas. Lime also was shown to be critical for legume production on many soils of the eastern one-fifth of Kansas.

Concurrent with the research for this period, educational activities with farmers also were initiated. E.H. Teagarden writes in his history of extension that farmer educational activities, including lectures and demonstrations, were conducted through Farmers' Institutes, with personnel from K-State conducting the educational activities. The railroads operating in southeastern Kansas cooperated with the college with "educational trains," which made numerous stops along the line for speakers to address farmers present on the need for lime for production of alfalfa and sweet clover and other agronomic practices.

1926–1946

Research and educational activities during this era continued to stress the importance of crop rotations, soil erosion control and use of barnyard manure for optimum crop production. Throckmorton and F.L. Duley (1932) state, "The system of farming, since settlement of the state, has been a system of taking from the soil all that it would give and in most cases of returning little or nothing to help maintain fertility. Most of the soils have been handled as though they were to be used for only a short period of time to supply food for mankind and little thought has been given to the conditions in which they will be left to the next generation."

Although ten elements (C, H, O, N, P, K, Ca, Mg, S, and Fe) had been established as essential for plant growth at the start of this two-decade period, only P had been shown to be widely needed in Kansas. The need for N had been established for continuous grain-crop production in eastern Kansas, but supplemental N for grain crops in legume rotations had not shown a consistent economic yield increase. By the end of this two-decade period, the need for N fertilizer for grain-crop production had been well established.

P.L. Gainey, M.C. Sewell, and H.E. Myers (1937) authored an Agricultural Experiment Station bulletin entitled *Nitrogen–The Major Cause in the Production of Spotted Wheat Fields*. In their conclusions, they state, "Typical spotting under Kansas conditions is due to deposits of urine by grazing animals, and the nitrogen in the urine is the factor responsible for the development of the spot." Additional research during this era established that other grain crops responded to N in the eastern part of the state, but a 1954 Agronomy Department memo with fertilizer recommendations for western Kansas does not recommend N on non-irrigated crops except for wheat in southwestern Kansas, as a spring application on wheat that emerged early with a good stand and had a minimum of three feet of moist soil under the crop.

The need for potassium was also established early in the era for southeastern Kansas in long-term crop rotation studies started in 1924 and conducted at the Columbus Experiment Field. F.W. Smith, F.E. Davidson, and V.H. Peterson (1955) reported excellent response to potash fertilizer by corn in their long-term rotation, with modest responses by soybean and alfalfa, but no response by wheat, oat, or flax.

Extensive correlation research on soil test methods for N, P, K, and lime requirements was conducted during this period, but no soil test service to the public was offered. There were some in-field quick tests for pH run by some country agents for farmers as early as the late 1920s.

1946–1966

In 1947, a soil test lab was established in the Agronomy Department. This was concurrent with establishment of county soil test labs, with the first established in Cowley County. A peak of 60 county labs was reached in 1955, with more than 31,500 soil samples tested in 1953-1954. R.V. Olson provided support for development of procedures, written instructions for operation, and training on analytical procedures. Olson and Smith conducted much of the initial soil test calibration research, in cooperation with experiment field and branch station personnel across the state on farmer fields. R.A. Bohannon was hired in 1953 as the first Soil Testing Extension Specialist, appointed half-time for Extension and half-time for the Experiment Station. The county soil test labs offered tests for pH, lime requirement on low pH soils, P, K, and organic matter. In addition to the soil fertility package offered by the county labs, the Agronomy Department lab offered tests for salt-alkali, advisability to irrigate, and irrigation water quality. Based on correlation research by Ellis, a soil test for Zn was added in the early 1960s.

Nitrogen fertilizer production capacity greatly increased after World War II, and N fertilizer use rapidly increased over this two-decade period because of the low cost of fertilizer N. Likewise, the production capacity for P and K also increased rapidly. Research on fertilizer sources, rate, and placement was conducted on many of the experiment fields, as well as on farmer fields, supported in part by the fertilizer industry. An annual meeting with fertilizer industry personnel was begun in 1948 by Smith to review research findings for the past year, with an annual Kansas Fertilizer Report initiated. The annual Fertilizer Research Report continues to be published each year. The annual meeting with industry led to the formation of the Kansas Fertilizer and Chemical Institute, which has now evolved into the independent Kansas Agricultural Retailers Association.

Sulfur, zinc, iron, and boron deficiencies were confirmed in Kansas. Response to boron was recorded on alfalfa in southeastern Kansas. Zinc deficiency was reported in irrigated corn on fields newly leveled for furrow irrigation. Iron chlorosis was observed in sorghum and bean in western Kansas on highly calcareous soils. Response to sulfur fertilization was reported for alfalfa, corn, and wheat on sandy soils in several areas of the state.

1966–1986

Fertilizer production technology continued to rapidly expand in the early 1960s, with many new products released through the Research and Development Division of the Tennessee Valley Authority (TVA). Research and Extension personnel in the Agronomy Department were involved through the Test and Demonstration Division of TVA, and with support of fertilizer industry grants, studied the potential use of new products and improved efficiency for fertilizer sources currently being marketed.

Retention patterns for anhydrous ammonia applied by various types of equipment were studied extensively. Results of this work are still used for setup of tillage implements to apply ammonia (Murphy, Kelly, Gallagher, and Swallow, 1976).

A rapid expansion of the fluid fertilizer industry took place in the 1960s. The introduction of liquid ammonium polyphosphate fertilizer stimulated research into its efficacy and application methods including dual application with anhydrous ammonia (Adriano and Murphy, 1970; Janssen, Whitney, and Kissel, 1985; Murphy, Leikam, Lamond, and Gallagher, 1978; Leikam, Murphy, Kissel, Whitney, and Moser, 1983).

Continued furrow irrigation development in this period, exposing zinc-deficient subsoil, prompted zinc rate, placement, and source research with irrigated corn, grain sorghum, and soybean. Phosphorus application on these zinc-deficient soils was shown to markedly suppress zinc uptake, showing the importance of a balanced fertility program (Murphy, Ellis, and Adriano, 1981; Salako, Murphy, Gallagher, and Ellis, 1975). This research led to the soil test lab upgrading the zinc soil test procedure to the DTPA extraction method.

Confined-animal feeding operations expanded dramatically during this period in Kansas, with manure disposal a challenge. In the late 1960s and early 1970s, research in cooperation with feed yards was conducted on manure application disposal-rate effects on crop yields and soil properties (Wallingford, Murphy, Powers, and Manges, 1975). The results from this research were quite beneficial in establishment of standards for feedlots as environmental regulations from KDHE/EPA were imposed.

Availability of nitrogen fertilizers containing urea was increased markedly during this period. Extensive research on proper management of urea to minimize losses was conducted by David Kissel and students, resulting in a regional publication on urea management (Kissel, 1988). With public concerns about potential nitrate pollution of surface and groundwater from fertilizer use, considerable study of nitrogen rates and methods of application under various crop rotations and tillage systems was conducted, and many of these studies are reported in the annual Kansas Fertilizer Research reports for this period.

Low wheat yields in south-central Kansas in the mid-1980s were attributed to very low pH soils and wheat varieties with poor soluble-aluminum tolerance. Because lime was not readily available in this area and was expensive to obtain, research was conducted showing that lime at relatively low rates, phosphorus banded with the seed, or wheat variety selection could be used to overcome the problem (Unruh and Whitney, 1987; Whitney and Lamond, 1993). Wheat breeders now screen and select new varieties for aluminum tolerance.

1986–2006

The Clean Water Act has resulted in adoption of crop production practices to reduce soil erosion and nutrient loss into surface waters. No-till and very-reduced-till planting systems have been adopted by producers, and considerable soil fertility research has been conducted on starter fertilizer rates and placement, showing excellent response by corn and sorghum on soils with medium to high available P (Gordon and Whitney, 1995; Gordon, Lamond, and Whitney, 2002). More recently, strip-tillage research has been conducted on wheat stubble going to row crop production.

Phosphorus runoff is a major concern with eutrophication of surface waters. Residue cover has

Machine for strip tillage and fertilizer placement before plantng corn, East Central Experiment Field, 2003.

been shown to markedly reduce soil erosion, but it is not as effective in reducing soluble P runoff (Janssen, Pierzynski, Barnes, and Meyers, 1998). Best management practices for P have been published based on research findings to minimize P loss.

Global position systems (GPS), geographic information systems (GIS), and yield monitoring technologies have made site-specific nutrient application possible. John Havlin and colleagues, through a USDA-CSRS Special Research Grant, studied variable-rate nitrogen management for improving groundwater quality. Their research did not show a clear advantage over uniform N application (Redulla, Havlin, Kluitenberg, Zhang, and Shrock, 1996), but provided valuable data on variable-rate technology and has led to an undergraduate course of variable-rate technology (Schmidt, Ransom, Kluitenberg, Schrock, Harrington, Taylor, and Havlin, 2001). Grid soil sampling and variable-rate lime and fertilizer application are now being done on a limited acreage in Kansas.

Responses to chloride fertilization by wheat, corn, and sorghum have been investigated in numerous studies across the state in this period, and have led to a soil test for Cl and Cl recommendations (Lamond and Leikam, 2002). Chloride research results have shown both disease suppression and a nutrient response.

A strong soil fertility research program continues in the Agronomy Department that not only focuses on agronomic response, but also addresses economic and environmental issues. The concerns of researchers in the early 1900s of loss of soil productivity through organic matter loss are addressed in the current soil fertility research program, and soil-stabilization practices to achieve increases in organic matter are being investigated.

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Soil Management and Conservation

Loyd R. Stone

Kansas contains 52.66 million acres, with 89.6% of those acres (47.2 million) in farms. Of the on-farm acres, 29.54 million are in crops. The importance of our croplands, and the need for conserving our soil resource, has long been recognized by the K-State Department of Agronomy. "No agricultural problem is of more fundamental importance than the problem of soil conservation" (p. 24, 2nd Biennial Report, Kansas Agricultural Experiment Station, 1922–1924).

Areas of emphasis in soil conservation research discussed in the Biennial Report of 1922–1924 were: (1) Soil fertility, (2) Tillage, (3) Reaction of soil solution and the quantity of nitrogen fixed by *Azotobacter*, and (4) Soil and crop experimental fields. Soil fertility investigations gave special attention to the influence of rotations, manure, and fertilizers on yield and quality of winter wheat, corn, and alfalfa. Data were presented in the 1922–1924 Biennial Report on wheat yield and soil water conditions as influenced by tillage treatments that were established in 1909. Tillage treatments included date of tillage and type of tillage— disking, moldboard plowing, and lister plowing. For field research on the nitrogen balance of soil, 32 cylinders, each 3 feet deep and 2.5 feet in diameter, were installed in 1919 and 1920.

The 1922–1924 Biennial Report discussed the establishment of five crop and soil experimental fields in southeastern Kansas. Fields were located near Columbus in Cherokee County, Fort Scott in Bourbon County, Moran in Allen County, Parsons in Neosho County, and Rest in Wilson County. Work with soils on the fields emphasized crop rotations, commercial fertilizer applications, and applications of barnyard manure and green manure. Crops investigated at the fields included alfalfa, clover, winter wheat, oat, soybean, cowpea, cotton, corn, sorghum, and flax. Experiments conducted by the Department of Agronomy in cooperation with farmers in 1921 led to the statement, "While only a few data were obtained on the comparative yield of varieties of soy beans, the tests showed plainly the value of this crop in eastern Kansas" (1st Biennial Report, p. 10, Kansas Agricultural Experiment Station., 1920-1922).

The need for information on which to build a sound land-use program for Kansas was discussed in the 9th Biennial Report (p. 21, Kansas Agricultural Experiment Station, 1936–1938). The land-use program was to "provide for the conservation of the soil resources of the state as a continuing source of wealth."

The impact of flocculation-dispersion, and of organic carbon content, on soil aggregation was discussed in the 9th Biennial Report (p. 44, 1936–1938). The importance of residue loss with tillage was addressed by the statement, "Aggregate analysis studies indicated that fallowing reduced the degree of aggregation of the soil particles" (p. 44, 1936–1938). And "This is additional evidence indicating an important role of organic matter in soil aggregation." The favorable influence of legumes on physical properties of soils was discussed in the 13th Biennial Report (p. 17, Kansas Agricultural Experiment Station, 1944–1946). "Alfalfa and sweet clover had a marked favorable effect on soil aggregation."

Strip-till research plot, East Central Kansas Experiment Field, 2003.

The importance of tillage and residue management in the conservation of soil and the protection of young crops was noted in *"Kansas Agriculture After 100 Years"* (p. 65, Kansas Bulletin 392, 1957). "A finely prepared seedbed, free of clods and crop residues, was an open invitation to wind erosion, whereas "trashy farming," with clods and crop residues left on the surface, protected the wheat seedling." Reduced tillage and increased use of residues received strong recommendations in the 1980s for conservation plans, and particularly for highly erodible cropland (35th Biennial Report, p. 22, Kansas

Agricultural Experiment Station, 1988–1990). Primary benefits of increased residue resulting from reduced tillage are: (1) Reduced soil erosion by wind and water, (2) Increased conservation of water, and (3) Improved soil quality and productivity.

With the escalating costs for energy and energy-related items, and with the productivity and environmental issues associated with erosion losses, there is continuing need to assist the producer with modifying cropping systems to ones more economically feasible and environmentally sound. Management and conservation issues of soil erosion losses, soil degradation due to organic matter loss, soil compaction, and capture and retention of precipitation in soils continue to be of vital interest to Kansans.

During the Agronomy Department's first 100 years, many individuals have worked to improve the conservation and management of our soil and water resources.

Charles Ernest Millar came to K-State as an Assistant in Chemistry in the second half of 1910. Millar had received his B.S. degree from the University of Illinois in 1909. He was an Assistant in Chemistry at the University of Illinois and also Assistant Chemist in the Illinois State Water Survey in 1909 and through early 1910. In 1911, Millar received his M.S. degree from the University of Illinois and became an Assistant Chemist, and was also known as an Assistant in Soil Analysis. In July 1913, he transferred to the Department of Agronomy and was an Assistant in Soils. In 1914, Millar became an Instructor in Soils. As an Instructor in Soils, he taught Soil Research I and Soil Research II. On December 1 1915, Millar resigned and accepted a position with the Michigan Agricultural College.

Malcolm C. Sewell was appointed Superintendent of the Garden City Branch Agricultural Experiment Station effective March 1, 1914. He had received his B.S degree from Kansas State Agricultural College in 1912 and his M.S. degree from Ohio State University in 1914. He was the Superintendent at Garden City until December 1, 1915, when he was appointed Assistant Professor of Soils at the Kansas State Agricultural College in Manhattan. Sewell taught Basic Soils, Soil Fertility, and Soil Management. In 1920, he became an Associate Professor of Soils in the Department of Agronomy. As an Associate Professor, he taught Advanced Soils Laboratory, Soil Problems, Interrelations of Soils and Crop Plants, and Soil Research. He received his Ph.D. from the University of Chicago in 1922. Relatively early in his research career, Sewell cooperated on an examination of the concept of a dry layer of soil acting as a blanket in checking evaporation to conserve moisture — which it did not. From work with long-term tillage plots established in 1909, Sewell cooperated in studying the relation of weed growth to nitrate-nitrogen accumulation in soil, the effect of tillage treatment on soil nitrogen and carbon losses, and the effect of rotation and tillage on foot-rot of wheat in Kansas. He cooperated on studies of the nitrogen and carbon balances in cultivated soils of western Kansas (Hays, Garden City, and Colby). Sewell examined the effect of lime, superphosphate, and potash on soil pH and growth of alfalfa on acid soils of eastern Kansas. On August 31, 1931, he resigned to become general secretary of the Sigma Nu Fraternity. On December 3, 1961, Sewell died of a heart attack in Indianapolis, Indiana.

Frank Leslie Duley came to K-State and the Agronomy Department as an Associate Professor of Soils on September 1, 1925. He had received his B.S. degree in 1914 and his M.S. degree in 1915 from the University of Missouri. He was a Research Assistant in Soils at the Missouri Station in 1915. He got his Ph.D. from the University of Wisconsin in 1923, and became an Associate Professor of Soils at the University of Missouri. At K-State, Duley taught Advanced Soil Fertility, Advanced Soils Laboratory, Soil Problems, and Soil and Crop Management. On July 1, 1928, he was promoted to Professor of Soils. Duley was involved with research started in 1925 in cooperation with the U.S. Golf Association Green Section, in which the adaptation of different grasses and the effect of nitrogen fertilizers on turf were evaluated. His research program explored the interrelationships of water intake rates, runoff, and soil erosion by water. He studied the use of crop residues for protecting row-crop land against runoff and erosion. He did considerable work on the principles of stubble-mulch farming, with an eye to protecting the land against erosion by wind and water. He was granted leave of absence from December 1, 1933, to June 30, 1934, so he could serve as Regional Director for the Federal Soil Erosion Service in connection with a large federal erosion-control project in Jewell County. Duley went on indefinite leave July 1, 1934 and resigned June 30, 1935.

William Harold Metzger came to Kansas State College as an Assistant Agronomist, and received his M.S. degree from K-State in 1927. He had received his B.S. degree from Purdue University in 1922. From K-State, he went to the University of Arkansas where he taught and did soil research. He then accepted a research fellowship from the Ohio Agricultural Experiment Station, and was granted a Ph.D. degree at Ohio State University in 1931.

In 1932, Metzger became an Associate Professor and researcher at K-State. He taught Basic Soils, Advanced Soil Fertility, Development and Classification of Soils, Soil Problems, Research in Soils, Soil Fertility Laboratory, and Methods of Soil Investigation. Early in Metzger's research career, he worked on management of alfalfa and on alfalfa's impact on the crop following it. He reported on the distribution of fertilizer residues in soil after 14 years of a fertilizer experiment with alfalfa, on the residual effect of alfalfa cropping on yield and protein content of wheat crops following alfalfa, and on the relationship between fallowing and the "damping-off" of alfalfa seedlings. Metzger worked on soil water depletion by alfalfa and the restoration of subsoil moisture during fallow following alfalfa. Metzger studied the relationship between rainfall amount and soil heterogeneity, as measured by crop production. He worked on aggregation, nitrogen balance, and carbon balance of soils, as affected by crop and cropping system, lime application, and cultivation and erosion; on issues with phosphorus fixation and phosphorus chemistry in soils; and on characteristics of salt-affected soils. He held offices and committee appointments in the Soils Division of the American Society of Agronomy, and contributed numerous articles to technical journals, Experiment Station bulletins, and farm papers of Kansas. On June 1, 1942, Metzger went on a leave of absence from K-State due to illness. On July 7, 1942, William H. Metzger died in Columbia City, Indiana.

James Arthur Hobbs joined the K-State Agronomy Department as Assistant Professor in January 1950. He had received his B.S. in Agriculture degree in 1935 and his M.S. degree in 1940 from the University of Manitoba, Canada. He earned the Ph.D. degree from Purdue University in 1948. His first professional employment was as a Soils Assistant with the Manitoba Soil Survey from 1935 until 1941. He then served as an Agricultural Representative (County Agent) from 1941 to 1946. After he earned his Ph.D., he was appointed Assistant Professor of Soils at the University of Manitoba and served in that capacity for two years. At K-State, Hobbs' main area of teaching responsibility was Soil Management and Conservation. His research activity was also in soil management, dealing with crop rotations/soil fertility interactions and tillage studies. He published research about the replenishment of soil moisture after an alfalfa crop, nitrogen loss rates from cultivated dryland soils, deep-tillage effects on soils and crops, soil compaction, and the nitrogen and organic carbon contents of soils.

Hobbs spent more than nine years overseas on KSU/USAID or MIAC/USAID projects in Botswana, Morocco, Nigeria, Sri Lanka, and Zimbabwe. Project activities ranged from planning new development projects and evaluating current projects, developing a Faculty of Agriculture in a regional government university, and developing the extension/research part of a national crop production program. For several years, he worked part time in K-State's International Agriculture Office as the University's foreign agricultural student adviser. Hobbs retired as Professor/Agronomist from K-State in September 1985 and lives in Canada.

Laureston Van Withee became an Assistant Agronomist at the Garden City Branch Experiment Station in 1953. He had received his B.S. degree from K-State in 1947. He worked for the Soil Conservation Service in Kansas, located at Eldorado (1947–1949) and Parsons (1949–1951). He received his M.S. degree from the University of Nebraska in 1952. He was then an Associate County Agent in Lancaster County, Nebraska, from 1952 to 1953. In 1956, Withee became an Instructor in the Agronomy Department at K-State in Manhattan. In 1963, he received his Ph.D. degree from K-State and was promoted to Assistant Professor. Between 1966 and 1968, he was the Assistant Dean of Agriculture at Ahmadu Bello University in Zaria, Nigeria. In 1968, Withee was promoted to Associate Professor of Agronomy at K-State and began teaching at the graduate level. In 1973, he was promoted to Professor of Agronomy and had the title of Soil Management Research Scientist of the Kansas Agricultural Experiment Station.

In his research program, Withee worked on the effects of tillage and crop rotations on phosphorus content in soil, reaction products resulting from the addition of phosphorus to calcareous soils of southwestern Kansas, weathering and mineralogy of soils, and foliar and soil applications of iron compounds to control iron chlorosis of grain sorghum. For many years, Withee served the K-State Department of Agronomy as Assistant Head for Instruction. He served as president of the Kansas State University Faculty Senate in 1982–83. Van Withee retired from the Department of Agronomy in 1988. In retirement, Withee served for many years as a docent at the Konza Prairie Biological Station, specializing in plant and soil identification. Withee lives in Manhattan.

Loyd Raymond Stone joined the Evapotranspiration Laboratory and Department of Agronomy at K-State as Soil-Plant-Water Management Specialist on July 1, 1973. He had earned a B.S. degree in agronomy in 1967 and an M.S. degree in soil physics in 1969, both at Oklahoma State University. He obtained a Ph.D. degree in soil physics from South Dakota State University in 1973. Stone has taught graduate-level soil physics (Physical Properties of Soils) at K-State each spring semester since 1977. He has taught Soil Conservation and Management each fall semester since 2001.

Stone's research has primarily been in the areas of soil physical properties (aggregation, compaction, and infiltration of water) and the efficient use of water (crop water use, yield response to limited irrigation, water drainage from soil, and water storage efficiency with preplant irrigation). He had major involvement in developing computer software programs CORN-WATCH and KS Water Budget. CORN-WATCH is used for the selection of corn hybrid maturity, and KS Water Budget projects the influence of water on crop production in the High Plains region of western Kansas. In 1999, Stone served as a consultant for the State of Kansas on crop-yield/water-use relationships and the establishment of crop yield losses due to water deprivation from the Arkansas River region for the court case Kansas v. Colorado, No. 105, Original, U.S. Supreme Court. He testified at trial as an expert witness in January 2000. He served as an associate editor of the *Soil Science Society of America Journal* (Division S-6, Soil and Water Management and Conservation) (1980–1985), the *Agronomy Journal* (1988-1993), and the *Journal of Environmental Quality* (2002–2004). Stone was elected Fellow of the American Society of Agronomy in 1999. In 2004, he was presented the Distinguished Faculty Award by the Kansas State University chapter of Gamma Sigma Delta.

John L. Havlin joined the K-State Department of Agronomy on October 18, 1985. Havlin was born in Chicago, Illinois, and graduated from Illinois State University with a B.S. in chemistry in 1973. He completed his M.S. (1980) and Ph.D. (1983) programs in soil fertility/chemistry at Colorado State University. From 1983 to 1985, he was an assistant professor and extension specialist in dryland agriculture at the University of Nebraska. At K-State, he taught Soil Fertility and Soil Management/Conservation, and developed one of the first undergraduate GIS courses in agronomy. He received the Gamma Sigma Delta Teaching Award of Merit in 1992. In 1994, he was selected as a NACTA Teacher Fellow. Havlin's research program focused on soil/crop management effects on nutrient and water use efficiency, nutrient cycling and organic matter dynamics, soil productivity, and environmental quality. His dryland cropping systems research focused on alternative dryland crop rotations to enhance water use efficiency, increase profitability, and improve soil productivity. His research quantified tillage, residue, and rotation effects on organic carbon and nitrogen accumulation and/or depletion. Havlin demonstrated increased profit potential and increased soil organic matter with more intensive cropping systems, compared with traditional fallow systems. He organized and conducted a comprehensive education program, Great Plains Dryland Conservation Technologies, which linked soil and water conservation technologies and dryland cropping systems to profitability and sustainability. He served as president of the Kansas State University Faculty Senate in 1995–96. He served as an editor of *Agronomy Journal* and the *Soil Science Society of America Journal*, was elected Fellow of the Soil Science Society of America in 1995. John Havlin resigned in 1996, and became head of Soil Science at North Carolina State University.

Soil Physics

William L. Powers and Mary Beth Kirkham

The Soil Physics Program at Kansas State University did not begin with the construction of a building, nor with the creation of a faculty position for a soil physicist. Rather, the soil physics program began as an integral part of several areas of ongoing interests within the University. Such areas of interest included Soil Management, Water Conservation, Wind Erosion, and Water Erosion. Because physical properties such as soil aggregation, strength, and structure play a dominant role in these areas of ongoing interest, soil physics began to emerge as a separate discipline. Although it became part of the Department of Agronomy, soil physics was an important component of studies in the USDA Wind Erosion Laboratory, Agricultural Engineering Department, Civil Engineering Department, and later in the Evapotranspiration Laboratory. Soil Physicists assigned to the Department of Agronomy probably served on as many, or even more, graduate student advisory committees in other departments and laboratories than in the Department of Agronomy. As is true for most disciplines in the College of Agriculture, there are three main components to the Soil Physics Program at Kansas State University: research, teaching, and extension.

During the late 1950s and early 1960s, R.J. (John) Hanks became the focal point of soil physics research at Kansas State University. Sid Bowers was another USDA soil physicist at the time (Edward L. Skidmore, personal communication, March 3, 2006). Hanks is best known for his research, and when he came in 1957, he was assigned to the USDA Wind Erosion Laboratory (Table 1) replacing Louis Olmstead when Olmstead retired (Jacobs, 2006a). Both Olmstead and Hanks were USDA employees. Olmstead, according to Hanks, studied the effects of various crops on soil structure (Jacobs, 2006b), and never could get a good relationship (Jacobs, 2006a). Hanks believes that Olmstead did not teach any courses at Kansas State University, but Hanks, although a federal employee at Kansas State University, taught "Advanced Soil Physics" at the university for five years because Hanks' administrator agreed amicably to the arrangement (Jacobs, 2006a). Orville Bidwell taught undergraduate Soil Physics, starting in 1952 when Ray Olson became Head of the Department of Agronomy (Jacobs, 2006b). Although Olson was a soil chemist, he taught Soil Physics from his arrival at Kansas State University in 1948 (Jacobs, 2006a; Table 1) because no one else was available to teach it. Subsequently, Hyde S. Jacobs offered to teach Soil Physics, and Bidwell accepted his offer (Table 1). Jacobs had audited Hanks' class and become interested in his research, which later led to a sabbatical leave with Hanks at Utah State University (Jacobs, 2006a). They studied evaporation and transpiration. Hanks left Kansas State University in 1962 for a USDA position in Fort Collins, Colorado, and later went to Utah State University as a faculty member (Table 1). Jacobs taught Soil Physics for one semester, possibly two, until William L. Powers, a soil physicist was hired in 1966 (Jacobs, 2006b).

While assigned to the USDA Wind Erosion Laboratory (1957–1962), Hanks studied the process of water and water-vapor transfer through soils. His primary interest was in developing ways to reduce evaporation from soils. He studied the effects of straw mulches and gravel on reducing vapor transfer from soil to the atmosphere (Hanks and Woodruff, 1958). He did some studies on water harvesting and on reducing water evaporation by spraying organic gels on the soil surface between plant rows. He also spent some time on the development of an electrical resistance model to simulate water movement in soils. When Hanks left Kansas State University in 1962, Edward L. Skidmore, who has remained active in soil physics and evapotranspiration research, replaced him in the Wind Erosion Laboratory. It was during Hanks' tenure at K-State that the Soil Physics program began to emerge as a separate discipline. Shortly after Hanks' departure, the Department of Agronomy created a Soil Physics position and searched for a professor to fill it.

In the summer of 1966, William L. Powers was hired as an Assistant Professor of Soil Physics in the Department of Agronomy. During the mid to late 1960s, the soil physics research emphasis was on improving water conservation in cropland by reducing evaporation from the soil surface and concentrating rain-water runoff near the plant. Also, it was during this time that some of the earliest work in the United States on the movement of atrazine in soils was part of the soil physics research program at Kansas State University (Snelling et al., 1969). During the

1970s, the soil physicist became part of a research team with soil fertility specialists and agricultural engineers interested in the effects of applying animal wastes to cropland. As a result, the emphasis of soil physics research shifted more toward determining the effects of their application rates on water infiltration and the movement of nutrients toward surface and ground water (Powers et al., 1975; Terry et al., 1981). When Loyd R. Stone, the soil physicist for the newly created Evapotranspiration Laboratory arrived in 1973, the amount of soil physics research regarding the movement of water though the soil was further enhanced.

Because feedlot operators became interested in land disposal of animal wastes, the soil physicist led a team to develop a series of K-State Extension circulars on this topic (Powers et al., 1973; Powers et al., 1974). The main theme of these circulars was controlling the application rate of animal byproducts to minimize the effect of sodium on reducing the infiltration of water into the soil and to minimize the movement of nutrients toward the ground water. Copies of these circulars are still used by extension educators in Nebraska.

A senior and graduate-level course on soil physics was developed and taught by Powers from 1968 to 1976, when it was turned over to Stone in the Evapotranspiration Laboratory. A graduate-level course, Advanced Soil Physics, was developed and taught every other year by Powers, starting in 1967. It was during this time that Powers, assisted by the tedious typing of mathematical equations by Pamela Barnes, co-authored a text named for his course and the course taught at Iowa State University (Kirkham and Powers, 1972). Another course, based on soil physics principles, and called Advanced Microclimatology, was developed and taught in 1970. The newly hired microclimatologist for the Evapotranspiration Laboratory, E.T. (Ed) Kanemasu, began teaching this course in the early 1970s.

In 1980, Powers left to accept a position as the Director of the Water Resources Center at the University of Nebraska. James B. (Buck) Sisson was hired to replace Powers. Sisson arrived in October 1982. He studied soil water and soil strength, coordinated tillage research, and taught advanced soil physics. His major research interest was studying the effects of residue on soil temperature and moisture content. After getting his B.S. degree (1968) and M.S. degree (1972) at Montana State University, Sisson served a year in Iran with the Peace Corps, conducting research on pistachio production. He then earned his doctoral degree at New Mexico State University, where he studied the steady-state infiltration rates as a stochastic process. Sisson came to Manhattan from Richland, Washington, where he was senior soil physicist with Rockwell International. Sisson was a computer expert and constructed his own personal computer. He taught Advanced Soil Physics, Agronomic Systems Modeling, and Mechanics of Erosion. Sisson left K-State in April 1989 to join the Idaho National Engineering Laboratory in Idaho Falls, Idaho.

Sisson was replaced by Gerard J. Kluitenberg, who was hired in December 1989. Kluitenberg received his Ph.D. degree in soil physics at Iowa State University under the direction of Robert Horton, Jr. He had B.S. and M.S. degrees from the University of California-Davis. His research program involves measuring and modeling the soil-plant-atmosphere continuum, including environmental quality factors such as residue management, water and solute transport, and other transport phenomena.

Kluitenberg currently teaches Soil Physics (Agronomy 816) every other year, including the transport of water, heat, gases, and solutes in soil. In this class, examples are presented that relate to both agricultural and engineering land uses, and emphasis is given to the understanding of how soil physical properties and soil management practices influence transport processes. He also teaches Advanced Soil Physics (Agronomy 916) every other year. It is an advanced study of the transport of water, heat, and solutes in soil. The theory of unsaturated water flow, coupled heat and water flow, and the convection and the dispersion of reactive solutes are studied in detail. Spatial variability of soil physical properties is discussed. The class also focuses on computer modeling.

Since 1977, Stone has taught yearly a popular and rigorous class in soil physics for advanced undergraduate students and graduate students, Physical Properties of Soils (Agronomy 746). He uses the classic texts in soil physics written by Daniel Hillel. He routinely gets high ratings by students in his classes, and the material learned is used by them decades later. This class covers the properties of soils as affected by their physical environment, including water content, water potential, temperature, aeration, flocculation-dispersion, and soil compaction.

In 1984, M.B. Kirkham began to teach Plant-Water Relations (Agronomy 820), which includes soil physics in the first third of the class. Students who take both Agronomy 820 and Agronomy 746 find that the two classes complement each other. Kirkham's lecture notes have recently been published (Kirkham, 2005), and include figures from *Advanced Soil Physics* (Kirkham and Powers, 1972), which Powers kindly allowed to be reprinted.

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Table 1. Chronology of Soil Physics at Kansas State University (Jacobs, 2006b).

Year	Comment
1948	Raymond V. Olson comes to K-State and teaches Soil Physics for undergraduates
1952	Olson becomes Department Head Orville W. Bidwell begins to teach Soil Physics
1957	R. John Hanks replaces Louis Olmstead as the USDA Soil Physicist at K-State John Hanks begins to teach "Advanced Soil Physics" Both Bidwell and Jacobs audit Hanks' class at various times
1962	John Hanks leaves K-State for a USDA position at Fort Collins, Colorado, and subsequently became a faculty member at Utah State University
1964–1965	Jacobs teaches Soil Physics at K-State for one or two semesters Those duties were relinquished to William Powers upon his arrival
1966	William L. Powers joins the K-State faculty as a Soil Physicist
1973	Loyd R. Stone joins the K-State faculty as a Soil Physicist
1980	Powers leaves K-State to become Director of the Water Resources Research Institute at the University of Nebraska
1982	James B. (Buck) Sisson joins the K-State faculty as a Soil Physicist
1989	Sisson leaves KSU for the Idaho National Engineering Laboratory and Gerard J. Kluitenberg joins the KSU faculty as a Soil Physicist

Soil Microbiology

Charles W. Rice

Soil Microbiology in the Department of Agronomy is a relatively recent addition with the creation of a dedicated position in 1988 and the hiring of Chuck Rice. Before having a dedicated position in the Department of Agronomy, soil microbiological research was conducted in the Department of Bacteriology (which later merged into the Division of Biology) and by USDA scientists at the Fort Hays Branch Experiment Station.

The first Kansas publication on soil bacteria was KAES Bulletin 117, *Bacteria of the Soil* by Mayo and Kinsley, published in 1903. Mayo was listed as a veterinarian in the Veterinary Department. This was an excellent bulletin on bacteria in soil, but apparently there were not extensive studies in soil microbiology. In 1907, a Department of Bacteriology was formed, with most of the experimental work directed toward two areas: 1) pathological bacteriology and 2) soil bacteriology. Walter E. King, a graduate of Cornell University, was elected as its head. Walter King conducted an investigation on the influence of deep and shallow plowing on the bacterial content of the soil. In 1907 (KAES Report 21), he reported on the effect of deep and shallow plowing on the numbers of soil bacteria:

> *"Results show that deep plowing increases the number of bacteria. The rate of increase, according to depth, is more uniform in silt soil than in sandy soil. The various activities (nitrification, ammonification, gas production, etc.) of the bacteria found under different conditions are being determined. The individual species of organisms making up the flora are being described and identified."*

It is not clear what occurred between 1908 and 1913, because no annualreports were issued, but in 1913, P.L. Gainey was hired to devote full time to agricultural experiment station research in soil bacteriology. Gainey had a very productive career at K-State and retired in 1958, an amazing 45-year career. One of his first reports was on *Seed-bed Preparation for Wheat.* In the report he states:

> *"The variations in nitrate nitrogen accumulation in soil following various methods of seed-bed preparation were not found to lie in any potential differences in bacterial flora of the respective plots, nor in variations in the activity of the nitrofying organisms, but they appear to be in the activity of those organisms bringing about cleavage, hydrolysis, or oxidation of native proteins-thus they are physical."*
>
> –KS Agric Exp. Stn Report, 1917

His first scientific journal article was "The Effect of Time and Depth of Cultivating a Wheat Seedbed upon Bacterial Activity in the Soil," (P.L. Gainey, *Soil Science*, 2:193-204). In 1918, Gainey started a project on azotobacteria in soil, which lasted for more than 22 years. He reported that in eastern Colorado the azotobacter group of organisms, in conjunction with the nitrifying group, can not only maintain the supply of available soil nitrogen, but actually cause large accumulations. In many Kansas soils, the azotobacter group was not found.

In 1926, another project was initiated to determine "The Influence of Legumes and Free Living Organisms on the Growth of Plants and on the Nitrogen Balance." This project was a joint project between the Departments of Agronomy and Bacteriology to compae the effects of alfalfa, sweet clover, soybean, and free-living nitrogen-fixing organisms on the crop yields of corn, oat, and wheat and upon the nitrogen in the soil. Gainey also worked with several faculty in the Department of Agronomy on the nitrogen (N) balance in cropping systems and the role of N in wheat production. Gainey had more than 40 publications, and served as Department Head of Bacteriology after Bushnell stepped down in 1946.

The 1938 Report highlighted 50 years of research, noting that

> *"The role played by the reaction of the soil solution in the distribution and activity of free-living nitrogen-fixing bacteria was discovered and interpreted by the station. Also, investigations relative to the factors influencing available nitrogen and its significance as a factor in crop production in Kansas have contributed to the land-use problems of the state."*

The 1938 report also noted the hiring of F.E. Clark and M.L. Fierke, two USDA-ARS soil microbiologists working with the Kansas Agricultural Experiment Station at Fort Hays. Francis E. Clark made major contributions to the field of soil microbiology, particularly with respect to the cycling of nutrients in terrestrial ecosystems and to understanding soil, plant, and microbial interactions. His long and distinguished career included work with the USDA Agricultural Research Service and faculty affiliations at Colorado State University and Iowa State

University, as well as K-State. Clark co-authored a well-used textbook on Soil Microbiology with E.A. Paul. By 1940, C.L Stumbo replaced Fierke as the second USDA-ARS soil microbiologist at the Fort Hays Experiment Station. It is not clear when the USDA removed those two soil microbiologists from Hays.

In the 1942 report, J.O. Harris was added to the Department of Bacteriology. Some of his research was on soil organisms. His first report was on the respiratory activity of Azotobacter. He reported on isolating 10 different strains of *Azotobacter chroococcum* from soil in the vicinity of Manhattan. Harris worked on a variety of microbiological issues that ranged from basic physiology to the impact of asphalt on soil organisms. It is not clear when Harris retired, but he had publications as late as 1972.

It is clear that there was a void in soil microbiology research efforts at K-State with the retirement of Harris until 1988, when the Agronomy Department created a new position in soil microbiology, 80% research and 20% teaching. The primary research responsibility was to initiate and develop a basic research program in soil microbiology. C.W. Rice was hired to fill the position. Rice's long-term research interests focus on: 1) soil organic matter dynamics in agricultural and grassland ecosystems; 2) soil nitrogen transformations, particularly denitrification and N mineralization; and 3) soil microbial ecology.

Rice has been actively involved in both basic and applied research. He has made important contributions to two significant research subjects: 1) denitrification and 2) carbon and nitrogen cycling and microbial ecology in soils, and the relation to management and global climate change. Rice contributed to understanding the environmental controlling factors and the microbial ecology of denitrification in subsoils. Research in carbon and nitrogen cycling has lead to the national and international activities in soil organic matter (carbon) that relate to climate change and sustaining soil resources. Some of the original work on documenting loss of soil organic matter was done by Hobbs and Brown (1965; Technical Bulletin 144, KAES., Manhattan)., who found that tilled prairie lost an average of 36% organic matter after 40 years. This work has often been cited to illustrate the loss of carbon from soils, which is typical of cultivated soils around the world. With better management such as reduced tillage and improved varieties and crop rotations, however, soils in Kansas and around the world have been shown to be a sink for atmospheric carbon dioxide. Therefore, Kansas research has resulted in important contributions to soil organic matter research throughout its history.

Karini Fabrizzi, collecting soil CO_2 data in a greenhouse experiment, 2005.

Soil microbiology has a long history at K- State. Gainey and Rice have made significant contributions to the field of soil microbiology in Kansas, nationally, and internationally. Continued efforts in soil microbiology are expected to continue because the soil is often considered to be one of the most complex ecosystems on earth. Only a fraction is known about the ecology of microbes in the soil, yet the health of the soil and society is dependent on truly understanding soil microbes.

Evapotranspiration Laboratory

Mary Beth Kirkham

The Evapotranspiration Laboratory (ET Lab) at K-State was the only laboratory in the world dedicated to the study of evapotranspiration. It was established in 1968 by the Legislature of the State of Kansas. Funds for the construction of the laboratory came from state and federal appropriations (Kanemasu, 1973). The objective of the Legislature was to provide a scientific team that could study means of reducing evapotranspiration.

While the laboratory existed (1968-1994), it was located in Waters Annex, a building behind the center wing of Waters Hall. The laboratory had space for four permanent research scientists, a secretary, an electronics technician, a manager of field plots, a data analyst, a computer expert, graduate students, postdoctoral fellows, and visiting scientists. At any one time, there were about 15 graduate students, three postdoctoral fellows, and one visiting scientist in the laboratory.

When the laboratory was established, it was anticipated that there would be four disciplines represented: soil physics, plant physiology, agricultural microclimatology, and soil and crop management (Kanemasu, 1973). The first three disciplines were chosen because of the need for basic research on the transport of water in the soil-plant-atmosphere continuum. The fourth discipline was established to ensure that research results were used to solve applied problems (Kanemasu, 1973).

The first Director of the Evapotranspiration Laboratory was Hyde S. Jacobs, who also at that time was Director of the Kansas Water Resources Research Institute. William L. Powers, a soil physicist in the Department of Agronomy at K-State, was the Associate Director. He became the Director in 1978. The first people hired for the management, plant physiology, and agricultural microclimatology positions were Stewart Michael (Mike) Goltz, Iwan D. Teare, and Edward T. Kanemasu, respectively. In 1973, Loyd R. Stone replaced Goltz, who moved to the Department of Plant and Soil Sciences at the University of Maine (and later to NASA Goddard Space Flight Center in Greenbelt, Maryland). In the spring of 1980, Mary Beth Kirkham replaced Teare, who moved to the Agricultural Research and Education Center, University of Florida, Quincy, Florida. In the fall of 1980, Powers moved from K-State to the University of Nebraska to assume leadership of the Water Resources Research Institute. Kanemasu replaced Powers as Laboratory Leader before Kirkham was hired in 1980 and, with the help of the Dean of Agriculture, made administrative changes so that the Evapotranspiration Laboratory became part of the Department of Agronomy. Up to that time, it had been a separate entity in the budget of the State of Kansas.

When the Evapotranspiration Laboratory was being developed, Powers received a grant from the Office of Water Resources to construct two sensitive weighing lysimeters, initiating the establishment of the Evapotranspiration Field Research Site, located at the Ashland Agronomy Farm, 15 km south of Manhattan, Kansas. It became one of the most complete field-research sites in the United States. The site had two weighing lysimeters, two rain-out shelters (10 x 10 m and 3 x 4 m), a rhizotron with 22 chambers, a solid-set irrigation system, a line-source gradient for irrigation, three mobile laboratories, and two buildings with instruments. Facilities associated with the laboratory in Waters Annex included a walk-in, constant-temperature room, computers in the laboratories of each professor, and a computer room containing a SUN minicomputer with five workstations.

The facilities of the Evapotranspiration Laboratory permitted a strong research program to be developed. The program, in turn, attracted outstanding graduate students, postdoctoral fellows, and visiting scientists from around the world. The lists of publications of the personnel at the Laboratory indicate the scope of research and the diversity of people who worked at the laboratory.

When the laboratory was initiated in 1968 by the Legislature of Kansas, the specific objectives of the laboratory were: 1) to improve the efficiency of crop water use; 2) to optimize the efficiency of water use on the basis of energy and/or economics; and 3) to develop techniques for selecting genotypes for efficient water use under stressful environments (for example, excess water, drought, cold, heat). A fourth objective was added in the late 1970s and 1980s: to develop remote-sensing techniques for assessing crop and soil conditions.

Rhizotron with glass-sided chambers for researching root growth, 1984.

In addition to research serving the formal goals of the laboratory, scientists also: 1) cooperated with the Soil Conservation Society of America to provide requirements for irrigation; 2) led an annual water-use workshop for scientists in Kansas; 3) supported a solar-radiation network for Kansas; 4) developed computerized irrigation-scheduling techniques; 5) calculated models of crop growth and yield; and 6) conducted cooperative experiments in association with scientists throughout Kansas, as well as in other parts of the United States and the world.

The scientists at the ET Lab did pioneering research. Stone determined basal crop coefficient curves (Amos, 1985); examined the efficiency of limited irrigation systems, including irrigation timed during off-season (Stone et al., 1987); and compared the water-use requirements of crops (Hattendorf et al., 1988). The latter paper is frequently cited because it showed that C_3 crops (pinto bean, soybean, and sunflower) had a dry matter water-use efficiency (WUE) of 17.5 Mg ha^{-1} m^{-1}, half that of C_4 crops (maize, grain sorghum, and pearl millet; WUE of 33.3 Mg ha^{-1} m^{-1}). Sunflower depleted more water from deeper soil depths (0.99–1.60 m), and had a greater daily water-use rate, than the other five crops.

Kanemasu, the agricultural microclimatologist, was involved in several projects. He participated in a collaborative study that included researchers in Lubbock,Texas; Manhattan, Kansas; Lincoln, Nebraska; Mandan, North Dakota; Lethbridge, Canada; and two stations in China. The work was partly supported by the National Science Foundation (NSF). The objective was to assess the production functions of wheat under different water, nitrogen fertilization, and climatological regimes (the Great Plains of North America and the Northern Plains of China). Identical experiments were developed at each location. The results were published in an entire issue of *Agricultural and Forest Meteorology* (1988; Special Issue: Winter Wheat, Water, Nitrogen and Latitude, 44:(2)). One of the results of the study was the discovery that nitrogen and water regimes did not alter the photochemical efficiency at a location, but the efficiency did change with location (Garcia et al., 1988).

Kanemasu also assessed the agroclimatology of the Sahel with support from AID (Agency for International Development) and WMO (The World Meteorological Organization). Agrometeorological analyses were conducted for different conditions (e.g., wet and dry periods, planting date), and a simple water-balance model was developed.

In the 1980s, most of Kanemasu's work focused on remote sensing. In one effort to examine the use of remote sensing for addressing farm-management decisions, video cameras were placed aboard a small aircraft and flew over farmers' fields in western Kansas and over research plots in Manhattan, Kansas. Ground observations were compared with video imagery. Results indicated a large potential for video imagery in determining fertility and timing of irrigations.

Between 1987 and 1989, Kanemasu was involved with a large project funded by NASA (National Aeronautics and Space Administration). Biophysical characteristics as measured by remotely sensed observations were studied in an international experiment at the Konza Prairie just south of Manhattan, Kansas. More than 100 scientists from many different countries participated in the project. The Evapotranspiration Laboratory provided site support, as well as made spectral measurements and conducted energy-balance studies.

Kirkham and students carried out row-direction work, also using remote-sensing techniques. The amount of light reflected from plants can tell how much vegetation is growing in the field. Reflectance was monitored with hand-held radiometers, configured spectrally to specific wavelengths of the electromagnetic spectrum. A vegetative index (VI) was calculated from the data, using a normalized difference between infrared (IR) and visible bands, as follows: VI = (IR-visible)/(IR + visible). The data showed that the reflectance was highly dependent on the direction of tillage and planting. Winter wheat grown in rows in the east-west direction had a lower vegetative index (less green-plant material) than wheat grown in rows in the north-south direction. The ultimate goal of the reflectance work was to be able to determine plant growth remotely—that is, from airplanes or satellites, equipped with radiometers scanning the earth.

Kirkham began studies at the ET Lab with NSF funding. These studies were the first to document the value of liquid sewage sludge applied to land in a semi-arid region. Kanemasu and Kirkham, and their students, were the first to study the effects of elevated levels of carbon dioxide on the growth of plants in the field under semi-arid conditions. The work was supported by the Department of Energy. Results, among many, showed that soil water content is greater to a depth of two meters under elevated concentrations of carbon dioxide compared with ambient levels, because transpiration is reduced, and that water-use efficiency is increased, of great importance in semi-arid regions.

Kanemasu left K-State in 1989 to join the University of Georgia at Griffin, and later became Director of International Agriculture for the College of Agriculture and Environmental Sciences. When Kanemasu left K-State, Kirkham became Acting Laboratory Leader. Jay M. Ham, hired in 1990, replaced Kanemasu as agricultural microclimatologist.

Howard Schimmelpfenning was the first electronics technician in the ET Laboratory, hired by Kanemasu soon after he joined K-State in 1969. Dale W. Reed replaced Schimmelpfenning in November 1974. Reed took courses for his B.S. degree while he worked as the electronics technician in the ET Lab, and received his B.S. degree in electrical engineering in May 1989. He then left K-State to become Electrical Engineer for El Dorado-National in Salina, Kansas, where he still works. Fred W. Caldwell replaced Reed as electronics technician, and currently assists the former faculty members of the ET Lab. The secretary of the ET Lab in 1980 was Myrtle Hilbert. Pat Chapman, who replaced Hilbert, moved to a position in the Department of Education at K-State soon after Kanemasu moved to Georgia. Regina (Jeannie) Stucker replaced Chapman, and currently is Administrative Assistant for the former ET Lab members (Stone, Kirkham, and Ham).

A Cooperative Research Special Review Team had the following comments about the Evapotranspiration Laboratory, after an external review of the Department of Agronomy in March 1981 (Ham, 1981):

> *"Creation of this laboratory was an imaginative and bold experiment in interdisciplinary research. The staff which it attracted, experimental results obtained, and funding to date fully justify the effort. … It is developing information which has direct and immediate application to problems in the State. A better understanding of the climate and weather allow much greater predictability of crop and pasture response to various management practices. More often than not, the weather in Kansas is the limiting factor in crop yields, whether by effect on available water or by effect on diseases or insects. …[The Evapotranspiration Laboratory's] value lies in its ability to tackle interdisciplinary problems with whatever means are available on an appropriate time scale. This capability must be preserved."*

The laboratory was never formally disestablished, but when the personnel in the laboratory moved from Waters Annex to Throckmorton Hall in September 1994, the laboratory ceased to exist.

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USDA–ARS Wind Erosion Research Unit

John Tatarko

Introduction

The removal, transport, and deposition of soil by wind, also known as wind erosion, has long been a problem that has plagued mankind. Even before agriculture, wind erosion was an important natural process, as evidenced by the vast areas of loess soils throughout the world. With the introduction of cultivated agriculture, soils normally covered by natural vegetation were exposed to the forces of the weather, resulting in greatly accelerated erosion by wind.

Substantial portions of Asia, the Middle East, and North Africa were once fertile lands supporting prosperous populations. But soil erosion by wind depleted the fertility of the soil and, in some areas, it transformed once-fertile lands into sandy deserts (Lowdermilk, 1984).

Probably the first known writings about wind erosion in the United States appear in Zebulon Pike's journals of 1807, where he writes of "hills of sand" at what is now know as the Great Sand Dunes National Park in southern Colorado (Pike, 1996). Chepil (1957) cites weather records from the 1890s that indicate dust storms occurred in the region of Dodge City, Kansas, at a time when virtually no cultivation of land in the southwestern United States had begun. The problem of wind erosion on cultivated land was first reported by King (1894) in Wisconsin, followed by Free and Westgate (1910), who described control measures for blowing soil.

Events during the 1930s, a period known as the Dust Bowl, with its "Black Blizzards," created public awareness of the damaging effects wind erosion can have on both the soil and environment. The Dust Bowl, caused by an extended drought and over-cultivation of the land, was centered in Morton County, Kansas, and affected thirteen Great Plains states from Texas to North Dakota, and also affected Canada. Although most dust storms were local, some were as large as 600 by 400 miles, with many lasting more than 10 hours (Clements, 1938) and one lasting as long as 908 hours (Hurt, 1981). The USDA *Yearbook of Agriculture* for 1934 announced, "Approximately 35 million acres of formerly cultivated land have essentially been destroyed for crop production; 100 million acres now in crops have lost all or most of the topsoil; 125 million acres of land now in crops are rapidly losing topsoil." In 1935, experts estimate that 850 million tons of topsoil had blown off the Southern Plains during the course of the year (USDA, 1935). Dust from one Great Plains storm deposited an estimated 12 million pounds of dust on Chicago—four pounds for each person in the city—and went on to darken the skies of the U.S. Capitol, where Hugh Bennett used the descending dust cloud to successfully argue for the creation of the U.S. Soil Conservation Service. By 1938, an average of 480 tons per acre had been lost (Hansen and Libecap, 2004).

Early in-depth, scientific work on wind erosion processes was reported in *The Physics of Blown Sand and Desert Dunes* by British researcher, Ralph Bagnold (1941). Much additional research followed to expand knowledge about wind erosion and its control on agricultural lands (Chepil, 1958; Chepil and Woodruff, 1963).

Today wind erosion is still a dominant problem on 75 million acres of land in the United States alone, with four to five million acres moderately to severely damaged each year. Wind erosion damages the soil by physically removing the most fertile part, reducing water-holding capacity, degrading soil structure, and increasing soil variability across a field, resulting in reduced crop production. It tends to remove silts and clays, making the soils more sandy. It also causes plant damage from abrasion, blowouts, and deposition. In addition, some soil enters the atmosphere, where it obscures visibility, pollutes the air and water, causes automobile accidents, fouls machinery, and imperils animal, plant, and human health.

1947–1953

The Dust Bowl helped to stimulate serious attention on the fundamental importance of our land as a resource. As a result, the Research and Marketing Act of 1946, popularly known as the Flannagan-Hope Bill, provided funding for the establishment of a research program to study regional wind erosion problems (Koury, 1947). Because of K-State's proximity to the heart of the Dust Bowl and being the location of a Land Grant University, the Wind Erosion Project was established on the campus of Kansas State Agricultural College in Manhattan in 1947.

The project was administered by the Research Division of the Soil Conservation Service of the USDA, in cooperation with the Department of Agronomy in the College of Agriculture, and called for two agricultural engineers, two soil physicists, and four "sub-professional men". Austin W. Zingg, agricultural engineer, was the first supervisor, and held that post until 1953. E. A. Engdahl was the second engineer and also started work in 1947. William S. Chepil, a soil scientist and pioneer of wind erosion research in Canada, was hired in 1948. The project was first officially known as the High Plains Wind Erosion Laboratory and was located in the Farm Machinery Hall on campus, where the laboratory wind tunnel and related equipment were housed. Early work focused on setting up research facilities, as well as basic research into the mechanics of soil erosion by wind, delineating the factors with major influences on wind erosion, and developing methods to control soil loss by wind. This research contributed a considerable volume of knowledge, including aerodynamics of soil surfaces, soil erodibility factors, effects of windbreaks, erosion and soil measurement techniques, and climatic influences on wind erosion.

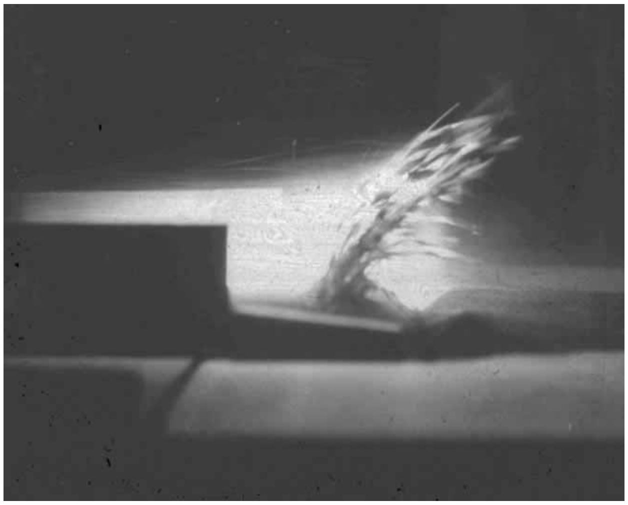
William S. Chepil.

1953–1963

Chepil became leader of the research program in 1953. During this period, Chepil and colleagues set out to develop the Wind Erosion Equation (WEQ) that would parallel the Universal Soil Loss Equation (USLE) used for predicting water erosion. The development of this equation led to an understanding of the fundamental factors that cause wind erosion, as well as those that control it. The factors that influence erosion include soil cloddiness, ridge roughness, field length, climate, and vegetative materials. Numerous laboratory studies were conducted aimed at discerning the basic processes affecting these factors. Many studies, with both laboratory and portable field wind tunnels, were also conducted to verify the factors and their effect on soil loss by wind. Another focus was the development of equipment used in wind erosion research, such as a rotary sieve to determine aggregate size distribution and dry aggregate stability. Most of the work developing WEQ was completed under the direction of Chepil, but he died of cancer in 1963 at age 59 before he could see the first publication of the equation. A new laboratory facility, which Chepil planned, was completed just before his death. The new laboratory was located just to the northeast of Weber Hall on the University campus. The building and original wind tunnel are still used today. Administrative and some scientist offices were established in East Waters Hall.

1963–1975

Neil P. Woodruff was research leader of the wind erosion research program from 1963 until 1975. The Wind Erosion Equation (WEQ), designed to estimate soil loss on an average annual basis from cultivated fields, was published in 1965. WEQ was actually a series of equations and functions that required the use of tables and figures to obtain loss estimates. It became the standard for predicting soil loss from wind erosion in the United States and around the world, and could also be used for designing control practices. It was used in the United States primarily by the USDA Soil Conservation Service in assisting farmers to develop conservation plans, classify the erodibility of soils, and estimate crop tolerances to wind erosion. Other uses of the equation include (a) determining spacing for barriers in narrow strip-barrier systems, (b) estimating fugitive dust emissions from agricultural and subdivision lands, (c) predicting horizontal soil fluxes to compare with vertical aerosol fluxes, (d) estimating the effects of wind erosion on soil productivity, (e) delineating those croplands in the Great Plains where various amounts of crop residues may be removed without exposing the soil to excessive wind erosion, and (f) estimating erosion hazards in a national inventory. This period saw continuation of research into the process and



Plant damage studies.

control of wind erosion, as well as efforts to improve the predictive capabilities of WEQ. Research also included investigations into the sandblast damage to plants, climate effects on wind erosion, wind barriers, residue management, and the development of dust-sampling equipment. The awkwardness of the manual solution of WEQ prompted a computer solution to the model, known as WEROS. Laboratory research facilities known as the Wind Erosion Laboratory continued to expand on the northeast corner of campus, and offices continued to be housed in Waters Hall, although location of offices within Waters Hall changed over the years.

1975–1988

Leon Lyles served as research leader from 1975 until 1988. Despite the many improvements to WEQ, complex interactions between variables were not accounted for in calculation procedures, and it was not easily adapted to untested conditions or climates far different from those of the central Great Plains where WEQ was developed. To overcome the shortfalls of WEQ, the Wind Erosion Prediction System (WEPS) project was initiated in 1985. George W. Cole was first leader of the WEPS project, which had the goal of replacing WEQ by developing a process-based, computer simulation model that would compute surface conditions, weather, management, and erosion on a daily basis. Advances in erosion science and increased power in personal computers allowed the development of this more flexible, processed-based erosion prediction technology. Field, laboratory, and office research needed for WEPS commenced, including studies into the temporal changes of surface properties such as soil aggregation, ridge roughness, plant growth, and residue decomposition, tillage effects on soil and plant residues, the simulation of climate and wind in particular, and erosion processes such as aggregate abrasion and soil transport. Because WEPS was a long-term project, work also continued on improving WEQ, including enhancements to the climatic factor, small-grain equivalents for additional crops, development of period-based version of WEQ, and accounting for preponderance, field shape and orientation, and row direction. Other research included continued studies into plant damage, barriers, and the development of research equipment such as a soil-aggregate crushing-energy meter (SACEM), and an automated system for determining soil roughness from pin meter photographs. In 1986, Lawrence J. Hagen became leader of the WEPS project. Research facilities continued to reside in the Wind Erosion Laboratory, with offices in Waters Hall.

Ridge studies.

1988 - 1994

Upon the retirement of Lyles in 1988, Hagen became research leader. At the same time, he continued as the WEPS project leader. Research focused heavily on the development of the WEPS model, which included considerable work on the model framework and design. Field and laboratory research included studies of aggregate abrasion by wind eroded material; generation of PM10 (particulate matter less than ten microns); the development of a wind simulator and associated database; overwintering of soil ag-

Research for WEPS.

gregates; soil roughness and trapping of eroding particles; tillage effects on aggregation, soil hydrology and surface wetness; plant canopy measurement, and effects on wind erosion; and several field validation studies for WEPS. Considerable effort was also put into developing the source code for the model, which included a rudimentary user interface. Limited research continued on improving WEQ, including the development of small-grain equivalents for shrub-dominated rangeland and coupling WEQ with the EPIC model. Offices were moved from East Waters Hall to the newly expanded Throckmorton Plant Science Center in 1993. Throckmorton Hall included several research laboratories used by Wind Erosion Research Unit (WERU) scientists.

1994–present

Edward L. Skidmore has served as the WERU Research Leader since 1994. A highlight of this period was the 50th Anniversary of wind erosion research by WERU in cooperation with K-State. The WERU celebrated this milestone by hosting an International Symposium held in June 1997 on the campus of K-State. More than 100 wind erosion scientists from 25 countries participated. Research continued into the development of WEPS, including work on plant canopy measurement and plant canopy effects on wind erosion, reduction of plant residues by tillage, soil database development, PM10 generation by wind erosion, wind erosion effects on air quality, revision of the WEPS wind simulator and database, wind erosion of organic soils, wind erosion risk-assessment mapping, and WEPS applications to non-cultivated lands. Researchers also developed a user-friendly graphical interface for WEPS and the WEPS technical documentation. Larry Wagner became WEPS project leader in 1999. A second highlight of the period was the official hand-off of WEPS by WERU to the Natural Resources Conservation Service (NRCS) in 2005. The NRCS is currently in the process of field testing WEPS. In 2002, WERU offices moved from the K-State campus to the USDA Grain Marketing and Production Research Center, which is located off campus about one mile to the west.

During the 58 years of wind erosion research in cooperation with K-State, WERU scientists have published more than 428 peer-reviewed journal articles, proceedings, and book chapters (see the complete WERU bibliography at: *http://www.weru.ksu.edu*). WERU scientists have been invited to visit more than twenty countries to present workshops, teach courses, and cooperate in research projects. International scientists from more than thirty-one countries have traveled to WERU since 1997. Research generated has included seventeen Masters Thesis projects and nine Ph.D. Dissertations. Many WERU research scientists have adjunct professor appointments in the Department of Agronomy and the Department of Biological and Agricultural Engineering at Kansas State University. Many have served as either major professors, members of graduate committees, or adjudicators of graduate students abroad. The number of scientists at the unit in any given year has ranged from one in 1947 (the initial project supervisor) to ten in 1967, with five scientists currently on staff. The WERU is currently the only laboratory in the United States with a sole purpose of wind erosion research, and it has become known as the center of wind erosion research in the United States and the world.

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Personnel

Dean V. Armbrust	Soil Scientist	1961–1963, 1966–2001
William S. Chepil	Soil Scientist (RL 1953-1963)	1948–1963
George W. Cole	Agricultural Engineer	1980–1988
Jerry D. Dickerson	Agricultural Engineer	1963–1979
Lowell A. Disrud	Agricultural Engineer	1966–1976
E. A. Engdahl	Agricultural Engineer	1947–1948
C. L. Englehorn	Soil Scientist	1949–1951
Fred A. Fox	Agricultural Engineer	1998–present
Donald W. Fryrear	Agricultural Engineer	1960–1962
Lawrence J. Hagen*	Agricultural Engineer (RL 1988–1994)	1967– present
R. K. Krauss	Soil Scientist	1965–1970
Leon Lyles	Agricultural Engineer (RL 1975 – 1988)	1957–1960, 1964–1988
R. D. Lynch	Soil Scientist	1956–1957
C. S. Parsons	Soil Scientist	1953–1954
Francis H. Siddoway	Soil Scientist	1957–1963
Edward L. Skidmore*	Soil Scientist (RL 1994 – present)	1963–present
R. M. Smith	Soil Scientist	1962–1967
John Tatarko*	Soil Scientist	1980–present
Gary L. Tibke	NRCS Cooperating Agronomist	1996–2004
Page C. Twiss	Geologist	1966–1968
Simon J. van Donk	Agricultural Engineer	1999–present
Larry E. Wagner*	Agricultural Engineer	1988–present
Neil P. Woodruff	Agricultural Engineer (RL 1963–1975)	1949–1975
Austin W. Zingg	Agricultural Engineer (RL 1947–1953)	1947–1953

* Current or Past Adjunct Professor in Agronomy. RL: Research Leader.

Superintendent Oliver Russ at the Newton Experiment Field, circa 1961.

Experiment Fields

Cynthia A. Harris and Gary M. Paulsen

Introduction

Agronomy Experiment Fields began on July 1, 1923, when the Kansas Legislature appropriated $6,000 for their establishment in southeastern Kansas for agronomy and horticulture studies. Their need grew out of the realization that the stations at Manhattan and the four branch stations inadequately represented the diverse soils and climatic differences across Kansas. The experiment fields followed earlier cooperative experiments that were begun in 1911 under the leadership of H.J.C. Umberger. Studies were located on individual farms throughout Kansas for seed quality evaluations, crop variety and adaptation (suitability) tests, soil fertility trials, and comparisons of seeding rates and dates. Over time, these efforts grew to encompass crop rotations, cropping systems, and the current Crop Performance Testing Program.

At least 27 experiment fields have been administered during the history of the Department. Some were established to research specific problems, such as field bindweed, sandy soils, and irrigation. Others represented unique regions of soil and climate, so that optional crop management strategies could be developed for producers in the surrounding area.

Valuable long-term crop rotation and cropping system studies have been conducted at the various Agronomy Experiment Fields. The fields have always been a key linkage between the Agronomy Department faculty and Kansas farmers and producers. Field days have always been a key activity at which research scientists and extension specialists provide information and demonstrate successful agronomic management practices for local farmers.

Although each field has been unique, some of their activities are similar. Each field tracked weather conditions. The early annual reports for each field contain extensive records of rainfall, drought, wind, erosion, crop disease and insect infestations, dates and damage of tornadoes, and heavy snowfalls. Today, each field report is recorded in the yearly *Agronomy Field Research* publication.

Experiment fields were working research farms. Several fields included homesteads, storage buildings for equipment and grain, and irrigation systems. Most of the fields sold hay, grain, fodder, and seed during the year and used the receipts to pay for equipment, field improvements, repairs, new buildings, and other work deemed necessary. Often, as part of their salary, an employee was allowed to live in the farm house in exchange for being on call during the off hours.

A big problem that each experiment field faced was the lack of funds for equipment. Equipment was often borrowed from one field for another. As early as 1914, field employees modified equipment to meet their needs. Annual reports indicated that when the department did not have funds available, employees paid from their own pockets to modify or purchase equipment. As funds became more available, each field purchased new or used equipment. When equipment was beyond repair, it was taken to Manhattan for disposal. Obsolete equipment still in good condition was often sold at auction, and the money was put back into the experiment field budget.

Experiment fields in existence today include East Central Experiment Field at Ottawa, Harvey County Experiment Field at Hesston, Irrigation Experiment Field at Scandia, River Valley Experiment Field at Rossville and Silver Lake (Paramore), North Central Experiment Field at Belleville, Sandyland Experiment Field at St. John, and South Central Experiment Field at Hutchinson.

Past Experiment Fields

The first fields established by the Kansas Legislature in 1923 were at Columbus, Moran, Fort Scott, Parsons, and Rest (Table 1). A sixth field was established at Thayer in 1938.

The fields were rented from progressive farmers, who were paid by the hour for their work, livestock (horses and mules), and equipment. The college provided each field with a pair of platform scales and a lime spreader. Crops became the property of Kansas State Agricultural College. After the college collected samples of seed, hay, fodder, or grain for analysis, the rest was either sold to the landowner or to local elevators.

Table 1. Past experiment fields operated by the Department of Agronomy.

Field	Years Opened	Closed	Primary Projects	Personnel
Columbus	1923	1966	Corn, soybean, wheat, alfalfa	W. H. Shaffer family
Moran	1923	1943	Alfalfa, corn, oat, sorghum, soybean	R. O. Fumeaux family
Ft. Scott	1923	1932	Alfalfa, corn, cowpea, oat	H. Fulton
Parsons	1923	1933	Soybean, alfalfa, grasses	E. O. Volmer
Rest	1923	1931	Alfalfa, corn, cowpea, oat, sorghum	R. W. Wing
Thayer I	1938	1953		I. K. Landon, F. E. Davidson
Thayer II	1953	1962	Lespedeza, small grains, row crops	F. E. Davidson, V. H. Peterson
McLouth	1932	1942	Crop rotations, soil fertility	T. R. Reitz, E. Abmeyer
Sedgwick	1931	1951	Field crops, soil management	M. W. Reese
Kingman I	1931	1941	Field crops, soil management	C. Brand
Kingman II	1941	1952	Field crops, soil management	C. Brand
Pratt	1931	1933	Field crops, soil management	F. Schaffer
Reno	1938	1949	Field crops, soil management	W. Pierce
Meade	1936	1949	Wheat, sorghum, barley, corn, grasses	J. Hiatt, Arbuthnot family
Minneola	1937	1982	Wheat, sorghum, chrysanthemum, trees	A. B. Erhart, M. C. Axelton, D. J. Boone, M. Lundquist
Smith Center	1942	1949	Wheat, alfalfa, corn, barley, sorghum	J. E. Detwiler, C. Morgan
Mankato/Esbon	1949	1976	Variety tests, herbicides, soil fertility	
Concordia	1952	1957	Crop rotations, irrigation	I. Hanson
Canton	1941	1960	Weed control, esp. bindweed	D. E. Crumbaker, V. F. Burns, V. W. Woestemeyer, O. G. Russ
Newton	1960	1975	Crop rotations, management, soil fertility	O. G. Russ, F. Davidson, D. Gronau, K. L. Failes, N. E. Humburg, P. W. Stahlman
Liberal	1949	1951	Wind erosion, soil stabilization	M. C. Axelton
Corn Belt	1954	2000	Corn, oat, sorghum, soybean, wheat	C. E. Wassom, L. B. Hertz, K. W. Snelling, R. F. Sloan, M. Claassen, M. Kesler, M. Lundquist, J. Long, B. Marsh

Threshing flax plots at the Southeast Kansas Experiment Field with unique power source developed by Superintendent Floyd Davidson, circa 1923.

Field committees did not initially plan for publicity of the experiment fields. It was only after many farmers stopped by the fields and asked questions that the Extension Division of the college decided to host a series of field days. The first field days were held in Cherokee, Labette, Allen, and Bourbon counties on May 19–22, 1925.

Twenty-two of the experiment fields that were once operated by the Department are no longer in existence (Table 1). Many of them were closed because of changing agronomic research priorities; others ceased operations when personnel were lost, leases ended, or financial support was insufficient to support field operations.

Present Experiment Fields

South Central Experiment Field, Hutchinson, Reno County, 1949–Present

Personnel

Clarence E. Crews	1932–1937	Superintendent
Clare R. Porter	1938–1943	Superintendent
Walter R. Moore	1943–1980	Superintendent
George E. Mueller-Warrant	1981–1985	Superintendent
William F. Heer	1985–Present	Agronomist-in-Charge

The South Central Experiment Field, also known as the new Hutchinson field or Hutchinson field, was established in 1949 on a tract of land southwest of Hutchinson that formerly belonged to the U. S. Government and known as the High Frequency Director Finder Station or the U.S. Coast Guard Radio Receiving Station. When the property was declared surplus in 1949, it was transferred to Kansas State College for agricultural, educational, and experimental purposes.

Work began at the South Central Kansas Experiment Field in 1950. When Sedgwick and Kingman fields closed in 1951 and 1952, respectively, work was transferred to the new Hutchinson field. Experiments dealt with production of alfalfa, corn, grain and forage sorghum, oat, rapeseed/canola, soybean, sunflower, and wheat. Breeder and foundation seed of wheat and oat varieties are produced to improve seed stocks available to farmers. A large portion of the research program at the field is dedicated to wheat breeding and germplasm development.

On January 22, 2004, 300 acres was donated to the Kansas State University Foundation by George V. Redd and Mabel E. Bargdill for educational and experiment purposes. It was assigned to the South Central Experiment Field in March 2004, and is currently known as the Redd-Bargdill land. One parcel of 140 acres is in CRP until the contract ends in 2007. The second parcel, 160 acres, is in foundation wheat, wheat production, and grain sorghum.

North Central and Irrigation Experiment Fields, Republic County, 1942–Present

Personnel

North Central Kansas Experiment Fields

Robert F. Sloan	February 1942–September 15, 1944	Superintendent
Milburne C. Axelton	September 18, 1944–1946	Superintendent
Robert F. Sloan	April 16, 1946–1960	Superintendent
Robert Morin	l961–October 1963	Superintendent
James E. Congrove	January 27, 1964–March 1, 1965	Superintendent
Lowell A.Burchett	May 1, 1965–1969	Superintendent
George R. Ten Eyck	1969	Acting Superintendent
Donald J. Boone	1970	Acting Superintendent
Stanley R. Clark	1972	Acting Superintendent

Personnel

Belleville and Irrigation Fields

Robert F. Sloan	1952–1953	Superintendent
Warren W. Rasmussen	1953–1954	Superintendent
Robert F. Sloan	1955–1961	Superintendent
Robert J. Raney	1955–1989	Superintendent
W. Barney Gordon	1990–Present	Agronomist-in-Charge
Richard W. Hanson	1953–1955	Irrigation Engineer
Harry L. Manges	1965–1964	Irrigation Engineer
George R. Ten Eyck	1964–1968	Irrigation Engineer
Stanley R. Clark	1972–1973	Irrigation Engineer
James Scharplaz	1974–1978	Irrigation Engineer
Michael Powell	1980–1982	Irrigation Engineer
G. E. Thierstein	1985–1986	Irrigation Engineer

The Belleville Experiment Field is located two miles west of Belleville on the north side of U.S. Highway 26 in Republic County on a farm owned by W. W. Gish. The agreement was made for the lease of 28 acres, but Mr. Gish had seeded wheat on 6 acres in the fall of 1941 and did not wish it to be destroyed. Therefore, 22 acres were rented for $5 per acre in 1942 and increased to $10.75 per acre in 1947. The field has Crete silt clay loam soil, slightly sloping southeast. The Crete series consists of deep, well drained soils that have a loamy surface underlain by clay subsoil. Crete soils have slow to medium runoff and slow internal drainage and permeability.

Work on the field has included variety testing of alfalfa, barley, corn, oat, sorghum, soybean, and

Lateral move irrigation system, Scandia, 2001.

wheat. The varieties tested were, and are, standard varieties and new varieties as they are developed by the Kansas and other experiment stations. Current research emphasis is on fertilizer management for reduced-tillage crop production and management systems for dryland corn, sorghum, and soybean.

Irrigation experimental studies were relocated from Concordia to their present site near Scandia in the Kansas-Bostwick Irrigation District in 1958. Water is supplied by the Miller Canal and stored in Lovewell Reservoir in Jewell County, Kansas, and Harlan County Reservoir at Republican City, Nebraska. The 160-acre field was leased for $15 per acre from George O. Faulkner of Belleville, Kansas. The field is located three miles west and two miles north of Scandia, Kansas.

The soil on the field is classified as Crete silty clay loam, developed from loess (wind-blown soil). Crete is the predominant soil type in the irrigation district area. The field originally had a sloping topography characteristic of much land in the irrigation district. Most of the land on the field, however, has been leveled for effective furrow irrigation.

Today, the field has 160 acres, plus a 5-acre site in the Republican River Valley on the Mike Brzon farm that is used for irrigated crop research. In 2001, a linear sprinkler system was added on a 32-acre tract two miles south of the present Irrigation Field.

Overall research at the field is to help develop, use, and manage wisely the natural resources of North Central Kansas. Current research on the field focuses on managing irrigation water and fertilizer in reduced tillage and crop rotation systems. Crops studied have included bromegrass, castor, corn, grain sorghum, soybean, sugar beet, sweet corn, and sweet clover.

Soybean variety maturity x planting date study, Belleville, 1999.

Harvey County Experiment Field, Hesston, Harvey County, 1975–Present

Personnel

Phillip W. Stahlman	1975–1976	Superintendent
Joseph P. O'Connor	1977–1981	Superintendent
Mark M. Claassen	1982–present	Agronomist-in-Charge

Land arrangements for the Hesston Experiment Field were finalized in the spring of 1975. The 80-acre field was leased from Hesston College, and two adjoining 40-acre fields were leased from the Schowalter Foundation and Dr. Harold Aiken. The Hesston Unit was designated as the field headquarters site. The annual lease was $1,500 for the Hesston College Unit and $1,200 each for the Schowalter and Aiken Units.

The soil on the Hesston and Aiken Units is classified as Ladysmith silty clay loam. Soil on the Schowalter Unit is Ladysmith, Detroit, Geary, and Irwin silty clay loams, and Smolan silt loams.

Research at the Harvey County Experiment Field includes many aspects of dryland crop production on soils of the Central Loess Plains and Central Outwash Plains of central and south central Kansas. Focus is primarily on wheat, grain sorghum, and soybean, but also includes alternative crops such as corn and oat. Investigations include variety and hybrid performance tests, chemical weed control, tillage methods, fertilizer use, and planting practices, as well as disease and insect resistance and control.

Sandyland Experiment Field, St. John, Stafford County, 1952–2004

Personnel

Frank E. Lowry	1952–1956	Superintendent
Marvin C. Lundquist	1956–1968	Superintendent
Walter R. Moore	April 1963–June 1963	Superintendent
George R Ten Eyck	1969–1993	Superintendent
Marvin C. Lundquist	1969–1975	Agronomist
Phil R. Rahn	1975–1977	Agronomist
James D. Ball	1977–1983	Agronomist
James H. Long.	1983–1985	Agronomist
Richard G. Greenland	1985–1990	Agronomist
Victor L. Martin	1991–2004	Agronomist /Agronomist-in-Charge

In 1951, the Kansas Legislature authorized a field to be established in Stafford County to study problems that producers faced in sandy land. A committee of Kansas State College Agronomy staff selected a 120-acre farm owned by Stafford County, known as the "County Poor Farm," three miles south of St. John at the intersection of U.S. Highways 281 and 50 South, as the location for the experiment field. On March 5, 1952, the County Commissioners and the Kansas Agricultural Experiment Station signed a memorandum of understanding for $400 in rent for 1952 and $6 per acre annually thereafter.

The soil on the field was classified as Pratt loamy sand, hummocky phase, Pratt loamy fine sand, summocky phase, Carwile sandy loam, and Carwile loamy fine sand. The hummocky condition was caused by knolls of sand and low depressed areas. Soil in the low area was characterized by compact clay or claylike material of variable thickness.

Superintendent of the field, Frank E. Lowry, emphasized methods to prevent soil erosion by wind. "Use of stubble mulch or residue management, narrow stripping, use of narrow rows in grain sorghum production over the first few years has done much to stabilize soils on the fields," stated Lowry. Tillage was kept to a bare minimum to avoid blowing sand. The handicap to the field in 1955 was the lack of proper equipment, especially a satisfactory sub-tillage cultivator.

Seeding alfalfa performance tests at Belleville, 2004.

By 1983, center-pivot irrigation was widely used in the sandy land area of south central Kansas, greatly impacting the regional economy. Research work and variety performance testing on irrigated sandy soils at the experiment field included alfalfa, corn, grain sorghum, peanut, soybean, sunflower, and winter wheat. Experimentation included fertility, management and cultural practices, physiology, plant breeding, and herbicide trials.

In 1999, a cotton research program was established to evaluate the long-term feasibility of cotton production in the Great Bend Prairie. The program was discontinued in 2001 because producer interest was insufficient and irrigated plot acreage was lacking. Field personnel closed the sprinkler-irrigated quarter in 2000 when the lease was not renewed, but supplemental water rights were obtained in 2001 to conduct subsurface drip irrigation on another quarter. In late 2004, administration of the field was transferred to the Western Kansas Agricultural Research Centers.

East Central Kansas Experiment Field, 1952–Present

Personnel

J. Eddie Braum	1952–1965	Superintendent
Clarence W. Swallow	1965–1967	Superintendent
Clifford N. Gruver	1967–1973	Superintendent
Charles W. Knight	1973–1977	Superintendent
Quentin S. Kingsley	1977–1978	Superintendent
Keith A. Janssen	May 1979–2004	Agronomist-in-Charge
Larry D. Maddux	2004–present	Agronomist-in-Charge

The Kansas Legislature appropriated $7,500 in 1951 for the establishment of the East Central Kansas Experiment Field. The field was established in February 1952 on two tracts of land (a 160-acre and an 80-acre tract) adjacent to the Ottawa Municipal Airport in Ottawa, Franklin County. The purpose of the field was to conduct research with grasses and legumes for grazing and for beef cattle production.

Until 1965, grass variety, soil fertility, and beef and cattle production research was conducted. When John Eddie Braum resigned in early 1965, the cattle pasture work was transferred to Parsons and included in the Southeast Branch Experiment Station. The same year, Clarence Swallow was hired as superintendent, most grassland on the field was plowed, and dryland agronomic crop research began.

Agronomy studies have included crop variety and hybrid performance testing, fertility, plant breeding, herbicide, tillage systems research, and, more recently, surface water quality studies. Soil on the field has been classified as Woodson series. The terrain is upland, level to gently rolling. The surface soil is dark, gray-brown, somewhat poorly drained, silt loam to silty clay loam with slow permeable clay subsoil.

Kansas River Valley Experiment Field, Rossville and Topeka, Shawnee County, 1971–Present

Personnel

Neil Humburg	1970–1975	Superintendent
Larry D. Maddux	1975–present	Agronomist-in-Charge
Larry S. Axthelm	1971–1976	Irrigation Engineer
Jim L. Gartung	1976–1979	Irrigation Engineer
Phil L. Barnes	1980–1998	Irrigation Engineer

The Kaw Valley Irrigators Association, formed by Kansas River Valley farmers, was instrumental in obtaining funding for the Kansas River Valley Experiment Field to determine effective management of irrigation water resources for crop production in the Kansas River Valley. A 10-year lease for two parcels of land owned by Washburn University was signed, and on March 1, 1971, the experiment field became reality.

The field consists of two units, the Rossville Unit and the Topeka (Silver Lake) Unit located in Shawnee County. The fields were leased from Washburn until 1994, when they were purchased by K-State. The Topeka Unit was renamed the Paramore Unit at that time.

The soil on both units is classified as Eudora silt loam with small areas in the Sarpy, Kimo, and Wabash series. The soils are well drained, except for small areas of Kimo and Wabash soils in low areas. Soil texture varies from silt loam to sandy loams, and the soils are subject to wind erosion. Most soils are deep, but texture and surface drainage vary widely. These soils are typical of the majority of the soils in the Kansas River Valley.

Research projects have included nitrogen management on corn, crop rotations, macronutrient fertility, tillage, irrigation scheduling, water and chemical management, chemical weed control, date of planting, plant population, and row spacing. In addition to field-initiated research, areas have been provided for cooperative research with Manhattan-based faculty and graduate students. Crop performance tests have been conducted on alfalfa, corn, grain sorghum, and soybean.

A more extensive and detailed history of the Agronomy Experiment Fields, authored by Cynthia A. Harris, is included on the CD-ROM version of this publication.

Agronomy Farm

By Cynthia A. Harris

The Agronomy Farm is adjacent to the K-State main campus at 2200 Kimball Avenue. This location next to campus has been very convenient for teaching, research, extension, and demonstration activities throughout its history.

Land

In 1909, the legislature appropriated $35,000 for the College to purchase additional land for the Agricultural Experiment Station.[a] The money made it possible to purchase two parcels of land, including one that is the present site of the Agronomy North Farm. The farm, located approximately one mile northwest of campus, originally consisted of 321.8 acres located on the north and south side of Kimball Avenue between Denison Avenue and College Avenue. The 160-acre south farm was purchased from Oliver A. Hutchings for $150 per acre.[b] The 161.8-acre north farm was purchased at $135 per acre from Marlow W. Ingraham.[c] The total paid for both parcels of land exceeded the original $35,000 appropriation, so the purchase must have been supplemented from other funds.

In 1910, the Agronomy Department also farmed 85 acres known as the "Old Farm," located at present day Founders Hill at Claflin and College Avenues; 30 acres known as the Higinbotham field, possibly located at the southeast corner of the south farm along Denison Avenue where Edwards Halls is located; and 10 acres west of the shop buildings on campus, probably located near Memorial Stadium along Denison Avenue, which was used for experimental work and small grain breeding.[d] In 1911, the "Old Farm" was transferred to the Department of Horticulture, with the exception of 12 acres in the northwest corner that was farmed by the Department of Agronomy. The forty acres located at the southeast corner of the farm where Jardine apartments used to be along Denison Avenue, and used by Animal Husbandry, was purchased by the state in 1918 and placed under Agronomy management.[e] In 1949, the pasture was rented to the Dairy Department, which housed 2 cows and 12 heifers during the summer.[f]

Twenty acres was acquired from Animal Husbandry in 1954. It was located at NW1/4, 10S, 7E directly across the road from the farm.[g] During the late 1970s and early 1980s, the Athletic Department, needing space for expansion, including the new football stadium, and later Bramlage Coliseum and other major athletic facilities, purchased the south farm land, which stretched from the corner of Denison and Kimball avenues north to College Avenue. In 2001, forty acres in the southwest corner of the portion of the farm west of College Avenue was sold for development, with the proceeds used to obtain a significantly larger acreage of land more suitable for plot research, now a part of the Ashland Agronomy Farm. Today the farm is generally known as the Agronomy North Farm and consists of 395 acres.

Improvements

The early years at the farm focused on improvement of the grounds and the overall appearance of the farm, with the goal to make it a model farm. When the season and weather did not permit work in the fields, farm workers concentrated on tasks such as razing or erecting buildings; installing drainage ditches, creating or improving roads; building or reinforcing bridges; trimming or removing hedgerows; installing or repairing fences; and installing water tanks. Other general work performed by farm employees included cleaning buildings, tending gardens, tending to work stock (horses and mules), mowing the lawn, planting trees, cutting fire wood, and hauling coal. By 1916, farm foreman J.W. Crumbaker found it nearly impossible to keep improvement accounts and farm accounts separate because often they were so similar.[h]

In 1927, Farrell Library was built on campus. The waste material from the new library building was hauled and dumped into the main drive at the farm, just inside the south entrance. The waste materials packed into the ground and improved the driveway.[i] Many other improvements were made to buildings such as the farm house.

Buildings – Farm House

Both the north and south sections of the farm had homesteads when they were purchased in 1909. One employee was permitted to live in the north farm house in exchange for caring for the farm during the off hours. The employee who resided in the house was usually the farm foreman.

In 1913, the farm house at the north farm was moved from its original location back about forty-five feet and raised about eighteen inches. A basement was dug under the entire house and a concrete foundation installed. The foundation was made from one part cement and three parts sand and six parts crushed rock. The sand was hauled from the Blue River. The rock from the old foundation was crushed and used to make walls. The house was not materially disturbed by being moved, although some plaster did crack in several places. The cost of the moving and foundation construction totaled $665.51[j]

After the house was lifted and the basement poured, extensive remodeling was done inside. The basement held the furnace room, laundry room, bath room, and fruit cellar. The furnace room held a coal bin, which held 12 tons, and the pressure tank furnished the house with water. A torrid hot-air furnace was installed, and pipes led to all rooms. It gave excellent results when either wood or coal was burned. The clothes chute for the laundry room came from the second-floor bathroom. A bathroom in the basement had both hot and cold water connections. The fruit cellar had three apple bins and shelves for storage. Each room had a drain attached to the sewer line, which led to a cesspool in a horse pasture west of the barn.[k]

The lean-to kitchen on the back of the house was torn away, and a two-story addition was built in its place. The addition included a kitchen and stairways that led to the basement. A state-of-the-art kitchen was installed, with a built in pantry and a large sink beside the cistern pump, which had both hot and cold water faucets. A screen porch was added to the first-floor addition and a sleeping porch built on the second floor.[l]

The second-floor held closets and an up-to-date bathroom with a large enameled bath tub, a solid porcelain toilet, and an enameled vanity. The clothes chute was located in the bathroom and led to the basement laundry room. Other improvements to the house included a new front door with beveled plate glass, large bay windows in the sitting room and parlor, and a new chimney. Some of the inside walls were painted; others were wall papered. The outside of the house was also painted. The cost of the remodeling work inside the house was $3,184.29.[m]

Throughout the years, additional house repairs were made as needed to the house on the north farm. In 1928, renovation took place to change the old wash room into a bathroom.[n] The north porch was replaced in 1936 when it was discovered badly rotted. Also in 1936, lattice panels were installed to conceal the space underneath the porch.[o] In 1966, the house was destroyed in a devastating tornado that did major damage to the farm and its surrounding buildings. When the new house was constructed, it was placed further back. The peony bush that was once in the backyard stood firmly against the new front steps. When farm manager Clarence Swallow moved in 1989, Vernon Schaffer, manager of the Foundation Seed Project, occupied the farm house.

Threshing wheat variety test plot samples at Agronomy Farm in 1911.

Other Buildings

The north farm included many other buildings, such as the tool house, seed house, hen house, oil house, storage sheds, and barn. In 1911, the seed house at the college was vacated. It was demolished, and the lumber was hauled to the north farm and used in the tool- and seed-house improvements. A double floor was installed and a brick flue was built to place a stove in the seed corn drying room.[p] In 1912, a shop was built on the north end of the tool and seed house, at the cost of $194.31.[q] In 1922, W. G. Ward, extension architect, and Professor L. E. Call, head of Agronomy Department, completed a new two-story seed house. It contained five storage bins for storing pure seed from the farm, a space for cleaning machinery, an office and work room, and a fire-proof vault for valuable seed samples. Space on the second floor was used for storage of clean seed that awaited shipment.[r] The seed house was destroyed in the 1966 tornado and had to be rebuilt.[s]

In 1914, an old building was moved to a position north of the seed house. It was placed on a concrete floor and repaired and painted. It was used as an oil house for the storage of such items as gasoline, paints, tar, and dynamite.[t] In 1915, a five-barrel underground gasoline tank was installed near the oil house because it was inconvenient to haul the gasoline from town in a barrel when it was needed. The oil companies delivered and gave wholesale prices when the farm bought gasoline in large quantities.[u] After the 1966 tornado, the oil house was moved to a storage area south of the farm equipment storage building.[v] In its place a building was erected to store fertilizer for the Soil Fertility Project.[w]

A new barn was built in 1912 at the cost of $1,989.63. A water system was also installed at the cost of $68.21.[x] The old barn was torn down and its lumber used to help erect a hay barn.[y] In 1921, the hay barn burned and a new barn was erected in the southeast corner.[z] Loose stone floors were installed in the barn in 1926 to prevent moisture from damaging loose and baled hay on the barn floor.[aa]

When the old hen house was torn down in 1914, a new one that held 60 to 75 chickens was constructed. It was 14 by 20 feet, with a concrete floor; the inside was white washed and the outside was painted.[ab] A farm house, tool house, seed house, oil house, barns, and hen house are all buildings one expects to find on a research farm.

The 1966 tornado destroyed the seed house, two hay sheds, three machine sheds, two research buildings, eight grain bins, one house, and four other buildings.[ac] Although rebuilding took some time, the college set about rebuilding the farm. The new buildings were occupied in early 1969. The new buildings included the Farm Research Center, with 14,000 square feet, which included five work rooms, 18 office or storage rooms, four threshing and drying rooms, cold storage room, and restroom facilities. The Farm Operations Center was 5,000 square feet and contained truck storage, a supply room, wood shop, metal and machine maintenance shops, wash and paint room, office space, and restroom facilities.

Equipment

When the Agronomy Department purchased the farm in 1909, very little farm equipment, as we know it today, existed. In 1910, the farm equipment consisted of two mule teams, one team of horses and a few plows and wagons that were in poor condition.[ad] All repairs on the farm equipment were done at the farm shop. All the tires for the wagons were shrunk and boiled in oil. A tire shrinker was purchased in 1913 at the cost of $15. Seven sets of tires were shrunk, which saved the department $73.47.[ae]

At the turn of the 20th century, farm machinery companies were looking for potential buyers. In 1913, Fairbanks-Morse Company loaned a gasoline tractor to the farm for plowing wheat. It was a 25 horsepower engine, and two men were required to operate it and the four-bottom gang that was used in the plowing.[af] The tractor worked fairly well, and several machines and implements were tested on the farm during 1914. Test equipment included a Buckeye Alfalfa and Grass Seeder, made by the American Seeding Machinery Company, a Western Land Roller, a Force Feed Lime and Seed Sower, and Oliver Sulky Plow, and an Auto Fedan Hay Press. It was reported that the Buckeye Alfalfa and Grass Seeder worked excellent; the Western Land Roller worked well; the Force Feed Lime and Seed Sower was difficult to regulate and took much guesswork to get it functioning; the Oliver Sulky Plow did an excellent job; and the Auto Fedan Hay Press did not work successfully for the baling of straw because it was impossible to get large enough feed into it.[ag] Although most of these machines did not pass the farm test, the farm purchased several implements that year. Among these were a J. I. Case corn planter, a Van Brunt Grain Drill, a New Century cultivator, a Deering Corn Binder, and a 6 horsepower Dempster gasoline engine.[ah]

Machinery was often heavy, did not perform well, took lots of power to pull, and was expensive. One staff person was hired to maintain all the equipment and machinery, making repairs to keep the equipment in good working condition and avoid delays in field operations.[ai]

Labor

Mules and horses were relatively cheap, especially when they worked for their room and board. Although the farm had only two mule teams and one team of horses in 1909, more were acquired over the years. Like machinery, when a mule or horse broke down and could no longer be used, it was either sold or put out of its misery. In the early years of the farm, a mule or horse was valued at $.075 per hour, the labor of a man was valued at $.15 to $.255 per hour, and a mechanic was valued at $.30 per hour. A boy was valued at $.10 per hour.[aj] Whenever extra help was needed during planting or harvesting, men were paid $.35 per hour until August, then wages were cut to $.30 per hour. If extra teams of mules and/or horses were needed, the owner was paid $.15 per hour, or double the usual value of livestock.[ak]

World War II caused a labor shortage and, in 1945, assistant professor of farm labor E. H. Leeker was authorized by the Board of Regents to travel to Missouri and Arkansas to recruit harvest labor.[al] That same year, Gerald J. Brown, Instructor of Agriculture Economics, was authorized to accompany a group of farm laborers from Kansas to North Dakota to help harvest crops in the north part of the country.[am] Because there was a shortage of labor during the war years, more modern methods with less manual

Personnel

Foreman in Charge/Managers

Floyd Howard	Spring 1909–July 1910
B. S. Wilson	July 1910–September 1912
F. B. Lawton	September 1912–July 15, 1913
Waldo E. Grimes	July 15, 1913–August 1, 1914
Alfred L. Clapp	September 1, 1914–August 1, 1915
A. E. McClymonds	September 1, 1915–October 21, 1916
J. W. Crumbaker	December 1, 1916–November 8, 1917
George H. Phinney	November 8, 1917–June 4, 1921
E. S. Lyons	June 4, 1921–December 31, 1921
George H. Phinney	1922–1927
Clarence E. Crews	1928–1931
Floyd G. Ackerman	1932–1933
F. L. Timmons	1933–1934
Frank G. Parsons	1935–1937
Robert F. Sloan	1938–1946
Dale S. Crumbaker	1946
Andrew D. Kauer	1947–1962
Floyd Wilson	1964
Clarence W. Swallow	1965–1994
Karl Mannschreck	1994–2004
Vernon A. Schaffer	2005–present

Personnel

Classified Employees

Fred Palmer	1921	Wilfred Johnson	1969–1989
A. N. Jones	1921	Galen Quantic	1969–1973
Andrew Kauer	<1949–1963	Eldon Slagle	1970–1986
Floyd Wilson	<1949–1974	Roy Ensley	1970–1972
		Fred C. Piper	1978–present
Edwin Reavis	1953–1986	Ron Bone	1983–1991
Frank Conrow	1956–1958	Harold Erichson	1985–2000
Don Weik	1958–1959	Neil Wickstrum	1987–1989
Howard Kientz	1959–1960	Mark Sellens	1989–1992
Chesley “Chet” Larkin	1960–1968	Don Bieling	1990–1999
Marian Becker	1961–1963	Mark Leuthold	1991–present
Raymond Nelson	1961–1969	Lee Tucker	1992–1997
Walt Rollins	1966–1983	Mark Scott	1997–2001
Verlin Larson	1967–1968	Mason Lee	2000–present
George Shackleton	1967–1969	Shawn Winne	2001–present
Orville Hecox	1968–1969	Steve Milne	2002–2004

labor were necessary, and tractors began to replace the work stock, which required considerable feed and labor. Barns had to be cleaned, manure hauled from lots, hay and straw hauled to and from the barn, feed had to be ground, hoofs had to be trimmed and shoed, and each animal was usually sheared. During the spring and summer of 1946, all work stock was sold. All horse-drawn machinery that could not successfully be modified for use with tractors were condemned and sold and replaced with new tractor-drawn machinery.[an]

Although the transformation began in 1946, it was not until Clarence Swallow became farm foreman in 1965 that the Agronomy Research Farm began to truly mechanize and forge its way into the progressive 20th century. Lack of equipment and funds forced Swallow to be inventive. He modified equipment and built other equipment from plans he drew himself.

The Agronomy Farm has always been an open-air laboratory for plant science majors and plant science research faculty. High school and college students have held jobs at the farm planting, weeding, and harvesting crops. Many undergraduate and graduate student gained first-hand farming knowledge through employment and class projects at the farm.

Crops

Crops planted at the farm have primarily included corn, oat, sorghum, sorgo, soybean, and wheat. Waldo E. Grimes reported in 1910, "The best method of handling the kafirs and sorghums was to carry a chopping block from shock to shock." A photograph in the 1910 report showed that two men could keep one man busy heading the crops. The fodder was piled on the ground as the heads were thrown on a hay frame and hauled to the threshing machine. Most of the fodder was sold at $1.50 per ton in the field or $2.50 per ton delivered, which made a profit for the farm.[ao] Other crops grown for the market included alfalfa hay, barley, corn, grain sorghum, millet, oat, and wheat.

Plot planter designed by Clarence Swallow and constructed in the Agronomy Farm shop, 1987.

One of the risks that every farmer must take when he plants a crop is the possibility of having the crop destroyed or damaged by insects and pests. In 1934, great flocks of blackbirds and crows descended on the Atlas sorgo, and one employee was kept busy from September 20 to October 25 with a shotgun, on and off, to keep the pests from completely destroying the grain.[ap] Other insects and pests the farm dealt with over the years include armyworms, beetles, chinch bugs, gophers, grasshoppers, Hessian fly, mice, moles, rats, and other rodents. salt was used to kill bindweed, but cockleburs, morningglory, and other weeds were a problem, as were leaf and stem rust.[aq]

Over the years, the farm has overcome many problems, and new products have helped to eliminate or control insects and pests. Studies have proven that corn is on the cutting edge for an innovative fuel alternative; ethanol, and soybean has been used in biodiesel. From wheat field to the breadbasket, the Agronomy Farm is on the cutting edge of helping farmers and commercial producers put food on many tables.

Notes

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d B.S. Wilson. *Agronomy Farm Report*. (Manhattan, KS: Department of Agronomy, Kansas State Agricultural College, 1910), 17.

e George H. Phinney. *Agronomy Farm Report*. (Manhattan, KS: Department of Agronomy, Kansas State Agricultural College, 1919), 2.

f Andrew D. Kauer. *Agronomy Farm Report*. (Manhattan, KS: Department of Agronomy, Kansas State College, 1949), 1.

g Andrew D. Kauer. *Agronomy Farm Report*. (Manhattan, KS: Department of Agronomy, Kansas State College, 1954), 27.

h J.W. Crumbaker. *Agronomy Farm Report*. (Manhattan, KS: Department of Agronomy, Kansas State Agricultural College, 1916), 86.

i George H. Phinney. *Agronomy Farm Report*. (Manhattan, KS: Department of Agronomy, Kansas State Agricultural College, 1927), 82.

j Waldo E. Grimes. *Agronomy Farm Report.* (Manhattan, KS: Department of Agronomy, Kansas State Agricultural College, 1913), 31.

k A.L. Clapp. *Agronomy Farm Report*. (Manhattan, KS: Department of Agronomy, Kansas State Agricultural College, 1914), 107-119.

l Ibid.

m Ibid.

n C.E. Crews. *Agronomy Farm Report*. (Manhattan, KS: Department of Agronomy, Kansas State Agricultural College, 1928), 88.

o Frank. G. Parsons. *Agronomy Farm Report*. (Manhattan, KS: Department of Agronomy, Kansas State Agricultural College, 1936), 11.

p B.S. Wilson. *Agronomy Farm Report.* (Manhattan, KS: Department of Agronomy, Kansas State Agricultural College, 1911), 58.

q F.B. Lawton. *Agronomy Farm Report*. (Manhattan, KS: Department of Agronomy, Kansas State Agricultural College, 1912), 114.

r *Industrialist*. (Manhattan, KS: Kansas State Agricultural College, 1922), 2; Robert F. Sloan. *Agronomy Farm Report*. (Manhattan, KS: Department of Agronomy, Kansas State College, 1940), 55.

s *Collegian*. (Manhattan, KS: Kansas State University, June 23, 1966), 1.

t Clapp, 1914, 123.

u A.E. McClymonds. *Agronomy Farm Report*. (Manhattan, KS: Department of Agronomy, Kansas State Agricultural College, 1915), 106.

v Clarence W. Swallow. *Agronomy Farm Report*. (Manhattan, KS: Department of Agronomy, Kansas State University, 1968), 1–2. Note – it is unclear whether or not the oil house was one of the four other buildings destroyed in the tornado or if the building was moved when other buildings were erected.

w Ibid.

x F.B. Lawton. *Agronomy Farm Report*. (Manhattan, KS: Department of Agronomy, Kansas State Agricultural College, 1912), 114.

y Waldo E. Grimes. *Agronomy Farm Report.* (Manhattan, KS: Department of Agronomy, Kansas State Agricultural College, 1913), 25.

z E.S. Lyones. *Agronomy Farm Report*. (Manhattan, KS: Department of Agronomy, Kansas State Agricultural College, 1921), 21.

aa George H. Phinney. *Agronomy Farm Report*. (Manhattan, KS: Department of Agronomy, Kansas State Agricultural College, 1926), 87.

ab Clapp, 1914, 121.

ac *Collegian*. (Manhattan, KS: Kansas State University, June 23, 1966), 1.

ad Waldo E. Grimes. *Agronomy Farm Report, 1909–1912*, 26.

ae Waldo E. Grimes. *Agronomy Farm Report*. (Manhattan, KS: Department of Agronomy, Kansas State Agricultural College, 1913), 32.

af Grimes, 1913, 51.

ag Clapp, 1914, 71 & 76.

ah Clapp, 1914, 77.

ai J.W. Crumbaker, 1916, 65; George H. Phinney. *Agronomy Farm Report*. (Manhattan, KS: Kansas State Agricultural College, 1919), 1.

aj Grimes, 1909–1912, 55; Grimes, 1913, 8.

ak Clapp, 1914, 1; McClymonds, 1915, 1; Crumbaker, 1916, 1.

al Board of Regents. Board Minutes, May 26, 1945, 2.

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an Dale S. Crumbaker. *Agronomy Farm Report*. (Manhattan, KS: Department of Agronomy, Kansas State College, 1946), 50.

ao Grimes, 1909–1912, 23.

ap F.L. Timmons. *Agronomy Farm Report.* (Manhattan, KS: Department of Agronomy, Kansas State College, 1934), 61.

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Ashland Agronomy Farm

Cynthia A. Harris

The Ashland Agronomy Farm was established in 1953 and is located about ten miles south of Manhattan, Kansas, in the area locally known as the Ashland Bottoms. The farm includes several tracts of land purchased over many years from various farmers. In 1938, the Federal Government purchased land from the heir of H. W. Williams for $13,425. Williams purchased the land from Hanson N. Claypool, who obtained the land from the government for serving in the War of 1812. In 1939, another parcel of property was purchased for $1,500. In 1947, the government purchased a parcel of land that had originally belonged to a Mr. Kinney, who also acquired the land from government for serving in the War of 1812. In 1953, Kansas State College purchased 60 acres for $16,549.50 from Ben Puett. Puett retained 20 acres, which included his farmstead. In 1956, the University added additional land that was purchased from Will T. Malyneaux.[a] In 2000, the Department purchased 318 acres from the Otto estate, using funds from the sale of 40 acres of the Agronomy North Farm. In 2001, 15 acres adjacent to Unit I were purchased from the Berry family. In 2005, the Department of Agronomy purchased 65 acres with several buildings, long known as the Horticulture Farm, from the Department of Horticulture.[b] In total, the Ashland Agronomy Farm currently consists of 626 acres.

Although Andrew D. Kauer was the first superintendent of the farm, it was Clarence W. Swallow that stayed the longest stretch of time. Swallow began his superintendent duties in 1954 and stayed to retirement in 1994. During his tenure, Swallow pulled double duty. His duties were extended in 1965 to the Agronomy Farm near the college. Managing two farms lead Swallow to be dubbed “The Master of Modification.”

Although it was quite difficult to operate one farm with limited staff and funds, managing two farms was an even greater challenge that Swallow greeted with open arms. The farms had to “make do” with what they had or find the money to buy new equipment. When Swallow arrived on the scene, the farm did not own a planter. The only planter available was located on the Agronomy North Farm in Manhattan; therefore, Swallow built one, beginning a large number of farm improvements.

Work on the farm was typically seasonal, slowing during the winter months. Swallow was determined to improve the Ashland farm, so he put the staff to work overhauling a 1947 International C Tractor, a 1948 Ford 8 N tractor, a Diamond T truck, a 1946 International Panel, a power unit (E-50-International) on well number 2, and Combine No. 23. The master machinist taught the employees that work was always waiting to be done. Under Swallow’s keen oversight, the staff built a fertilizer application attachment for an Oliver Iron Age planter; a trailer for hauling irrigation pipe, from welded pipe and a 1946 Ford rear axle; and an elevator for elevating sacks of grain to the upstairs of the seed house, from angle iron and pipe, with a 20-inch flat belt to carry the sacks. Swallow tolerated no idle hands. The Staff constructed a bagging attachment for the large seed cleaner from an old unloading auger from a 1950 Allis Chalmers combine and powered by an electric motor.[c]

When worked also slowed in the shop, Swallow sent the staff outdoors to improve the grounds. Fences were removed; trees and brush were cut and removed; the road cleaned; buildings were erected for storage; and outside lights were installed. After the grounds came the house. Cabinets were built and installed in the kitchen, plumbing was installed to the sink and for a bathroom shower. Clothes closets were added, as well as a cold storage room in the basement. Oak floors were installed in the living and dining room, and inlaid linoleum was installed in the kitchen. When funds were lacking, where did money come from for all the projects? Swallow knew two things: first, if there was no work for the employees during the winter months they would more than likely be laid off with no income and, second, the farm needed all the improvements. Therefore, Swallow sometimes provided cash himself.

Under Swallow’s direction, the Ashland farm saw many improvements between 1954 and 1994. In 1974, a new headquarters building was built. It was metal covered over a wood and steel frame. The main structure with a shop area measured 40 by 80 feet. Staying true to his calling as a renovator, Swallow remodeled a grain bin and attached it to the east side of the building to be used as an office and restroom area.[d] Additional buildings on the farm included two houses, a garage, a storage building, a wash house, a machine shed, seed storage, and a grass seed drying building.[e]

Crops grown at the farm included 'Buffalo' alfalfa, corn, grasses, bromegrass, 'Greenleaf' sudangrass, 'Kaw' big bluestem, lespedeza, clover, oat, Andrew oat, raspberry, sorghum, trees, and wheat. The raspberry was short lived. In April 1954, the land was disked and cultivated to remove all the raspberry.

Although the Ashland farm escaped damage from the tornado in 1966, like the rest of Manhattan it suffered heavily from the ice storm of March 18, 1984. Tree limbs were broken, power lines were downed, and it was nearly impossible to do daily work.

At the time Swallow retired in 1994, both the Ashland Agronomy Farm and the North Agronomy Farm in Manhattan were under his direction. In 1994, Karl Mannschreck was hired as farm manager. Mannschreck resigned and left Manhattan in the summer of 2004, and Vernon Schaffer assumed the duties of Farm Manager, in addition to his responsibilities as Director of the Foundation Seed Program.

Notes

a Clarence W. Swallow. *Ashland Agronomy Farm Annual Report.* (Manhattan, KS: Kansas State College, Department of Agronomy, 1954–1956), 1.

b Vernon Schaffer, Farm Foreman, 2005.

c Swallow, 1954–1956, 55–57.

d Clarence W. Swallow. *Ashland Agronomy Farm Annual Report*. (Manhattan, KS: Kansas State University, Department of Agronomy, 1974), 1.

e Clarence W. Swallow. *Ashland Agronomy Farm Annual Report*. (Manhattan, KS: Kansas State College, Department of Agronomy, 1958), 3.

Field Day at Ashland Agronomy Farm, circa 1974.

Personnel

Superintendents and Farm Foreman		Classified Employees	
Andrew D. Kauer	1953	L. Earl Cross	1954–1959
Clarence W. Swallow	1954-1994	Walt Rollins	1955–1966
Karl Mannschreck	1994-2004	Jack Lewis	1959–1961
Vernon Schaffer	2005-Present	Emmanual Weixelman	1961–1962
		George Wege	1967–1968 and 1970–1984
		Joseph Nash	1969–1970
		Wilfred Johnson	1973–1976
		Jimmy Lear	1975–1976
		Stan Rundquist	1975– present
		Jack Currie	2001–2003
		Neil Wickstrum	2004vpresent

Bags of certified seed stored in the original seed house at manhattan, circa 1910.

Service Programs

Foundation Seed

Vernon A. Schaffer

In the early phase of seed certification in Kansas, it was desirable to establish a certification program with the crop varieties then grown on farms. To establish such a program, members of the Agricultural Experiment Station and Extension Division cooperated in locating seed sources that had been carefully produced by the same farmer over a number of years and was relatively pure as to the variety intended. Seed from such fields was designated foundation, some with, and some without, any type of testing. These selections proved to be good in most cases. Some of the varieties handled by this method were: 'Kansas Common' alfalfa, 'Wheeler' sudangrass, 'Reno' winter barley and 'Achenbach' smooth bromegrass.

As new crop varieties were produced through breeding programs, the foundation seed was grown from seed furnished by the originator of the variety. At first there was no established procedure for maintaining a supply of seed worthy of being designated foundation.

'Buffalo' alfalfa was the first variety produced by the Kansas Agricultural Experiment Station to be grown under certification for the production of foundation seed. Seed furnished by the breeder, C.O. Grandfield, was planted at the Fort Hays Branch Experiment Station, for foundation production. The seed from this production was sold to producers of certified seed in Kansas and other states.

In 1925, a two-story building (now called "the old seed house") was built on the Agronomy North Farm. This replaced a smaller seed house that was located in about the same spot. A small seed cleaner was located on the lower level of the seed house, and seed was stored in the upper level. Seed was harvested and bagged directly from the combine in the field. The bags were then transported to the seed house to be conditioned, and the seed was bagged in two-bushel bags and stored upstairs.

Another early effort to produce a class of seed that might be considered foundation was the increase of corn inbreds. In 1943, the board of directors of the Kansas Crop Improvement Association approved an agreement with the Agriculture Alumni Association, West Lafayette, Indiana, to increase seed of five corn inbreds. This action was taken to assist Kansas hybrid-seed growers in setting up a program of hybrid-corn seed production as promptly as possible. The inbred seed was sold to growers to produce single-cross seed.

In 1945, the Kansas growers of hybrid seed corn realized the necessity of arranging for production of their inbred seed within the state. The Agronomy Department of the Kansas State College had produced the increase of seed stocks for Kansas hybrids, but the increase demand for the seed, and the limited facilities in the department for this type of work, created the need for a production organization in Kansas. As a solution to this problem, the Kansas Hybrids Association was organized, with Clare R. Porter as manager. Kansas Hybrids Association was a non-profit cooperative with membership made up of growers of hybrid seed corn in Kansas. It produced sufficient seed stocks to supply demands within Kansas and, if possible, to supply demands outside of the state.

The first advisory board of the association included R I. Throckmorton, E.G. Heyne, A.L. Clapp, L.E. Willoughby, E.A. Cleavinger, Walter O. Scott, O.J. Olsen, and C.R. Porter. After organization, the Kansas Hybrids Association constructed a metal building 100 feet long and 40 feet wide, on land purchased by the association, situated at the northeast corner of Claflin and Denison roads in Manhattan, the present location of Throckmorton Hall on the K-State campus. Three-fourths of the building was used for seed corn processing and storage, and the south one-fourth was used as an office and laboratory.

With the resignation of Porter in 1947 to accept a position as secretary of the Nebraska Crop Improvement Association, Carl B. Overley became manager. This association worked entirely with corn inbreds until hybrid sorghums were ready for production by Kansas growers in 1947. The increase of sorghum hybrids was then included in the program of the Kansas Hybrids Association.

This program soon became less important because the number of hybrid seed growers in Kansas was reduced by unstable seed yields and competition from the expansion of private seed companies, and the program was abandoned January 30, 1954. By that time, the Agricultural Experiment Station staff realized the necessity of a strong seed increase program, and Overley was placed in charge of seed production for the Kansas Agricultural Experiment Station.

Assets of the Kansas Hybrids Association were transferred to the Agronomy Department. Branch experiment stations and Experiment fields assumed the responsibility for production of foundation and registered seed of one or more crop varieties, and several others were grown on the Agronomy farms at Manhattan.

At the Experiment Station Conference, January 2, 1957, it was recommended that a foundation class be recognized, and that standards be developed to allow certification of this class. It was believed that a foundation class of seed would provide seed growers with superior seed and would assist in keeping Kansas certified seed high in quality. Until this time, foundation seed did not require any inspection or have to meet any standards.

In 1967, the present seed-conditioning center was built, with a small office in the southwest corner of the building. The building was state of the art, with an underground tunnel with a conveyer from the bins to the conditioning center to supply seed to the seed conditioning equipment. An overhead conveyor system was also installed to fill the bins. In 1972, an additional storage area and office were added to the north of the present seed-conditioning center.

In 1987, Overley retired as manager of the Foundation Seed Project, and Vernon Schaffer was hired as manager. In June 2004, Schaffer also accepted the responsibility of managing the Agronomy farm. New office space and bathrooms were added in 1988, and a new insulated 54 x 90 x 12 foot seed storage building was added in 1999 just northwest of the seed conditioning center to provide more, and greatly enhanced, seed storage space.

Personnel

Managers	
Clare Porter	1945-1947
Carl Overley	1947-1987
Vernon Schaffer	1987-present

Technicians	
Fred Piper	1947 - 1976
Wilfred Johnson	1977 - 1989
Harold Erichson	1985 - 2000
Will Fritzler	1992 - 1996
Mark Sellens	1988-1991
Mark Scott	1995-2000
Shawn Winne	2000-present
Steve Milne	2001-2004

Crop Performance Testing

Kraig Roozeboom

Once the crop has been chosen, selection of the specific variety to grow is one of the most fundamental decisions made by farmers. Researchers at Kansas State University have been conducting field studies designed to assist with that decision since the inception of crops research in the mid-1800s. Edward Mason Shelton, Kansas State Agricultural College professor of agriculture from 1874 to 1890, supervised variety tests with wheat, corn, barley, oats, millet, sorghum, alfalfa, and various grasses, in addition to crop-management experiments (True, 1937).

Shelton's life reflected the increasingly global nature of society of his time. He was born in Huntingdonshire, England, in 1846, went to New York in 1855, and on to Michigan in 1860, where he graduated from the Michigan Agricultural College in 1871. Before coming to Kansas, he spent a year as superintendent of the experiment farm at Tokyo, Japan, and spent some time in Greeley, Colorado, although no mention was made of his activities there. After leaving Kansas, he was agricultural advisor to the Government of Queensland, Australia, and was first principal of the Queensland Agricultural College. He eventually returned to the United States, living in the state of Washington until he died in 1928 (True, 1937).

For many years, variety trial results were reported as a part of a larger set of experiments dealing with a particular crop. In his 1888 summary, "Experiments with Wheat," Shelton (1888) listed two primary goals of his studies, one of which was the comparison of varieties (sorts):

> *"For several years experiments with wheat have been in progress at the College farm, having for their object (1) to show the comparative values of common and unusual sorts, and (2) to give expression to varying methods of treatment."*
> – E.M. Shelton, 1888

The difficulties associated with this task in the widely fluctuating environments of Kansas were evident to Shelton (1889), who stated:

> *"The testing of varieties is perhaps the most unsatisfactory work that comes to the experimenter. The experience of a single season is almost entirely worthless, because whatever results are obtained, where a long list is under examination, they are very likely to be contradicted by the experiences of another year. This tendency is made almost a certainty by the fact that but a very small number (usually only one) of small plats can, from the nature of the experiment, be used for each sort tested. On this account, the experience of years usually involves contradictions of soils, as well of seasons. It is only by 'striking a balance' of many of these opposing results that we get at an approximation to the truth. The reader is therefore cautioned against considering the facts of our table as being anything more than suggestively useful."* – E.M. Shelton, 1889

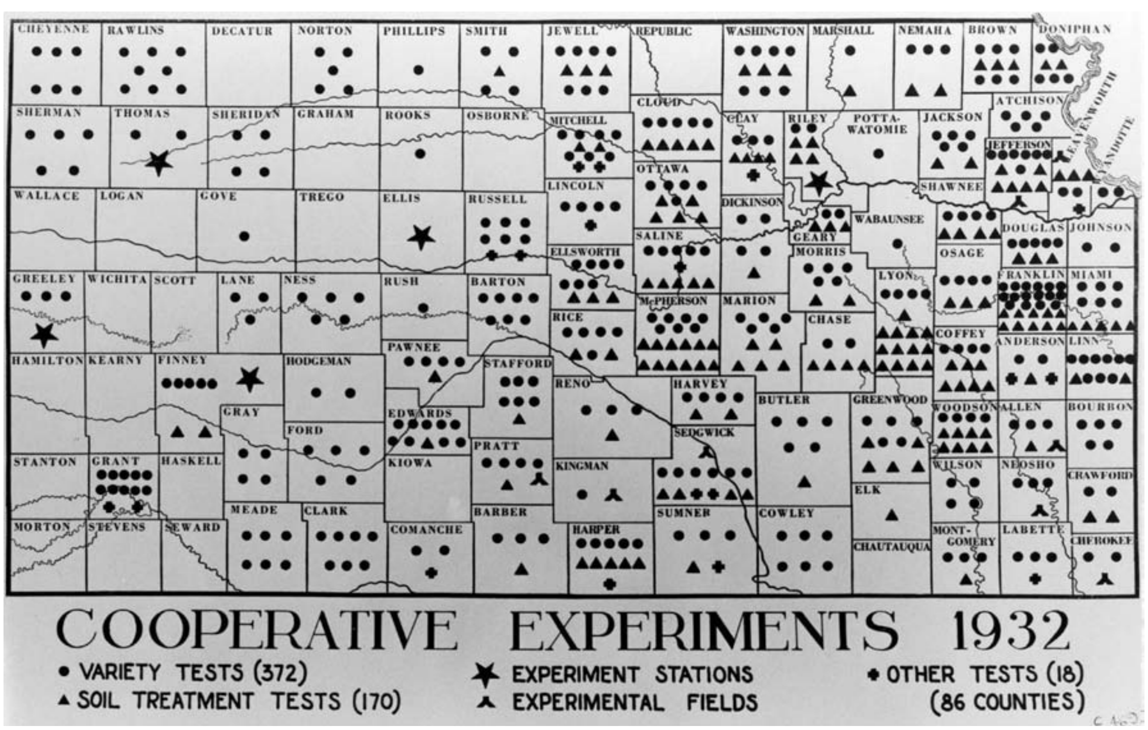
His statement may be considered somewhat strong, but is still accurate today if applied to non-replicated studies as he implies. Even with replicated studies, the large year-to-year and location-to-location variation common to Kansas has made it necessary to test varieties at several locations in more than one year.

Following Shelton, variety comparisons were conducted by C.C. Georgeson and others in the Department of Agriculture with corn (Georgeson et al., 1891) and oats (Georgeson et al., 1890), by G.H. Failyer and J.T. Willard (1890) in the Chemical Department with sweet sorghum and sugar beets, and by C.R. Weeks (1919) with alfalfa at what was then known as the Fort Hays Branch Experiment Station.

One of the first publications from the Department of Agronomy dealing exclusively with tests of crop varieties was authored by A.M. Ten Eyck (1910), Agronomist in Charge. Ten Eyck mentioned tests lasting from two to seven years, with more than 200 varieties of white dent and yellow dent corn, 44 varieties of spring oats, 32 varieties of spring barley, spring emmer, six varieties of cane (sorghum for syrup or forage), several varieties of cowpea, soybean ("not so well adapted for growing in this state as cowpeas"), and millet (German or foxtail, Hungarian, and Proso). He also highlighted improved varieties of kafir corn, dwarf and standard broom corn, and dwarf milo maize that were developed at K-State by head-row breeding. Ten Eyck summarized test results by listing the recommended varieties, their areas of adaptation, and their distinguishing characteristics.

Relatively slow turn-over of varieties in the first part of the Twentieth Century allowed extensive testing. C.C. Cunningham and B.S. Wilson (1921) summarized corn variety trials conducted from 1906 through 1919, including five- and seven-year yield means and detailed histories and descriptions for adapted varieties. S.C. Salmon and H.H. Laude (1932) presented a comprehensive summary of 20 years of variety tests with winter wheat, in conjunction with "a period of unprecedented activity in crop improvement." Although several varieties were tested, the report focused on results for Turkey, Blackhull, and Kanred, the most widely grown hard red winter wheat varieties at that time. Yields for Kanred, Turkey, and Blackhull averaged 21.1, 20.7, and 22.1 bushels per acre, respectively, over 571 cooperative tests from 1919 to 1930. Although Tenmarq was included in only seven years of testing, the authors concluded that it was worthy of consideration, but its susceptibility to Hessian fly and scab was a concern. A.F. Swanson and H.H. Laude (1934) summarized test data from 1912 to 1931 for varieties of sorghum of several types—forage, grain, grass (sudan), broom, and sweet— presenting 4, 8, and 12-year yield averages for a number of varieties. A 1942 update to their report (Swanson and Laude, 1942), included many of the same varieties, presented 5, 9, 12, and 18-year yield averages for several, and gave up to 23-year yield averages for a few of those varieties. Others contributing to these reports were R.E. Getty and D.A. Savage, forage investigations; I.K. Landon and F.E. Davidson, Southeastern Experiment Fields; Clare Porter, South Central Experiment Field; A.B. Erhart, Southwestern Experiment Field; L.C. Aicher, A.L. Hallsted, and A.F. Swanson, Fort Hays Branch Station; F.A. Wagner and Alvin Lowe, superintendents of the Garden City Branch Station; T.B. Stinson, superintendent of the Tribune Branch Station; and E.H. Coles and B.F. Barnes, superintendents of the Colby Branch Station. Cooperating faculty and staff at off-campus facilities have played a vital role in crop variety testing throughout the history of the program.

During the first 33 years of the Department of Agronomy, a number of individuals published summaries of variety and production studies for several crops. Swanson and Laude (1938, 1943) summarized barley production and variety studies in 1938 and 1943. Davidson and Laude (1938) published a comprehensive flax production guide, including variety trial summaries, in 1938. Flax occupied well over 200,000 acres in 1890, but acreage had dropped since then to less than 50,000 acres, mostly in south-



Cooperative experiments in 1932.

eastern Kansas. As the country began to come out of the Great Depression, Davidson and Laude foresaw an increased need for linseed oil in response to increased construction. Their flax production guide was intended to help Kansas farmers respond to the potential increase in demand for a crop product that was obtained primarily via imports from other countries.

The fee-based Kansas Crop Performance Testing Program that is in existence today can trace its origins to the efforts of Alfred L. Clapp (Clapp, 1970). Clapp was a product of the department, receiving his B.S. degree in Agronomy in 1914 and M.S. in 1934. His service to K-State included superintendent of the Agronomy Research Farm, Morris County agent, district agent, extension agronomist, and head of Cooperative Experiments in the Department of Agronomy beginning in 1931. From 1935 to 1945 he served concurrently as secretary-treasurer of the Kansas Crop Improvement Association. Clapp retired from the Department of Agronomy in July, 1960 after a long career of service to Kansas agriculture.

The February 1939 publication *Hybrid Corn in Kansas* (Jugenheimer, 1939), announced the establishment of the Kansas Corn Performance Tests in response to the advent of hybrid corn. Before 1939, corn varieties had been tested for several years, resulting in fairly clear conclusions regarding the relatively small number of varieties that were adapted in Kansas. Corn hybrid technology had been developing over the previous 30 years, resulting in some outstanding yield records of hybrids, compared with open-pollinated varieties. Hybrids had been adopted rapidly in the Corn Belt states, growing from less than 1% of the acreage in Iowa, Illinois, and Indiana in 1933 to 50% or more by 1938. In 1938, only 3% of the Kansas corn acreage was planted to corn hybrids, but demand was strong and hybrid seed was being offered that had not been proven as superior to adapted varieties; some was not actually hybrid seed at all. The Kansas Corn Performance Tests were established as impartial, scientifically sound trials designed to “determine the local adaptation, vegetative characteristics and yielding capacity” of the large number of corn hybrids being made available by both public institutions and private companies. The committee appointed to oversee the tests included Clapp, chair, R.I. Throckmorton, H.H. Laude, and H.D. Hollembeak from the Department of Agronomy and R.W. Jugenheimer from the USDA. Fees were set at $6.00 per entry per location, with five replications per location. Plots were hand planted in two rows of 12 hills each, with three kernels per hill in the eastern locations and two kernels per hill in the central locations. Test results were to be published in a printed report distributed by the committee. The first report, printed in January of 1940, included results from the 1939 Performance Tests and the 1938 and 1939 un-replicated Kansas Cooperative Corn Strip Tests. Corn performance tests have been conducted every year from 1939 to the present day, with results published in 67 reports.

The scope and nature of the corn performance tests has changed over the years. From the inception of the tests until about 1970, a fair number of entries were from public institutions, including open-pollinated varieties that had been grown in Kansas for many years and new hybrids released from breeding programs at K-State, other universities, and the USDA. In the first years of the tests, the numbers of public versus private entries were almost equal, but beginning in the mid-1940s, roughly twice as many private as public hybrids were consistently entered in the tests. That relationship was maintained until the 1960s, when public entry numbers dropped to only about 20% to 25% of the total.

Since the early 1970s, the public entries have been limited to only three to five check hybrids, illustrating the predominance of private entities in corn hybrid development and marketing in the last 40 years. The total number of entries each year averaged close to 140 for the first 15 years of the tests. In the late 1950s and 1960s, annual entry numbers averaged less than 100. Since 1972, annual entry numbers have averaged roughly 200, with large year to year variation. The number of private companies submitting entries to the tests reached an early peak of 27 in 1947, but dropped to less than 10 in 1956 and 1959. That number gradually increased for the next 15 years, until roughly 33 companies participated for several years. The greatest number of companies entering hybrids in the tests occurred in the early 1990s, at about 40. Since that time, the number has again averaged about 33 companies. The corn performance tests included anywhere from 6 to 12 locations from 1939 until 1991. Since then, the number of locations has increased to more than 20, with additional irrigated tests in northeastern and central Kansas and more non-irrigated tests in western Kansas.

In the early 1950s, Clapp instituted a series of "Experiment Station Results" publications "intended to furnish timely information on the performance of crop varieties" (Clapp, 1955). This series was continued for several years, summarizing non-fee Experiment Station variety and crop management test results until the late 1960s. Over the years, the tests included several crops: sorghum, sudangrass, millet, safflower, soybean, pinto bean, castorbean, sugar beet, lespedeza, popcorn, oat, and spring barley (Walter and Nickell, 1969). Gradually, with the increased involvement of private seed companies in more and more crops, fee-based performance tests modeled on the Corn Performance Tests were established.

As with corn, the Grain Sorghum Performance Tests were instituted by Clapp in 1957 in response to the increasing numbers of hybrids available to farmers (Clapp, 1958). The 1957 tests included six locations, each with four replications of each hybrid, hand-planted in two-row plots. The Grain Sorghum Performance Tests have continued every year since then, with a total of 48 reports. Since the beginning, private entries have greatly outnumbered public entries. The total number of entries each year climbed gradually to more than 100 in 1970, from 35 in the first year of the tests. The number of entries reached about 200 in the late 1980s and early 1990s. Annual entry numbers have declined since then to just less than 100 in 2005. The number of private companies participating in the tests followed a similar pattern, starting with only a handful in 1957, climbing to about 20 in the 1960s, reaching a maximum of 35 to 40 in the 1980s, and declining since then to less than 20 in 2005. The number of locations has increased from 10 to 12 in the first 30 years to 18 to 20 in recent years. The increase in locations included additional non-irrigated locations in eastern Kansas and irrigated locations in central Kansas.

With the retirement of Clapp in 1960, Ted L. Walter moved to Manhattan from his position as agronomist at the Northwest Branch Station in Colby to take over as manager of the Crop Performance Tests. Walter supervised the performance tests for 30 years, until his retirement in 1990. During his tenure, he oversaw both the initial mechanization and computerization of the program. Performance tests were planted and harvested by hand until tractor-mounted plot planters were first used for the corn tests in 1972 and plot combines were first used in 1974. He first used mainframe computers to assist with data analysis in 1967, and he purchased the first desktop computer for the program in 1980.

Ted Walter with a display of 1989 Crop Performance Test publications.

Corn and sorghum forage performance tests were initiated in 1959 by Carl B. Overley (Overley et al., 1960), but were soon folded into the performance testing program coordinated by Walter. Forage tests have continued off and on in different formats over the years, with stand-alone forage corn and sorghum reports during the 1960s and early 1970s, combination grain and forage corn and sorghum reports during the later 1970s and 1980s and again in the mid 1990s. Beginning in 2000, stand-alone summer annual forage performance test reports have included forage sorghum, sudangrass, sorghum-sudangrass, and occasionally corn hybrids (Roozeboom and Evans, 2000). Entry numbers always have been relatively small, and have frequently dropped to the point that the tests were not conducted for a year or two.

Entry fees were initiated for soybean variety tests in 1972 (Nickell and Walter, 1973). The "Performance Tests" moniker was applied for the first time in the report summarizing the 1974 tests (Nickell et al., 1975). Although entries have been solicited and the report is now generated by the performance test coordinator, from the beginning, the soybean tests have been closely tied to the soybean breeding project, and have relied on the efforts of soybean breeders H.H. Laude, Cecil D. Nickell, and William T. Schapaugh. Tests have been conducted each year, with a total of 34 reports since the inception of the program. Annual entry numbers stayed well below 100 for the first several years of the tests, but were well in excess of 150 during most of the 1980s. Entry numbers dropped in the early 1990s, but rebounded with the introduction of varieties with the Roundup-Resistant® trait. In 2000, 20 companies entered a total of 307 varieties, in addition to 23 submissions from public entities. Annual entry numbers since then have dropped to just over 200, with most of those from private companies. The number of locations has stayed fairly consistent at 11 or 12 throughout the duration of the program.

Clapp and Walter had summarized and reported results from Experiment Station Variety Tests with winter wheat and other fall-planted small grains throughout their careers, but the transition to fee-based performance tests finally took place in the fall of 1975 (Walter, 1976) under the direction of Walter. Even with the implementation of entry fees in 1975, relatively few private, winter, small-grain varieties have been submitted over the years, causing this program to rely heavily on fees generated by other crops and on researchers at many locations who have conducted the tests with little or no compensation. In 1976, four companies entered only six varieties, which were accompanied by another six widely grown public varieties. Since the mid-1980s, the number of participating companies has been close to 10 each year. These companies typically entered between 30 and 40 varieties, only slightly more than the number of public varieties entered by the performance testing program. In 2005, the Wheat Performance Test report was distributed, along with the KCIA Certified Wheat Seed Directory, as an in-

Planting no-till grain sorghum variety test plots, 2005.

sert in the August “Seed Wheat” issue of the *High Plains Journal*. This was a joint effort involving the Department of Agronomy Crop Performance Tests, the *High Plains Journal*, and the Kansas Crop Improvement Association, with the aim of increasing the scope of distribution and decreasing costs to the university.

Alfalfa variety tests were coordinated by Department of Agronomy Extension Crop Specialist Verlin Peterson in the 1960s and 1970s (Peterson et al., 1975). Extension Crops Specialist James P. Shroyer continued to be involved after the program had been converted to an official performance test in 1980. Since 1987, the program has been largely under the direction of the performance test coordinator. Because of the perennial nature of the crop, tests are continued for several years. Most recently, the tests have been harvested for three years after the year of establishment, with a new test planted in the last harvest year of the previous test. Initially, roughly a third of the entries in the alfalfa tests were experimental lines from the USDA breeding program headed by Edgar Sorensen. After that program was discontinued in the 1980s, only two or three check varieties were maintained in the tests. Since 1990, tests have been conducted at six locations, including a total of 40 to 85 varieties from 20 or more companies annually.

Sunflower performance tests converted from occasional, gratis variety trials to fee-based performance tests in 1986, under the direction of John Lawless at Colby (Lawless et al., 1986). These tests are still coordinated almost entirely from the Northwest Research-Extension Center by Pat Evans, who took over the program when Lawless retired in 1993. Since the tests began in 1986, 13 to 18 companies have entered a total of 46 to 87 hybrids in any one year. The majority of the entries are meant for the oil market, with only a handful of confectionary types in a given year. In recent years, NuSun™ hybrids have become an important part of the sunflower industry, and have been included in the tests in increasing numbers. The oil from these hybrids does not require partial hydrogenation for stability, providing health benefits for consumers.

Kraig Roozeboom became coordinator of the Kansas Crop Performance Tests when Walter retired in 1990. Since then, technology involved with crop performance testing has continued to change at a number of levels. In the mid 1990s, precision air planters facilitated switching from over-planting and thinning to planting to stand for many tests. Beginning in 1995, performance test results were posted on a Kansas Crop Performance Test web site as soon as possible after harvest. In some cases, preliminary performance test results have been available on-line later in the same day that the test was harvested. In 1999, on-combine data collection was installed, allowing plot weight, test weight, and grain moisture to be stored electronically for transfer to desktop computers for data analysis and eliminating the need for hand entry of test data. In 2006, companies could download electronic entry forms, enter their information, and return them, all electronically, saving time and minimizing data entry errors. Systemic insecticide seed treatments were approved for sorghum in the mid-1990s and for corn a few years later, requiring decisions about whether to request untreated seed or to test the seed product as it was marketed. In 1995, STS soybean varieties, tolerant to sulfonylurea herbicides, first appeared in the performance tests, followed by Roundup® resistant varieties in 1997. Similar genetic technologies have since been incorporated into hybrids and varieties of corn, sunflower, wheat, and alfalfa.

Over the years, several individuals have provided additional assistance to the program. The following is not an exhaustive list, but these people were acknowledged in performance test reports from the 1950s until the present: C.D. Davis, H.C. Wiggin, and Carl Overley; technicians Fred Piper, Clarence Dunn, Robert Frank, Dail Nelson, David Stephenson, Teresa Wollen, Ed Quigley, and James R. Cochrane; clerk-typists Nancy Robinson, Linda Genetzky, Sheri Conner, Connie Bates, Janet Irvin, Paula Wasinger, Janet Vinduska, Diana Ruthstrom, Darlene Buller, and Nancy William; computer specialists Jac Morgan, David Yost, William Gottschalk, Jon Lane, Kip Holliday, and Mary Knapp. Although personnel, crops, test locations, and technologies have changed over the years, the ongoing goal of the Kansas Crop Performance Testing Program remains the same: to provide Kansas farmers with accurate, timely information on crop varieties to help with one of the most fundamental crop management decisions they make every year.

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Kansas Crop Improvement Association

Daryl Strouts

The Kansas Crop Improvement Association (KCIA), with nearly a century of history in Manhattan, has seen several changes to its services and affiliations throughout the years, but its core mission has remained the same: to cooperate with growers to produce high-quality seed for sale to producers throughout the state of Kansas.

In 1902, an organization called the Kansas Seed Corn Breeders Association was formed to improve and standardize several Kansas corn varieties. Twelve years later, because of a significant increase in wheat interests, the organization was renamed the Kansas Crop Improvement Association. In the early years, KCIA inspected fields and consulted with growers of various seed varieties, but it wasn't until 1922 that KCIA began to use the word "certified" to designate inspected seed.

In 1937, a Senate bill authorized Kansas State Agricultural College to appoint an agency for the purposes of statewide seed certification. Since then, KCIA has been the sole authority in the state regarding seed inspection and certification. The agency's mission has been recognized as essential to the agricultural economy. During tire and gasoline shortages during World War II, for example, the government assured KCIA that enough resources would be available for field inspection purposes.

Possibly the biggest milestone in KCIA history was the passage of the U. S. Plant Variety Protection Act in 1970. This act prohibited the illegal propagation and sale of new plant varieties and increased the need for enforcement of certification standards and procedures. It also encouraged investment in research and development of new crop varieties.

Until the mid-1980s, KCIA was housed in university buildings—first Waters Hall and then Call Hall. With its expanding mission and services, however, the agency urgently needed its own space. In 1986, it moved into its current location on the Kansas State University Agronomy Farm, north of the football stadium. This building was made possible through a KCIA donation to the university and is governed by a continuing-use agreement with K-State.

KCIA has had a long and mutually beneficial relationship with K-State and the Department of Agronomy. Until recently, the KCIA executive director also served as a tenured university faculty member. Professors and administrators in the agronomy department have held several positions at KCIA. Most notably, Ray Throckmorton, Leland Call, and Alfred Clapp made numerous contributions to both K-State agriculture and KCIA.

Under the leadership of Lowell A. Burchett between 1973 and 1998, and Daryl Strouts from 1999 to the present, the agency's development has been marked primarily by an increase in the professionalism of the seed industry and an increased interest in education and partnerships. In addition to maintaining diplomatic relations with other agricultural organizations, as well as the Kansas Department of Agriculture and state and federal legislators, KCIA enjoys offering internships, scholarships, and other educational opportunities to K-State students and others in the surrounding agricultural community.

With today's biotechnological advances in seed research and development, the KCIA mission is more important than ever. As an objective third party for producers and consumers of seed, the agency is well-positioned to continue to serve the essential interests of quality assurance and continued improvement of the seed industry.

The history of seed certification in Kansas from 1902 to 1970 was well documented by Clapp in his book, *The Kansas Seed Grower*, published by KCIA in 1970. In chapters 8 and 9, Clapp listed Presidents of KCIA from 1914 to 1970, Secretaries and Assistant Secretaries during these years, elected Directors from 1915 to 1969, Honorary Memberships, and Premier Seed Grower Award recipients from 1930 to 1970. These groups were updated to the present for inclusion in this summary.

The Kansas Crop Improvement Association Elected Presidents

1914	R. A. Willis, Manhattan
1915-16	W. G. Shelley, McPherson
1917-18	Carl Wheeler, Bridgeport
1919-22	Fred G. Laptad, Lawrence
1923-28	C. C. Cunningham, El Dorado
1929-30	E. H. Hodgson, Little River
1931-33	H. A. Praeger, Claflin
1934-35	Bruce S. Wilson, Keats
1936-37	H. E. Staadt, Ottawa
1938-39	Harlan Deaver, Sabether
1940-41	C. C. Cunningham, El Dorado
1942-43	B. H. Hewett, Coldwater
1944-45	T. Max Reitz, Belle Plaine
1946-47	Charles R. Topping, Lawrence
1948-49	Walter Peirce, Hutchinson
1950-51	F. J. Raleigh, Clyde
1952-53	C. C. Cunningham, El Dorado
1954-55	J. E. Sowder, Toronto
1956-57	Wallace White, Coldwater
1958-59	George Fuhrman, Atchison
1960-61	E. W. Underwood, Bird City
1962-63	Marvin C. Odgers, Sublette
1964-65	Raymond F. Roemer, Grainfield
1966-67	John Hamon, Valley Falls
1968-69	O. R. Caldwell, Emporia
1970-71	Lester Ewy, Partridge
1972-73	John Neuschwander, Tribune
1974-75	John Bunck, Everest
1976-77	Joe Jagger, Minneapolis
1978-79	Howard De Lange, Girard
1980-82	Ed Oborny, Jr., Bison
1983-84	Kent Symns, Atchison
1985-87	Alden Ensminger, Moran
1988-89	Adrian Polansky, Belleville
1990-91	Larry Hixson, Wakeeney
1992	Don Keesling, Chase
1993	Bob Sipes, Manter
1994-95	Dwight Glenn, Wichita
1996	Paul Conrardy, Kingman
1997-98	Cleta Roberts, New Cambria
1999-02	Jim Sipes, Manter
2003-04	John Evans, Hutchinson
2005-	Bob Bunck, Everest

Honorary Memberships

Leland E. Call, February 5, 1948
Jacob C. Mohler, February 5, 1948
Alfred L. Clapp, February 4, 1948
Ray I. Throckmorton, February 7, 1952
Louis C. Aicher, February 7, 1952
Claude C. Cunningham, January 27, 1959
Charles R. Topping, January 29, 1964
Carl B. Overley, January 30, 1986
Hyde S. Jacobs, January 31, 1989
John Hamon, January 30, 1990
George Ham, January 30, 1990
Walter A. Moore, January 26, 1993
Thomas Roberts, January 21, 1997
Art Armbrust, January 21, 1997
John Bunck, January 27, 1998
Lowell A. Burchett, January 26, 1999
Gerry L. Posler, January 28, 2004

A bag of certified hybrid seed corn for sale by a member of the Kansas Corn Breeder's Association, founded in 1902 and changed to KCIA in 1914.

Premier Seed Growers

1930	C. C. Cunningham, El Dorado
	J. K. Freed, Scott City
	Bruce S. Wilson, Manhattan
	Fred G. Laptad, Lawrence
1931	Frank J. Smerchek, Garnett
	Harold E. Staadt, Ottawa
1932	H. A. Praeger, Claflin
	Arthur J. White, Coldwater
1933	Harlan Deaver, Sabetha
	R. E. Getty, Clayton
1934	Frank S. Smerchek, Garnett
1935	Walter Claasen, Whitewater
1936	W. A. Barger, Larned
	G. D. Hammond, St. John
1937	Arnold C. Claassen, Potwin
	Herman L. Cudney, Trousdale
1938	B. H. Hewett, Coldwater
	Vincent J. Meyer, Umbarger, Texas (formerly of Olathe)
1939	John Regier, Whitewater
	I. G. Walden, New Cambria
1940	Rolly Freeland, Effingham
	A. T. Hoover, Detroit
1941	W. Fred Bolt, Isabel
	Charles R. Topping, Lawrence
1942	F. W. Chamberlin, Carbondale
	T. Max Reitz, Belle Plaine
1943	Walter C. Pierce, Hutchinson
1944	O. J. Olsen, Horton
	F. J. Raleigh, Clyde
1945	none
1946	Merle Barnes, Yates Center
	Clarence Fulton, Harper
1947	George Fuhrman, Scott City
	Ralf Hockens, Arrington
1948	J. E. Sowder, Toronto
	E. W. Underwood, Bird City
1949	Earl L. Collins, Wichita
	M. W. Converse, Eskridge
	L. L. Utz, Highland
	Laurence Woolley, Osborne
1950	George Conrardy, Kingman
	Herbert Niles, Lebo
1951	Edward J. Oborny, Timken
	Wesley R. Sylvester, Milford
1952	Bertram Garard, Osage City
	Walker Bros., Sterling
1953	L. B. Harden, Centralia
	Earl Lupton, Montezuma
	J. Ambert Meyer, Olathe
	Frederick H. Warnken, Hutchinson
1954	George Birkenbaugh, Kingman
	Virgil A. Britt, Junction City
	Wilfred M. Johnson, Manhattan
	G. Clarence Lynch, Minneola
1955	Henry Bunck, Everest
	Amos Dahlsten, Marquette
	C. J. Fear, Bala
	B. D. Hixson, WaKeeney
1956	H. W. Clutter, Holcomb
	John Jansonius, Prairie View
	F. J. Pechance, Timken
1957	Henry Arensman, Kinsley
	John Hamon, Valley Falls
	H. F. Roepke, Manhattan
	Howard Strouts, Wilsey
1958	D. C. Buller, Halstead
	Walter A. Hunt, Arkansas City
	Waldo H. Lee, Marysville
	Marvin C. Odgers, Sublette
1959	Bell Bros., Bucklin
	W. W. Jamison, Quinter
	Ed Visser, Riley
	J. A. Vondracek, Timken
1960	Charles W. Burt, Jr., Coldwater
	Roger C. Jones, Johnson
	Orville W. Wear, Halstead
1961	Orville Bryant, Rozel
	Lester Ewy, Partridge
	John A. Neuschwander, Tribune
	Elwyn Topliff, Jewell
1962	Paul Conrardy, Kingman
	Alois G. Urban, Bison
1963	Eddie Ewy, Arlington
	Cyril J. Habiger, Bavaria
1964	Neil Fischer, Plainville
	Max Kolarik, Caldwell
1965	Elmer Angell, Jr., Medicine Lodge
	Walter H. May, Oberlin

1966	Robert Korthanke, Robinson
	Ervin J. Miller, Partridge
1967	O. R. Caldwell, Emporia
	Harold E. Dobrinski, Lorraine
1968	Joe A. Fox, St. John
	Albert Kientz, Wamego
1969	Mrs. M. E. Schwarz, Caldwell
	Henry Pechance, Timken
1970	Sydney A. Johnson, Lindsborg
1971	Cleve Cook, Emporia
1972	Wayne Dicken, Desoto
	Gail Sharp, Healy
1973	Lawrence Kolarik, Caldwell
1974	Glenn Sipes, Manter
1975	Don Keesling, Chase
	Edward J. Oborny, Jr., Bison
1976	John Polansky, Belleville
1977	Herman Darnauer, Goodland
1977	Larry Hixson, WaKeeney
1978	Joe Jagger, Minneapolis
1979	Hamon Seed Farms, Valley Falls
	Albert Greiner, Haviland
	Archie Smith, Montezuma
1980	John Bunck, Everest
1981	Delmer Knackstedt, Windom
1981	George Sis, Belleville
1982	Carl Sobba, Garnett
1983	Carl Overley, Manhattan
	Marlin Cross, Bunker Hill
1984	Bill Daugherty, Culver
1985	Raymond Ohlde, Palmer
	Larry Kepley, Ulysses
1986	Adrian Polansky, Belleville
	Bob Sipes, Manter
1987	Charles Griffith, WaKeeney
	Kent Symns, Atchison
1988	Delmar & Peggy Sidener, Solomon
	Robert Goodin, Derby
1989	Howard De Lange, Girard
	Leon Neher, Quinter
1990	Clint Birkenbaugh, Kingman
	Sylvester Ranch, Ottawa
1991	L. A. Bunjes, St. Francis
	Casterline Seed, Dodge City
1992	Alden Ensminger, Moran
	Lawrence Strouts, Wilsey
1993	Kauffman Seed, Haven
	Wilbur Neaderhiser, Lyons
1994	LaVerne Miller, Patridge
	Rodney Ohlde, Palmer
1995	Tom Lutgen, Osborne
	Oscar Strahm, Bern
	Vernon Schaffer, Manhattan
1996	Don Phillips, Hope
	Roberts Seeds, New Cambria
1997	Griffith Seedstock, WaKeeney
1998	John Evans, Hutchinson
	Bill Mai, Sharon Springs
1999	John Blankenship, Udall
2000	John Griffin, Nickerson
	Otto Levin, Kensington
2001	Marion Lobmeyer, Garden City
2002	Bob Bunck, Everest
2003	Jim Sipes, Manter
2004	Maurice Miller, Healy
2005	Mike Baxa, Belleville

Soil Testing Activities

David A. Whitney

The intent of this history of soil testing in Kansas is to chronicle the major activities by K-State in providing soil testing services to farmers. It is beyond the scope of this history to identify and detail the valuable contribution of all individuals. Significant contributions have been made by numerous county agents, extension specialists, and researchers to the success of soil testing over the decades. Lime and fertilizer demonstrations and research studies conducted by county agents, and University research and extension personnel have been the foundation of sound lime and fertilizer recommendations, but will not be covered in this history.

Soil testing has long been recognized as a valuable aid in assessing lime and nutrient needs for crop production. As early as 1925, county agricultural agents were using an in-field test for assessing soil acidity (note from E.A. Cleavinger, county agent in Coffey County in 1926 and later extension agronomist retiring in 1968). Emil Truog at the University of Wisconsin developed the soil acidity test used by county agents (Wisconsin Agricultural Experiment Station Bulletin 312). The Truog test was based on the chemical reaction between zinc sulfide and acid soil giving off sulfide gas when boiled. The more acid the soil, the more gas evolved. Lead acetate paper was placed over the mouth of a boiling flask to absorb the sulfide gas, which darkened the paper in proportion to the amount of gas evolved.

Truog test kit, circa 1926.

The Truog test for acidity was replaced in 1928 by procedures developed at the University of Illinois by Roger Bray (Illinois Agricultural Experiment Station Bulletin 337) that tested for both soil acidity and phosphorus, referred to as "Rich or Poor" for acidity and "Hi-Lo" for phosphorus. These qualitative in-field tests were used extensively by county agents in the eastern half of Kansas. At this time, little soil testing was being done in western Kansas because of high-pH soils. Teagarten, in the history of the Kansas Cooperative Extension, reported "The number of soil samples tested for acidity reached 8,897 in 1929." No records of total soil samples tested in the 1930s and early 1940s were found, but references in the Teagarten history to increased use of lime and fertilizer during this period suggest continued strong growth of the soil testing program.

County Soil Test Lab System

The first county soil test laboratory was established in Cowley County in 1947 by the Cowley Agricultural Extension Council, with County Agent George Gerber in charge. Before the lab was established, a group of research and extension personnel traveled to the University of Missouri and University of Illinois to observe and to learn about lab operation and equipment from scientists in both states. C.W. (Woody) Woodruff at the University of Missouri was very enthusiastic about the Missouri system, which was structured on county soil test labs operated by county agents using a lime meter (pH) built by Woodruff for testing pH and lime needs and a colorimeter for testing for phosphorus (P), potassium (K), and organic matter.

R.V. Olson, Soil Chemist at K-State, worked with the Cowley County Agent and Extension Council to establish the first county lab, providing written instructions for operation and training on analytical test procedures. By 1949, soil testing labs also had been established in Brown, Bourbon, Labette, and Crawford counties. Each lab was equipped with a Woodruff lime meter and a Coleman Junior Spectrophotometer for a colorimeter. The county agent, in his respective county, supervised the operation of the county soil testing laboratory. All county agents were trained at Kansas State College in soil testing principles and techniques. In most instances, the county agents did not actually test soil samples. Ordinarily, they trained a soil testing technician who prepared the soil samples for analysis, analyzed the soil samples, and took care of records pertaining to each soil sample. The soil testing technician forwarded soil test results to the county agent, who wrote a lime and fertilizer recommendation (information supplied by Robert A. Bohannon).

Concurrent with the development of county soil test labs, a service for testing of public soil samples was established in the Department of Agronomy at Kansas State College to handle samples from counties without a lab. Olson, who was responsible for setting up the county lab procedures and development of test interpretations, most likely handled the initial on-campus testing. Scientists involved in soil test calibration and correlation research in this time frame included Olson, Harold Jones, and Floyd Smith. An early set of experiments conducted by Olson on calibration of the Bray P-1 test, with wheat yield response to phosphorus, showed an excellent relationship between Bray P-1 test and percentage of yield without added phosphorus for wheat. This 1950 relationship is still valid today.

Soil testing was promoted heavily by county agents, researchers, and extension specialists, with a peak of 60 labs in 1955 and more than 31,500 soil samples tested in 1953–1954.

County agents in several counties had special programs to promote soil testing. One example is taken from the 1962 Annual Report by Art Johnson, Jefferson County Agricultural Agent for the agricultural program in Jefferson County.

> *"The Crops and Soils Committee suggested that more emphasis be put on soil testing. The intensified Soil Fertility Program stressed soil testing as a key management tool. All fertility plots were based on soil test amounts of fertilizer versus no fertilizer and twice soil test recommended amounts. The plot results were used to demonstrate the soundness of the soil test recommendations under field conditions.*
>
> *The main publicity given to the Intensified Soil Fertility program was for the Soil Test Week held in November 1961. The week was set aside to focus attention on this important soil management tool.*
>
> *All of our county newspapers and area television, radio, and newspaper sources gave us a great amount of publicity. The Jefferson County Mirror-Times came out with a 40 page special edition to help promote soil testing week. A press conference held a month in advance of soil test week, November 17-31, gave news media people the opportunity to plan publicity well in advance. No county activity has had as much well planned publicity as did our Soil Test Week.*
>
> *A kick-off dinner of our various committees, fertilizer dealers, college personnel and other cooperators highlighted preparation for Soil Test Week. Our goal was to get at least 1,000 soil samples during the week. The result however was rain and a prolonged spell of very bad weather that made collection of samples impossible. The educational program did have lasting effects however. We exceeded all previous years soil sampling numbers as we tested over 800 samples. Most of these came in the spring after corn and milo were finally harvested. People were conscious of the need and desirability of soil testing. The agent has visited with many farmers about crop production and those not having recent soil test apologize for the lack of getting the job done. It also had an effect of starting at least 35 farmers sampling that had never had their soil tested before. We believe that is quite an accomplishment in one year."*

The number of county labs declined in the 1960s and 1970's because of several factors, including soil sample volume, county agent/county extension council interest, cost of equipment maintenance and replacement, and farmer demand for tests beyond the county soil test lab capabilities. Soil test analysis through commercial soil test labs also became available in the early 1960s, and many dealerships started using their services. The last county labs were in Cherokee, Montgomery, Jefferson, and Sedgwick counties, all closing in the late 1990s.

State Lab Development

The physical location of the State Soil Testing Laboratory in Manhattan has evolved from being a part of a research lab, using instrumentation in the lab, to a separate designed lab in Phase II of Throckmorton Plant Sciences Complex. No records were found for the location of the lab when a public soil testing service was initiated, but it undoubtedly was part of a research lab facility.

The Soil Testing Lab was located in the early 1950s in Waters Annex in a large open lab, in space shared with several research projects. With the completion of the new Department of Chemistry building, King Hall, in 1966, the lab was moved in the next year into space in Waters Annex (southwest corner) previously used as a teaching lab for introductory chemistry, with minor modifications. In the planning phase for a new plant science building in the early 1970s, a soil testing facility was included in the building plan. Because funding shortfalls required reducing the size of the designed complex, however, the soil testing lab was one of the items deleted. Space was identified within Phase I by the department head, because the lab support of research and teaching activities was considered essential. The lab moved into Throckmorton Phase I in 1981, into what originally had been designated research and greenhouse space. In the planning of Phase II of Throckmorton, a soil lab was designed into the building and, with completion of Phase II in 1994, the lab moved into facilities specifically designed for the operation.

A lab at the Garden City Experiment Station was added to the system in about 1950, offering the same tests as available through the county labs, plus irrigation suitability tests. This lab was set up in the basement of the Garden City Experiment Station office by Carl Carlson, soil scientist at the station, and subsequently was managed by L.V. Withee (1953) who followed Carlson at the station. George Herron succeeded Withee in 1956 (information from L.V. Withee and George Herron). The lab moved to the new research building on the station in 1968. Sample volume declined drastically in the early 1980s, and the lab closed as a public service lab.

Soil Testing Specialists

In 1953, Robert A. Bohannon was hired as the first Extension Specialist in Soil Testing. His appointment was half-time for Extension and half-time for the Agricultural Experiment Station. His responsibilities included training County Agents who had soil testing labs, and visiting the county laboratories at least once a year. In addition, he held regional and state training schools for County Agents to provide them with the latest information on soil testing, to train them in making fertilizer recommendations based on soil test results, and to keep them familiar with new information and technology in soil fertility. In 1955, he took leave to continue study for his doctorate at the University of Illinois. Glenn W. Hardy was hired in a temporary position during his study leave to continue support of the county lab program. In 1957, Bohannon returned to Manhattan and resumed his soil test responsibility. In June of 1962, George Wright was hired to replace Bohannon, who was asked to develop a program on unlimited opportunities through higher education. With Wright's departure to private industry in 1965, Roscoe Ellis, Jr., was interim manager until David Whitney was hired in September of 1966 to replace Wright. Whitney retired in January of 2001, and Ray E. Lamond, Extension Specialist Soil Management and Soil Fertility, was assigned the lab supervisory responsibilities. After the untimely death of Lamond, Dave Mengel assumed the supervisory responsibilities.

Laboratory Analytical Tests

An early mimeo from the State Soil Testing Lab advised producers of tests offered and how to determine which tests were needed. Tests available included a general soil fertility test (soil pH, lime requirement, available phosphorus, exchangeable potassium, and organic matter), salt-alkali test, advisability to irrigate test, and irrigation water quality test. Tests for other soil constituents also were available by special arrangement, and a minimum of 6 samples was required. This list of available analyses was maintained into the late 1950s to early 1960s. The soil test for advisability to irrigate was discontinued in the late 1950s as soil survey information became available and proved to be more accurate than the advisability to irrigate soil test on disturbed soil samples.

In the late 1950s and early 1960s, irrigation was expanding rapidly across the state. Most of this irrigation development was for flood/furrow irrigation systems, which require significant land leveling for efficient water flow. Areas within these leveled fields where topsoil was removed frequently were found to be deficient in zinc. Through the correlation work of Ellis and others, a soil test for zinc (0.2 N HCl extraction) was added in the early 1960s to the tests available through the labs in Manhattan and Garden City. Further research with zinc and iron by Ellis, Larry Murphy, George Herron, and Whitney led to the adoption of the DTPA extraction method for zinc and iron in 1972, replacing the HCl procedure. (For procedure see 1998 NC Regional Res Pub 221 (revised) Recommended Chemical Soil Test Procedures for the North Central Region.)

Nitrogen has long been recognized as the nutrient most likely to be deficient in Kansas for nonlegume crops. Organic matter measurement gives some estimate of potential nitrogen release from the soil, and was a part of the soil analysis package from the initiation of the testing program. The organic matter test has serious limitation because it does not measure legume effects on succeeding crops' nitrogen needs and does not measure residual available soil nitrogen (nitrate) from past fertilization/manuring. In 1970, a profile nitrogen soil test was added for which samples to a depth of two feet were recommended. The test analyzed for ammonium, plus nitrate concentration in a two-foot profile. Total pounds of available nitrogen was calculated, and the amount found was used to reduce standard nitrogen recommendations. In the mid-1980s, the profile nitrogen test analytical method was changed to determining only nitrate concentration. Researchers involved included Herron, Carlyle Thompson, Herb Sunderman, Murphy, Whitney, and Roy Gwinn.

In 1998, a test for chloride was added as a test available to the public, drawing on the research of Lamond and others. Sulfur research has been conducted for many years by several researchers, and a test for sulfate-sulfur also was added officially in 1998.

In addition to public service samples, the Soil Testing Lab in Manhattan in the early 1970s evolved into a service lab for research scientists in the Kansas Agricultural Experiment Station, for analysis of soil, plant, and water samples. Sample volume in the late 1990s was 25,000 soil samples, roughly half research and half public, and 15,000 plant samples from researchers.

Soil Test Recommendations

The Kansas Soil Testing service at its inception was structured to work closely with county agents in all aspects of the program (soil sampling, analysis, interpretation, and recommendation). Until the mid-1980s, all analytical results from the Manhattan lab were returned to farmers through county extension offices, with the county agent making the recommendations, as was the practice in the county labs. With the development of a computer recommendation program, and with county agent requests for results returned with recommendations, results are now returned with recommendations, but most public soil samples still continue to come through loca " extension offices.

Acknowledgements

This brief history of soil testing in Kansas would not be possible without the helpful input of many individuals, and I must especially thank several. When I first thought about doing this project in the late 1990s, our extension secretary, Cindy Harris, who had just completed a degree in history at K-State, was eager to pull together archived information. I thank Cindy for gathering much of the information on the early history. Next, I must recognize Robert A. Bohannon for his input and enthusiastic support. His reflections on the program through the late 1940s into the 1960s, both from the county and state perspective, were very helpful. Likewise, L. Van Withee was most helpful providing dates and personnel for the establishment and operation of the lab at Garden City, as well as his remembrances of soil testing events during his graduate study at K-State in the late 1940s. I also thank George Wright and George Herron for their reflections. Last I thank Troy Lynn Eckart for her secretarial input getting the history into manuscript form.

Additional Reading

Books

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Walters, J.D. 1909. *History of Kansas State Agricultural College*. 226 pp. KSAC Printing Dept.

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Ten Eyck, A.M. 1907. Agronomy at Kansas State Agricultural College. *The Industrialist.* 33(30):467–474. May 25, 1907.

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K-State Research and Extension

"Harvest of Knowledge," a set of four CD-ROMs contains many historic documents, plus some photos. Available from Kansas State University Department of Communications (Cost $26.80) or online <www.oznet.ksu.edu/library/cds/cdh.htm>.

KAES Annual Reports (1888–1920)/Biennial Reports (1922–1946 and 1988–date) are available online <www.oznet.ksu.edu/pr_histpubs/>. Those from 1948–1986 are available only in printed form at the AES Office or KSU Library. Several other AES historic publications are also available.

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Available from Agronomy Department or Other Sources

Kansas Fertilizer Conference Handbooks/Reports of Progress 1950–2006.

Paulsen, G.M. and C.A. Harris. 2002. Heads of Agronomy at Kansas State University. 1906–1998. Departmental Report, Kansas State University Agronomy Department.

Royal Purple K-State yearbooks. 1917–2006. K-State Student Publications, Inc.

Smith, F.W. 1981. Seventy-five Years of Agronomy at Kansas State University (1906–1981). 1981. 6 pp. Mimeo.

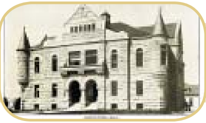
Wind Erosion: An International Symposium/Workshop Commemorating the 50th Anniversary of USDA-ARS Wind Erosion Research. Manhattan, Kansas. June 1997. CD-ROM.

Department of Agronomy Historical Timeline

1874-1889

E. M. Shelton conducted experiments with alfalfa, cowpeas, and tame grasses.

1906



Department of Agronomy established by action of the Board of Regents on July 17.

First AES Bulletin from the new Agronomy Department : The Study of Corn by V. M. Shoesmith

1909

The 320-acre Agronomy North farm was purchased, most of which is still used by the department.

1910

A. M. TenEyck, first Head of Agronomy, elected President of the American Society of Agronomy.

1916

Klod and Kernel Klub organized.

1917

Technical wheat breeding began with the hiring of John Parker, the first crop breeder in Agronomy.

1919

First inspection of a crop variety field, Kanred wheat, by the Kansas Crop Improvement Association.

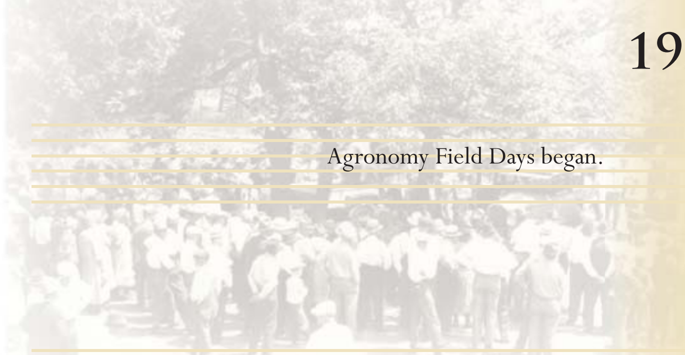
1923

The first Crops Judging Team competed in Chicago.

First Agronomy experiment field established at five locations in southeast Kansas.

1924-1928

Early Sumac, Kansas Orange, and Atlas sorgos released and certified.



1925

Agronomy Field Days began.

1931

Kansas State Agricultural College changed its name to Kansas State College of Agriculture and Applied Sciences.

1932

Tenmarq, the first K-State variety developed by hybridization was released.

1945

Soil Conservation curriculum created.

1947

First county soil testing lab opened (Cowley) to provide service to producers.

1951

Buffalo alfalfa released, providing resistance to bacterial wilt.

1951 - 1952

Ph.D. degree authorized in Agronomy (1951) and Soils (1952) by the Board of Regents.

1957

Fire severely damaged East Waters Hall.

Department of Agronomy Historical Timeline

1958 — Soils Judging Team began with O. W. Bidwell as coach.

1959 — Name changed to Kansas State University.

1963 — Extension Agronomy faculty relocated from Umberger to Waters Hall.

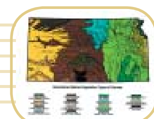
1964 — Kansas Water Resources Research Institute established.

Student club name changed to Wheat State Agronomy Club.

1968 — Evapotranspiration Laboratory established.

1977 — 'Newton' wheat, developed by E. G. Heyne, the first public semi-dwarf cultivar released in Kansas.

1978 — " Kansas Rangelands: Their Management Based on a Half-Century of Research" published



1981 — First Weeds team competed at the inaugural NCWSS contest, coached by L. Moshier.

Dedication of Throckmorton Hall Phase I.

1982 — Agronomy Newsletter initiated with O. W. Bidwell as Editor.

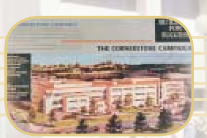
Roscoe Ellis, Jr., and Elmer Heyne lectureships established.

1989 — Rannells Flint Hills Prairie research site established.

1990 —

Harney silt loam designated as the state soil of Kansas.

1991 — Kling L. Anderson Lectureship established.



1994 — Phase II of Throckmorton Plant Sciences Center opened.

1998 — Betty and Heyne, first public hard white wheat varieties released.

2001 — Multi-state Consortium for Agricultural and Soils Mitigation of Greenhouse Gases established.

Sorghum Improvement Center established.

2003 — "Learning Farm" established at the Agronomy North Farm.

Kansas State University Agricultural Experiment Station and Cooperative Extension Service, Manhattan 66506

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