Grazinglands Research Laboratory

A Historical Perspective

October, 2008

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Preface

The Grazinglands Research Laboratory, located in the Great Plains, has a long and colorful history. In spite of a variable and often harsh climate, supported rich prairie ecosystems and vast buffalo herds that provided basic food, clothing, and shelter needs of the indigenous people. In the late 1860's the Cheyenne and Arapaho tribes were resettled by the U.S. Government into the Indian Territories of Oklahoma. In 1874, a military camp was established near the Government's Cheyenne-Arapaho Agency at Darlington, and Fort Reno's first buildings were constructed in 1876. In 1908, a Remount Depot was established to breed and train horses and mules for the U.S. Military and our allies. The Fort Reno Visitors' Center, operated by Historical Fort Reno, Inc. under agreement with the USDA, provides information and interpretation about the military era of our history to thousands of visitors each year.

In 1948, the Fort Reno property was transferred from the U.S. Army to USDA by Congress to support agricultural research. For the first half of our research history, Oklahoma State University provided substantial leadership to the animal science, forages, and grazing research under a Memorandum of Understanding with USDA. In 1970, the Agricultural Research Service established in-house research programs and over time the mission has broadened to include climate, water, and bioenergy research, along with livestock, forage, and grazing systems.

In celebration of sixty years of agricultural research at this Laboratory, we asked Mr. James B. Snow, USDA, Special Counsel for Real Property, Dr. William A. Phillips, Research Animal Scientist; and Dr. Jurgen D. Garbrecht, Research Hydraulic Engineer, to prepare this history. We thank them for their diligence in undertaking that task. We hope that our employees, supporters, and visitors will enjoy this fascinating and informative account for many years to come.

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Laboratory Director

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James B. Snow

The present Grazinglands Research Laboratory of the Department of Agriculture has its roots in the historical settlement and development of the American west, particularly its military establishments and in its relationships with Native American Tribes. Today, we can still see vestiges of that history in the historic Fort Reno site and the cemetery, and controversy continues over the interpretation of the history.

The United States acquired sovereignty over what is now Oklahoma through the Louisiana Purchase. By the Treaty with France in April, 1803, the United States acquired for $15 million more than 800,000 square miles of land extending from the Mississippi River to the Rocky Mountains. As a result, what is now the Grazinglands Research Laboratory became part of the public domain of the United States subject to disposition at the will of Congress. In subsequent decades after acquisition, the land would be inextricably linked with the policies of the U.S. Government toward Native Americans and the establishment of Indian reservations, primarily the Cheyenne-Arapaho.

Oklahoma was part of the so-called Indian country in the first half of the 19^{th} Century to which many Texan, eastern and northern tribes were relocated in some of the more tragic episodes of American history. Among them, the Cheyenne-Arapaho Tribes were relocated to Oklahoma from their traditional homelands in the northern plains through treaties with the United States. A treaty in 1867 defined the reservation in Oklahoma north of the Cimarron River, although actual settlement was made further south. Subsequently, a Presidential executive order in 1869 conformed the boundaries of the reservation to the territory actually being occupied by the Tribes comprising approximately 5.1 million acres. The Government's Cheyenne-Arapaho Agency was established at Darlington, and the role of the military was in part to protect and support the Agency.

After an outbreak of hostilities known as the Red River War in 1874, the land within the reservation near present day Fort Reno was occupied as a military camp for the primary purpose of protecting the Cheyenne and Arapaho Agency. In 1875, the site for the military post was chosen and the area was designated as Fort Reno in honor of Major General Jesse Reno who had been killed in the Civil War battle of Antietam. The first buildings were erected in the spring of 1876 and the Fort became a small city complete with quarters, stables, commissary and other structures necessary to support the cavalry. Noted historian Stan Hoig (Hoig, 2000) described some of the early activities at Fort Reno:

> In addition to their ultimate goal of engaging in battle, troopers at Fort Reno tended stock, provided escort details, search for strayed horses, investigated mishaps and troubles on the trail, constructed buildings at the Fort, cut timber for poles, made bricks, found prairie fires, and, on occasion, accompanied the Cheyennes and Arapahos on their buffalo hunts.

During the late 1870s and early 1880s, the Fort became more involved in quelling disputes between whites and Indians in the increasingly conflicted Indian territory. Intertribal disputes were also a problem. The relocation to Oklahoma of Northern Cheyenne to join their cousins the Southern Cheyenne created much discontent ultimately leading to the departure of the former and intervention by the cavalry at Fort Reno.

On July 17, 1883, Fort Reno was officially established as a military reservation when President Chester A. Arthur withdrew an area of 9,493 acres from the reservation for the establishment of the Fort Reno. The 1880s were Fort Reno's best years as a military post. The facility boasted tree lined parade grounds, comfortable officer residences, warehouses, barracks and administrative buildings. It was during this time that the job of the Fort turned primarily from keeping peace among disparate Indian groups to combating the illegal invasion of land hungry white settlers into areas of Oklahoma territory which were unclaimed by any Indian tribe. These white settlers, known as "boomers", made periodic invasions of the area only to be intercepted and removed by the cavalry. Ultimately, these lands were opened to settlement in the famous land runs, and the Army was called upon to prevent fraud by "sooners" and claim jumpers.

During the 1890s the role of the military at Fort Reno shifted more to keeping the peace among quarreling Indian tribes such as the intense internal strife among the Choctaw Nation in 1892. In 1898, most of the troops garrisoned at Fort Reno were called to serve in the Spanish-American War and the Fort provided training facilities for new volunteers. Subsequently, Fort Reno continued to provide for training until 1907 when, in November of 1907, the War Department decided to consolidate western posts and in Oklahoma decided to close Fort Reno and retain Fort Sill. Fort Reno's days as an active military base ended on February 24, 1908, when soldiers of the 2nd Battalion of the 19th Infantry departed.

In May, 1908, Fort Reno entered a new phase of service to the nation when Congress established it as a Remount Depot where mules and horses were provided for use by the military. To accommodate the new role, the Fort and its pastures had to be fenced, a project that took two years to complete. Sixteen quarter section pastures were cordoned off and facilities were converted for livestock. Some of the barracks became stables. The major function of the remount station at that time was to break and train horses and mules. After World War I, an active breeding program was undertaken and a major side line activity was the training of the Army's highly accomplished polo team.

By 1930, Fort Reno had over a hundred buildings accommodating over 800 horses run by over a hundred military personnel and a cadre of thirty civilian employees. Of the 10,000 acres of land, about 1250 acres were under cultivation with corn and oats for use at the station, and the remainder was in pasture. The veterinary hospital at the site was considered one of the best of its kind in the Nation.

In 1930, the federal government permitted use of a thousand acres of Fort Reno property to the Justice Department for the construction of the United States Southwestern Reformatory. That land was subsequently permanently transferred to the Justice Department in 1937 by Public Law 75-103. In 1963, additional land was transferred by Public Land Order 3089 to the Justice Department for purposes of the operation of the Reformatory.

During World War II, Fort Reno continued to supply animals for the military but the need for horses was diminished by the mechanization of warfare, and most of the horses were sold in 1943. Thereafter, the main animal function was providing mules for pack animals which were still required for action in mountainous and remote regions. In March, 1943, the Fort took on a new military role as a prisoner-of-war camp. Several hundred German prisoners were quartered at Fort Reno where they performed agricultural and industrial work. The last prisoner was not released in May, 1946, but a few POWs who died in captivity are still buried in a special section of the Fort Reno cemetery.

After World War II, the military utility of the Remount Service of the U.S. Army at Fort Reno had ended and therein ensued a public debate about the future of the facility. In 1947, Congress debated a bill H.R. 3484 which would transfer the Fort to the Department of Agriculture. The report of the Congressional Committee deliberations indicated the context of the debate:

> The purpose of the bill is to insure the maintenance of a Nation-wide horse-breeding program by transferring certain records, property, and civilian personnel of the Remount Service of the Quartermaster Corps, War Department, to the Department of Agriculture. The military importance of the horse-breeding program has decreased in proportion to the decrease in the need for horses in modern military operations. As a consequence, the War Department does not feel that the continued expenditure of funds can be justified as a military necessity or that the War Department is an appropriate agency to carry on this program as a civil function. In view of these factors, the War Department has determined that it will terminate the horse-breeding program not later than June 30, 1947, unless some other agency or branch of the government assumes that activity. There is an increasing demand for light horses for use on farms and ranches and for recreational purposes. It is, therefore, desirable that there be a continuing program for the improvement of light horse breeds. [Senate Report 357, June 26, 1947].

The subsequent statute, Public Law 80–494, transferred all records and property of the Remount Service to the Department of Agriculture with the intent of conducting horse breeding at the site. The statute authorized the Secretary of Agriculture to administer the property "in such manner as he deems will best advance the livestock and agricultural interests of the United States, including the improvement in the breeding of horses suited to the needs of the United States..." 62 Stat. 197.

The Department of Agriculture's use of the lands for horse breeding was short-lived. In 1949, Congress failed to appropriate funds for this purpose, and the Department negotiated a Memorandum of Understanding with the Oklahoma Agricultural Experiment Station affiliated with the Oklahoma Agricultural and Mechanical College (now Oklahoma State University). The research programs then established dealt with cattle breeding and production, and improved agricultural practices in general.

The management of the former Fort Reno by the Department of Agriculture for the last 60 years has not been without some controversy between the United States Government and the Cheyenne Arapaho Tribes. Various treaties, executive actions, statutes, and settlements dating back to at least 1865 have resulted in varying legal interpretations over the status of the lands. To this day, many of those issues continue to be discussed and played out in the Congress and the Courts.

Today, the land comprising Fort Reno is managed by the Agricultural Research Service of the Department of Agriculture. The land is now devoted to agricultural science and its contributions to the public welfare. But even today, in the historic setting and among some of the old buildings, one can still sense a time and place when our nation was young, its conflicts violent, and the land seemingly endless. The land remains and under its serene beauty lies concealed a tumultuous history.

History of the USDA-ARS Watershed, Water Resources and Climate Research at Chickasha, Durant and El Reno, Oklahoma

Jurgen D. Garbrecht, Patrick J. Starks, and John D. Ross

Introduction

The watershed, water resources and climate research conducted by the Great Plains Agroclimate and Natural Resources Research Unit at the USDA, ARS Grazinglands Research Laboratory in El Reno, Oklahoma, is rooted in events reaching as far back as the Dust Bowl and the Great Depression. In the following narrative, the historical background and evolution of this research program is retraced, and significant contributions to society are highlighted. The narrative is in chronologic order and the sections are organized by research themes and major research program reorganizations.

Early Soil and Water Conservation Milestones Preceding ARS Watershed Research

In the 1920s, the need for a national program of soil conservation was persuasively argued by Hugh Hammond Bennett, a career scientist in the Bureau of Chemistry and Soil in the U.S. Department of Agriculture (USDA). These efforts were rewarded with the Buchanan Amendment in 1929 and the agricultural appropriation act for fiscal year 1930 which authorized the creation of ten soil erosion experiment stations to study the effects of various conservation practices such as contouring, strip cropping, terraces and crop rotations on soil erosion, soil tilth, and runoff.

In September 1933, New Deal funds for a soil conservation program led to the establishment of the Soil Erosion Service in the U.S. Department of the Interior. Bennett served as the director of this agency, and under his leadership, the new, but temporary, agency developed comprehensive conservation plans for farms in selected watershed demonstration projects. Two years later in 1935, Congress established a permanent agency for soil conservation, the Soil Conservation Service (SCS) in the USDA.

Congress established a national flood control policy in the Flood Control Act of 1936. The 1936 act authorized USDA to investigate watersheds and measures for runoff and water flow retardation and prevention of soil erosion, and to submit plans to Congress. With regard to the Washita River Basin, Oklahoma, conservation work on watersheds along the Washita River began in 1936 with demonstration projects on soil-erosion control practices implemented by the Civilian Conservation Corps. Erosion control practices included terracing, drop-structures, farm ponds, gully plugging on eroded stream channels, scrub timber removal, and land use planning. However, it was the long history of flooding and associated land erosion along the Washita River that drew attention to this area of Oklahoma.

In the Flood Control Act of 1944 (Public Law 78-534), Congress authorized Corps of Engineers water development programs, as well as eleven watershed projects for runoff and erosion control submitted by USDA and henceforth under the authority of the Secretary of

Agriculture. Among the eleven authorized watershed projects was the Washita River project. Under the umbrella of this conservation program, SCS constructed flood retarding structures on tributaries of the Washita River. Plans called for 1150 flood retarding structures in the Washita River Basin. Although, Congress authorized SCS to build these structures in the eleven watershed projects, the approval of additional projects by Congress seemed unsuccessful.

The Watershed Protection and Flood Prevention Act of 1954 (Public Law 83-566) resolved this project approval predicament and established a new procedure under which projects would be investigated and approved. The Watershed Protection and Flood Prevention Act of 1954 (Public Law 83-566) broadened flood abatement activities initiated under the Flood Control Act of 1944. Conservation projects included watershed protection, flood prevention, and agricultural and non-agricultural water management. Under this Act, the SCS provided planning assistance and construction funding for flood control projects that were restricted to watersheds of 250,000 acres or less, and to structures of 25,000 acre-feet total capacity or less. Structures consisted primarily of earthen dams with an auxiliary spillway designed to reduce downstream flooding and channel erosion.

In September 1959 a report was presented to the United States Congress titled "Facility Needs – Soil and Water Conservation Research", popularly referred to as Senate Document 59. This document recommended establishing a national network of experimental watersheds, representing the major physiographic areas of the country, including the Southern Great Plains. In 1961, the Southern Great Plains Research Watersheds on a central portion of the Washita River Basin in Oklahoma was established. The central portion of the Washita River Basin was chosen because the SCS had already started construction of flood prevention structures and a large number had been completed on both the upper and lower reaches of the Washita River. The mission of the USDA-ARS Southern Great Plains Watershed Research Center was to study the effectiveness of erosion control, flood abatement and watershed protection programs initiated under the Flood Control Act of 1944.

Flood Abatement Research on the Southern Great Plains Research Watersheds at the Southern Great Plains Watershed Research Center, Chickasha, Oklahoma 1961-1978

In 1957, ARS established a soil and water research unit at Chickasha, Oklahoma, to study the effects of inundation on the tolerance, survival, and growth of grasses. In accordance with Senate Document 59, watershed research was initiated in 1960 on the central portion of the Washita River Basin, and in 1961, the Southern Great Plains Watershed Research Center was established with headquarters in Chickasha, Oklahoma. The mission of the Center was to assess the overall effects of the USDA-SCS flood control and watershed protection programs on erosion and flooding in the Washita River Basin for the purpose of improving similar programs in the future. Research was conducted on the Southern Great Plains Research Watershed (SGPRW), which was also established in 1961. The SGPRW consisted of 13 adjacent tributary watersheds to the Washita River covering a total of 1130 square miles. The 13 adjacent watersheds were alternatively referred to as Washita River reach watersheds, or study reach watersheds. Starting in 1961, the study reach watersheds were instrumented to measure rainfall, runoff and sediment transport. Installation of floodwater-retarding structures by the SCS on the SGPRW began in 1958 with the construction of Lake Chickasha. One hundred thirty eight flood-retarding structures were completed on the SGPRW by January 1979 controlling a little over 30% of the total drainage area.

The early research program at the Center focused primarily on watershed instrumentation and collection and analysis of field data on rainfall, runoff, sediment, soil-moisture and land use. These data were collected on sub-watersheds in the SGPRW, small unit source sites, and at river stream gauging stations on the Washita River, with the goal to determine the effectiveness of the SCS flood control and erosion prevention programs. In addition, data records of rainfall and runoff were available for other tributaries to the Washita River that were already outfitted with SCS flood retarding structures. These existing data were used for preliminary analyses of the effects of the flood retarding structures on the flow regimen along the main stem of the Washita River.

Instrumentation of the SGPRW

Starting in May 1961, daily precipitation data over the SPGRW was collected by a basic network of 168 rain gauges that were arranged on a 3 by 3 mile grid. Additional rain gauges were added over time on smaller subwatersheds until a maximum of 230 gauges were in operation in 1972. Air temperature, pan evaporation, wind speed and humidity data were measured at two climate stations. The objectives of the precipitation network were to quantify precipitation characteristics and support the evaluation of the impact of the flood-retarding structures on runoff and stream flow.

Continuous stream flow and sediment data were collected at 16 stream gauging stations located on the 13 tributary watersheds of the Washita River in the Study Reach, and at 6 stations on the Washita River itself. All gauging stations were operated by ARS. On several channels, cross sections were surveyed and compared to previous cross sections made by the SCS to determine possible channel instability impacts of the conservation treatment program. In addition, 22 small unit-source watersheds were installed and operated between 1965 and 1978 to estimate runoff and erosion from small, single land-use areas, and 88 groundwater observation wells were installed to monitor groundwater levels. Unit source areas included 10 rangeland areas, 8 cropland areas, and 4 timber areas.

Research and Selected Findings

The analyses of already existing hydrologic data from tributaries of the Washita River led to a comprehensive model of hydrologic responses due to construction of floodwater retarding structures. The model for tributary responses was based on data from six gauged Washita River tributaries. These six tributary watersheds had a wide range of physical and hydrologic differences from both upstream and downstream reaches of the Washita. The model estimated runoff from rainfall on all of the tributaries of the Washita River and routed the flow through structures. Results of the study quantified the reduction of peak flows in terms of size and frequency of peak flows, as well as location on the Washita River.

The research regarding flood abatement and conservation impacts on the Study Reach followed soon after data collection by ARS was initiated. Major results included the identification of changes in watershed runoff characteristics and reduction in sediment yield as a result of flood retarding structures. Runoff volume was not appreciably affected by the flood retarding structures. But peak flow rates and overbank floods were reduced, middle and low flow rates were increased, and hydrograph recession was lengthened. Recession flow increased with increase in the number of upstream flood retarding reservoirs. Sediment yield was sharply reduced immediately below flood retarding reservoirs in the tributary watersheds, but no corresponding evidence of sediment yield reduction was found downstream on the Washita River. It was recognized that there are multiple factors affecting sediment load in a stream, such as sediment delivery, bank instability, channel degradation, etc., and these factors tend to obscure the effect of upstream conservation treatment, and that a longer period of measurements was needed to separate the effects of multiple factors on stream sediment load. Starting in 1970, attention was also given to water quality issues. Examples include increased salinity in impoundments and in seepage flow below earthen dams; flow paths of agricultural chemicals in watersheds; and, nutrient and sediment yields from agricultural watersheds. Based on this research, the Agricultural Chemical Transport Model, ACTMO, was developed. It was one of the first ARS watershed-scale water quality models. Also, data from the rain gauge network supported research on stochastic weather generation methods and led to the development of the weather generator CLIGEN.

The first remotely sensed data gathered in the Chickasha area were collected by NASA aircraft in September 1969. These microwave radiometer data were shown to be correlated with soil moisture and helped estimate selected hydrologic parameters over watershed sized areas. Remote sensing studies were also conducted in years 1972-1974 to identify differences in watershed runoff using multi-spectral scanner (MSS) data from satellites. This research demonstrated that under dry land surface conditions satellite data can be related to the watershed runoff coefficient used in NRCS storm-runoff equations, and could improve estimates of the NRCS curve number. Infrared imagery was also investigated for potential identification of pollutants in surface impoundments, but suspended sediments dominated the reflectance signal. In 1978 a series of remote sensing experiments were designed to acquire data for analysis of relationships between remote sensed data and hydrologic variables. Remotely sensed data consisted of thermal infrared, passive microwave, and active microwave systems. The experiment was successful, though a wider range of soil moisture conditions was needed to confirm and validate the relationships.

Staff and Research Facilities

Seven scientists and thirteen support staff worked at the Southern Great Plains Watershed Research Center in 1961. Location directors/leaders were Monroe A. Hartman (1960-1968), Donn G. DeCoursey (1968-1974), Edd D. Rhoades (1974-1975, interim location leader), and Maurice H. Frere (1975-1980). From 1960 to 1962, scientists and support staff resided in the Old Chickasha Daily Express Newspaper building in Chickasha, and thereafter moved into the 2nd and 3rd floor of the Federal Building, also in downtown Chickasha. In 1962, a Quonset was assembled on the grounds of the Oklahoma State University (OSU) Cotton Research Station, a mile east of Chickasha, and served as storage and a maintenance shop facility. In 1965, a large Butler metal building was added on the south side of the Quonset and served as a laboratory for sediment and water quality analysis.

In 1975, eight unit source watersheds were built at the USDA-ARS Grazinglands Research Station located west of El Reno, Oklahoma. These watersheds are 4 acres in size and are currently referred to as Water Runoff and Erosion (WRE) watersheds. The watersheds were divided into two groups and managed differently to simulate a variety of agricultural and grazing practices. Rainfall, water runoff and sediment were collected at the drainage outlet of each watershed. The purpose of the watersheds was to assess productivity and soil losses that occur when warm season grasslands are converted to annual winter wheat.

Water Quality Research on Little Washita River Experimental Watershed at the Southern Plains Watershed and Water Quality Laboratory, Durant, Oklahoma 1978-1985

In the 1970s, several pieces of legislation were passed that supported conservation, protection and enhancement of the Nation's soil, water, and related resources. Most notably were amendments to the Clean Water Act in 1977, especially with regard to non-point pollution sources, and the passage of the Soil and Water Resources Conservation Act of 1977 providing for continued appraisal of the quantity and quality of soil and water resources. In the mid 1970s, position ceilings and limited funding at the Southern Great Plains Watershed Research Center at Chickasha became an operational concern. Similar concerns afflicted the US Agricultural Water Quality Management Laboratory in Durant, Oklahoma. In 1978, both research locations were merged to form the Southern Plains Watershed and Water Quality Laboratory, with headquarters in Durant and a field office in Chickasha. The research programs were integrated and aligned to address challenges put forth by the soil and water conservation legislations of the time. The new mission was to evaluate the impact of agricultural practices and management systems on the quality of water from agricultural watersheds with the goal of developing information to help protect and manage the quality of the Nation's water resources. Objectives were addressed by conducting multi-disciplinary research involving hydrology, erosion and sedimentation, chemical transformations and transport, aquatic ecosystems, and associated water quality issues.

Research Watershed and Instrumentation

As a result of the realignment of the research program and new mission statement, the data collection on SGPRW was for the most part discontinued in 1978, and only the Little Washita River Experimental Watershed (LWREW) was retained for watershed research activities. The LWREW was selected as one of seven areas in the United States for the Model Implementation Project, which was jointly sponsored by the USDA and the Environmental Protection Agency (EPA). The main objective of the MIP was to demonstrate the effects of intensive land conservation treatments and control of non-point sources of pollution on water quality using Best Management Practices (BMPs) in watersheds that were larger than about 25 square miles.

During the MIP investigation period, the rain-gauge network in the LWREW consisted of 36 rain gauges of which one was co-located at a climate station that measured air temperature, pan evaporation, wind speed and humidity. Stream flow, suspended sediment, sediment size distribution and water quality parameters were measured at two stream gauging stations, and 24 groundwater observation wells were operated to monitor water quality and groundwater levels.

Also, 11 unit source area watersheds were instrumented to quantify runoff and water quality of small intermittent flows that discharged into the Little Washita River. The MIP study was completed in 1985.

Research and Selected Findings

The effects of non-point source land conservation practices (conservation tillage and eroding gully treatment, flood and sediment control impoundments) on water quality were demonstrated for unit source areas and small subwatersheds. Research showed that while these conservation practices dramatically reduced sediment and phosphorous losses from upland areas and small subwatersheds, their effectiveness at reducing watershed-scale sediment and phosphorous transport depends to a large extent on their level of coverage and placement in the watershed. Unit source and subwatershed-scale response to BMPs were not being translated into significant reductions in nutrient exports from the LWREW. This was at first perceived to be a failure of the BMPs and to a lesser degree the MIP. However, the insights and findings of this research eventually became the cornerstone of current watershed management planning and remediation both nationally and internationally. First, while there is a minimum level of BMP coverage needed within a watershed to control soil erosion and nutrient movement, broadly applied BMPs over a large area will not affect a significant reduction in sediment and nutrient export unless high sources of sediment and nutrient export are targeted for specific remediation. Based on these insights, many research findings have been transferred into successful field tools that identify major hydrologic, chemical and land management factors controlling critical sources of sediment and nutrient export within watersheds. Second, there is a time-lag between BMP implementation and measured reductions in sediment and nutrient exports. Large amounts of nutrients are stored in the soil and sediments of the fluvial system. These are released slowly, even if all upland erosion and nutrients inputs were stopped. These are important considerations when assessing effectiveness of BMPs and budgeting for long-term observations. These findings highlight a major accomplishment of the ARS Watershed Program during this time period and under the MIP.

Also during this period, the first research findings based on the WRE watersheds at El Reno were published. Research pertained mostly to nutrient runoff and effects of tillage and cropping on soil properties. Much of this research lead to the conclusion that under proper management, the likelihood of any adverse environmental effects due to nutrient and sediment discharge from Southern Plains grasslands appeared slight. This research led to the development of nutrient model components that were eventually incorporated into the widely recognized field scale models EPIC (Erosion-Productivity Impact Calculator) and SWAT (Soil and Water Assessment Tool).

Though not directly related to watershed research in this time period, remote sensing techniques were developed to characterize the water quality of lakes and ponds from aircraft and satellites. Concurrently lake models were developed that described water temperature, sediment concentration, and light distributions in turbid lakes. The Durant laboratory was among the first to use remote sensing as a tool to study the impacts of agriculture on the water quality of impoundments in agricultural watersheds.

Staff and Facilities

Major organizational, staffing and facility changes occurred during the 1978-1985 period. First and foremost, the Southern Great Plains Watershed Research Center at Chickasha merged in 1978 with the US Agricultural Water Quality Management Laboratory in Durant, Oklahoma.

The US Agricultural Water Quality Management Laboratory, referred to as the Durant laboratory, was built in 1969 under the supervision of Ed D. Rhoades and dedicated in June 1970. Financial support for the establishment of the Durant laboratory was secured by Congressman and Speaker of the US House of Representatives, Carl Albert, who attended the dedication ceremony of the laboratory. In 1971, Dr. R. J. Menzel was appointed as the first director of the laboratory. He retained this leadership function until 1980, at which time Dr. R. J. McHenry assumed the post. The mission of the Durant laboratory prior to the 1978 merger was to develop basic information for predicting the effects of agricultural practices on water quality and maintaining desirable water quality for agricultural and other uses. Research was conducted on: the movement of nutrients, pesticides and other agricultural chemicals; the effects of soil and water conservation on water quality in agricultural watersheds; and, the management of water quality in ponds, waterways, and ground water. At the time of the merger of the Durant and Chickasha laboratories in 1978, the Durant laboratory name was changed to “Southern Plains Watershed and Water Quality Laboratory”, and two research units were formed: the Water Quality Research Unit under the leadership of Dr. R. G. Menzel, and the Watershed Research Unit under the leadership of Dr. M. H. Frere.

In 1982, the name of the Durant laboratory was changed to “Water Quality and Watershed Research Laboratory” and four research units were created: the Aquatic Ecosystems; the Chemical Transformation and Transport; the Erosional Processes; and the Water Resources Research Units. Research leaders for these research units were Dr. R. G. Menzel, Dr. S. J. Smith, Dr. F. R. Schiebe, and Dr. A. D. Nicks, respectively. One year later, in 1983, Dr. F. R. Schiebe became laboratory director and held that position until 1996.

Another research program reorganization occurred in 1985 in response to a Headquarter directive that research units should consist of about 10 scientists. Hence, the four existing research units were collapsed into two: The Water Quality and the Soil and Watershed Research Units, with research leaders Dr. S. J. Smith and Dr. J. C. Lance, respectively. This organizational structure remained in place until 1996.

Between 1978 and 1985, research scientists and administrative staff that resided at the Federal Building in Chickasha were gradually integrated with the staff at the Durant laboratory and the 3rd floor of the Federal Building was vacated by ARS. In 1985, the ARS laboratory building at the OSU Cotton Research Station at Chickasha was extended on the west side and existing space on the south side was converted to office space. Then, in May 1986, all technical and field support personnel were moved from the Federal Building in Chickasha to these remodeled ARS offices at the OSU Cotton Research Station. From that date forward, all watershed research activities were managed and coordinated from the Durant laboratory.

Watershed and Water Quality Modeling Research at the Water Quality and Watershed Research Laboratory, Durant, Oklahoma 1985-1992

Years 1985 through 1992 were marked by a reorganization of the staffing structure and a reduction-in-force. Yet, the research program remained largely intact with few changes consisting mostly of project-level realignments to better reflect national research priorities. While water quality and hydrologic watershed data collection and evaluation continued, the proliferation of Geographic Information Systems (GIS) and powerful desktop computers spurred the interest in watershed-scale hydrologic models. This opportunity was seized and the available watershed and water quality data was utilized to develop and validate a number hydrologic and water quality model.

Research Watershed and Instrumentation

At the end of the MIP investigation in 1985, research activities shifted emphasis towards computer model development, and monitoring activities on the LWREW were scaled back, mostly due to limited resources and flat budgets. The number of rain-gauges in the network was reduced to 14, the two stream gauging stations on the Little Washita River were discontinued, and all groundwater monitoring ceased. All but two unit source area watersheds near the mouth of the LWREW were discontinued. These two active unit source area watersheds were used to monitor channel instability, gullies and their remediation, and were discontinued in 1989.

Research and Selected Findings

During years 1985-1992, water quality research expanded beyond the LWREW and its unit source areas to include other watersheds across Oklahoma and the Southern Great Plains. Soil erosion and nutrient transport research included a range of different soils and tillage operations, as well as resulting impacts on water quality in streams and downstream reservoirs. The main findings of this research were that under careful tillage management and use of fertilizer at recommended application rates, the risk of nutrient loss in runoff could be minimized. However, water quality tradeoffs were apparent with certain management shifts. For example, conversion of watersheds in conventionally tilled wheat to conservation or no-till wheat reduced runoff 33%, erosion 95%, and total P and N loss 85% in five years. Because of greater infiltration afforded by increased residue cover, nitrate leaching to shallow ground waters (~30 m) increased about 5 fold. Further, dissolved P runoff increased 3 fold due to the accumulation of unincorporated fertilizer on the soil surface and from decaying surface crop residues. Studies on Little Washita River subwatersheds showed that shaping eroding gullies decreased P loss 5 fold and construction of an impoundment decreased P loss from the sub-watersheds 13 fold. However, there was no consistent decrease in P concentration in streamflow at the outlet of the main Little Washita River watershed.

Concurrently to the above research, laboratory and plot experiments were conducted to define chemical pathways, validate new theories of chemical transfer from soil to runoff, and quantify interflow rates as a function of soil hydraulic conductivity, slope, and seepage. Related research quantified the influence of soil surface aggregates and macropores on the transport of surface-applied agricultural chemicals in soil and to surface and groundwater. Extensive research was also done on the WRE watersheds in El Reno on the spatial variability of soil properties and their impact on crop yield.

Hydrologic research on the LWREW changed from predominantly observational and experimental research to include mathematical model development and applications. In the late 1980s, the stochastic daily weather generator, CLIGEN, was developed to fill the need for long time series of weather data in hydrologic model applications. With regard to distributed model applications, investigations focused on quantifying runoff volume, peak flow rates, sediment yield, and water quality parameters. Most observed trends of hydrologic variables on the research watersheds could be reasonably well reproduced by simulation, and the hydrologic modeling approach was found to be well suited for assessing long term effects of major land treatment shifts and flood retarding structures on the hydrology and sediment yield of the LWREW. In the early 1990s, model applications included investigation of the impact of global climate change on watershed hydrology. Research was also conducted on the impact of observed climatic variations on watershed runoff hydrology and on the effectiveness of flood retarding structures to reduce peak flow rates. The later research demonstrated the important role that climatic variations and trends played in watershed hydrology and soil and water conservation. In the early 1990s, a computer program (TOPAZ) was developed that automatically determined a watershed drainage network from digital landscapes and extracted relevant network and topographic parameters needed for distributed hydrologic modeling.

Remote sensing of agriculturally-impacted water bodies begun in the previous time period was continued and expanded. Research focused on remote sensing of suspended sediments and turbidity of reservoirs and impoundments using Landsat Multi Spectral Scanner data; understanding the relationship between lake temperature, suspended sediments and satellite response to these water quality variables; satellite mapping of suspended sediments in reservoirs; and detecting and quantifying chlorophyll in the presence of sediments. Other remote sensing research included detection of offsite/downstream effects of erosion, deriving land surface information from Landsat and Goes satellites for use in water budget models, and the application of NEXRAD radar precipitation in hydrologic models.

Staff and Facilities

In February 1985, the agency issued a policy statement on ARS scientific leadership, role, and responsibilities that directed that all research units in ARS be composed of about 10 scientists. The Area Director, Dr. Johnston, proposed a new research program structure for the laboratory which combined the Water Resources Unit with the Erosion & Sedimentation Unit under the leadership of Dr. J. C. Lance, and the Chemical Transformation and Transport Unit with the Aquatic Ecosystem Unit under the leadership of Dr. S. J. Smith. In spring 1986, the laboratory staffing chart was reorganized with the administrative personnel grouped under the supervision of Dr. F. R. Schiebe, the Water Quality Research Unit under Dr. S. J. Smith, and the Soil and Water Resources Research Unit under J. W. Naney. In addition, two technician positions at the Chickasha field office were abolished, and one scientist (Dr. Arlin D. Nicks) and one scientist support position (Gene A. Gander) were transferred to the Durant laboratory. As a result, all scientists that were previously working at the Chickasha field office were now working out of the Durant laboratory. In 1988, Dr. J. D. Garbrecht joined the Soil and Water Research Unit. In 1990, J. W. Naney retired and Dr. F. R. Schiebe assumed the research leader position for the Soil and Water Resources Research Unit. In 1991, Dr. L. R. Ahuja was relocated to the ARS Great Plains Systems Research Unit in Fort Collins, Colorado. The same year, the Durant laboratory was renamed the National Agricultural Water Quality Laboratory.

Hydrologic Campaigns on the Little Washita River Experimental Watershed at the National Agricultural Water Quality Laboratory, Durant, Oklahoma 1992-1996

The 1992-1996 period was a time of great change and new opportunities for research on the LWREW. In the early 1990s, the ARS-Global Change, Water Resources and Agriculture program revitalized watershed research which led to major instrumentation upgrades on the LWREW. This new research emphasized global change issues and addressed the exchange of water and energy in managed ecosystems, and the effects of land cover and climate on land-surface hydrology. During this period, five multi-agency, multi-disciplinary, intensive field campaigns took place on the LWREW.

Watershed and Instrumentation

Re-instrumentation of the LWREW began in 1992 and expanded the existing 14 rain gauges to 42 climate stations known as the “Micronet”. These climate stations measured rainfall, air temperature, relative humidity, incoming solar radiation, and soil temperature at four depths. Operation, maintenance and data acquisition, quality control and archiving were contracted out to Oklahoma State University. In addition, three “Mesonet” systems were located on or near the LWREW. The “Oklahoma Mesonet” is a network of 119 climate stations located across the State of Oklahoma, with an average spacing of about 20 miles. These Mesonet stations included, in addition to the above mentioned variables for the Micronet station, wind speed, wind direction and barometric pressure. Starting in 1995, selected Micronet sites were complemented by a sophisticated instrumentation package that measured soil water content, soil temperature, and soil heat flux

In 1992, three stream gauging stations were installed along the main stem of the Little Washita River. Three more stations were added in 1995 on tributaries to the Little Washita River and a fourth one was added in 1996. Four of these stream gauging stations are nested with upstream drainage areas of 4, 13, 62, and 236 square miles. In 1993, 1995, and 1996, three reservoir-level gauging stations were added to the network to monitor the pool elevation of SCS flood retarding structures. The USGS installed and operated the stream gauges, including data acquisition, quality control and dissemination.

Research and Selected Findings

The wealth of historical data on the LWREW created watershed-scale research opportunities that attracted federal, state and private entities alike. Data from this dense observational network have been used by the National Weather Service and researchers from the University of Oklahoma to improve and verify NEXRAD radar algorithms for rainfall estimation, and by NOAA's River Forecast Center in Tulsa, Oklahoma, to refine flood prediction models. The historic LWREW data and ongoing observation capabilities also attracted numerous, inter-agency watershed-scale hydrologic experiments that enabled testing of new remote sensing systems and associated algorithms for surface soil moisture estimation over large land areas. Examples of inter-agency hydrologic experiments include STORM-FEST during which new radar technologies of the United States National Weather Service were tested, and Washita'92, '94, '95 and '96 during which remote sensing techniques for soil moisture were evaluated and new microwave remote sensing devices were tested. The Washita-series field campaigns were conducted in cooperation with the ARS Hydrology Laboratory in Beltsville, Maryland, NASA, and a number of US and foreign universities.

Remote sensing of water quality continued during this time period. Research established that remote sensing instruments could detect chlorophyll and algae in the presence of suspended sediments. Also, one of the first multi-season Landsat MSS land use studies was carried out in the LWREW and led to an improved land use determination, especially in agricultural settings. Due to the growing interest in remote sensing potential for water quality studies, research was conducted to verify manufactures' specifications of hyperspectral instruments. It was found that manufactures' specifications may be inadequate when these instruments are used to measure ground truth data for satellite studies of water quality, and precision laboratory calibration of the instrument is advisable for ground truthing applications.

Staff and facilities

The scientific staff experienced numerous changes in the early 1990s. In 1992, Dr. J. A. Daniel joined the Water Quality Research Unit as a geologist. The same year Dr. P. J. Starks joined the Research Unit as a Postdoctoral Research Associate. In November 1993, G. C. Heathman transferred from the Durant laboratory to the Chickasha field office to assume the supervisory duties left vacant by the imminent retirement of G. A. Coleman. In early 1995, Dr. C. T. MacKown, Plant Physiologist, accepted a reassignment to Durant following the 1994 closure of the USDA-ARS Forage and Tobacco Research Laboratory in Lexington, Kentucky. In 1995, Drs. S. J. Smith and A. N. Sharpley retired and moved, respectively. In the Water Resources Research Unit, Dr. A. D. Nicks and Dr. F. R. Schiebe retired early in 1996.

Climate and Watershed Research on the Little Washita River Watershed at the Grazinglands Research Laboratory, El Reno, Oklahoma 1996-2004

Retirements and relocations in the early and mid 1990s, financial stagnation, and key vacant positions led to the 1996 merger of the ARS National Agricultural Water Quality Laboratory in Durant and the Grazinglands Research Laboratory in El Reno, Oklahoma, with new headquarters in El Reno. In March 1998, a program planning meeting was held in El Reno and led to the establishment of two Research Units: the Great Plains Agroclimate and Natural Resources Research Unit (informally referred to as the Climate and Watershed Unit), and the Forage and Livestock Production Research Unit. For the remainder of this report, only the research, events, and staffing issues relating to the Climate and Watershed Unit are reported upon. The mission of the Climate and Watershed Unit was to develop planning and management strategies based on climate projections, soil water utilization, and natural resources conservation to increase productivity, reduce risk, and ensure sustainability of water resources and forage-livestock systems.

Watershed and Instrumentation

Operation of the network of 42 climate stations that was established on the LWREW in 1992 was continued through 2004. Additional instruments that measured soil water content, soil temperature, and soil heat flux were installed at selected climate stations with 12 being operational in 2004. The stream gauging network that was in place in 1996 was also maintained through 2004.

Watershed Research

Three watershed- and regional-scale hydrologic and remote sensing field campaigns were conducted on the LWREW. The two Southern Great Plains experiments (SGP97, SGP99) and the Soil Moisture Experiment (SMEX03) aimed to establish whether or not retrieval algorithms for surface soil moisture developed from high spatial resolution truck- and aircraft-based sensors could be extended to coarser resolutions expected from future satellite platforms. Data collected on the LWREW have contributed to: (1) validating land-vegetation-atmosphere moisture-transfer models; (2) developing a simplified soil hydrology model to simulate soil water content in the soil profile; and (3) verifying soil moisture estimating radar sensors aboard a NASA satellite.

Climate Research

Seasonal climate forecasts by NOAA's Climate Prediction Center (NOAA/CPC) presented opportunities to develop climate-related risk information and decision support for water resources and agricultural management. Techniques were developed to assess the utility of the NOAA/CPC forecasts from an application point of view, and applied across the contiguous U.S. Results showed a wide variability in the utility of seasonal precipitation forecasts with region, with the best results in regions well-known to experience strong ENSO related variations in seasonal precipitation. On the other hand, the seasonal forecasts for higher than average temperature did have utility for most of the U.S., with the exception of the Northeast. A separate climate variability investigation quantified the magnitude and extent of multiyear precipitation variations in the Great Plains and their impacts on watershed runoff. These multiyear precipitation variations were found to be significantly larger than the NOAA/CPC forecast variations, and present potential opportunities for applications in water resources and agricultural management.

Staff and Facilities

In 1996, all leadership positions at the Durant laboratory were vacant and the budget was flat with little hope of improving. As a result of these dire conditions the Durant laboratory was merged with the Grazinglands Research Laboratories in El Reno, Oklahoma, which was beset by similar staffing and funding problems. All scientists and many of the support staff from the Durant laboratory were relocated to El Reno. Dr. J. E. Quisenberry was appointed director of the merged laboratories, and his first duties were to plan and oversee the renovation of the main building of the Grazinglands Research Laboratory, which was built in 1937 and originally served as barracks and then as hospital for the U.S. Army. From fall 1997 through winter 1998, during the renovation, scientists and technicians from the Durant Soil and Water Resources Research Unit conducted research from offices on Rock Island Street in downtown El Reno. In 1998, after the completion of the renovation, a Research Planning Workshop was held in March, and two research units were created: the Forage and Livestock Production Research Unit and the Great Plains Agroclimate and Natural Resources Research Unit. The later included two research projects: one addressing climate variability and risk management, and the other addressing integrated effects of climate, land use and management on water quantity and quality in large agricultural watersheds. In 1999, Dr. H. S. Mayeux assumed the position of laboratory director, and in 2001 Dr. J. L. Steiner became research leader of the Climate and Watershed Unit. The scientific staff of the Climate and Watershed Unit was augmented in 1999 by a research meteorologist, Dr. J. M. Schneider and in 2000 by two research hydrologists, Dr. J. X. Zhang and Dr. M. A. Van Liew. Furthermore, G. C. Heathman, supervisor of the staff at the Chickasha field office, was transferred in 2000 to the Grazinglands Research Laboratory in El Reno, and the watershed management and research activities were directed out of the El Reno laboratory. The remainder of the three technician positions and staff at the Chickasha field office were transferred to El Reno a year later. In 2004, G. C. Heathman accepted a soil scientist position at the ARS National Soil Erosion Research Laboratory in West Lafayette, Indiana.

Climate and Conservation Research on the Little Washita River and Fort Cobb Watersheds at the Grazinglands Research Laboratory, El Reno, Oklahoma 2004-2007

a) Little Washita River Experimental Watershed, 2004-2007

In 2003, the Conservation Effects Assessment Project (CEAP) was initiated by the Natural Resources Conservation Service (NRCS) and ARS in response to a mandate in the 2002 Farm Bill to educate, monitor, and assess conservation programs. CEAP was designed to quantify environmental benefits of conservation practices implemented on agricultural lands. The Watershed Assessment Study component of the project has the objective to provide a more detailed conservation assessment on selected benchmark watersheds and develop a framework for evaluating and improving the performance of the national assessment models. To address this new research focus, resources of the Climate and Watershed Unit were redirected to the nearby Fort Cobb Reservoir Experimental Watershed (FCREW). As a result of this programmatic realignment, research and monitoring on the LWREW was reduced, but was expected to pick up again with the anticipated implementation of the grazing lands component of CEAP.

Watershed and Instrumentation

In support of the CEAP effort, 15 climate stations were relocated from the LWREW to the FCREW (see next section). In addition, five climate stations, two reservoir-pool elevation gauges and three stream gauging stations were discontinued on the LWREW, leaving 22 climate stations, one reservoir-pool elevation gauge, and 4 stream gauging stations. The 22 climate stations were retrofitted with new soil moisture sensors that replaced the old SHAWM instruments. The new sensors allowed better measurement of volumetric water content in sandy textured soils which cover large portions of the watershed. These monitoring capabilities on the LWREW were deemed sufficient to support ongoing water resources research involving hydrologic modeling, as well as anticipated water quality research needs associated with the planned extension of CEAP efforts to grazing lands watersheds.

Watershed Research

In 2003-2005, several hydrologic model applications were conducted on the LWREW to test the calibration and performance of the watershed model called "Soil And Water Assessment Tool" (SWAT), which was selected for the CEAP assessment studies. The model adequately simulated watershed hydrology for climatic and physiographic conditions in the LWREW and was deemed suitable to address CEAP objectives in the Upper Washita River Basin. Simulation of streamflow on the LWREW demonstrated that the numerous flood retarding structures that were installed on the watershed in the 1960s through the 1980s reduced annual peak flows substantially.

b) Fort Cobb Reservoir Experimental Watershed, 2004-2007

The Conservation Effects Assessment Project (CEAP) led to the establishment of the FCREW in 2004 and enabled research on cropland watersheds and assessment of impacts of conservation measures on water quality at the watershed scale. The FCREW had been identified by the Oklahoma Water Resources Board, the Oklahoma Conservation Commission, and the Oklahoma NRCS as a focal point to apply conservation practices to land in the watershed in order to improve water quality in the reservoir. The Fort Cobb Reservoir and watershed have been the focus of monitoring and assessments for a number of years, providing a baseline of data against which future environmental conditions can be assessed. The objective of ARS' Fort Cobb CEAP study was to assess the effects and benefits of selected conservation practices as they relate to reduction of inputs of suspended sediments to surface water, and the reduction of phosphorus and nitrogen in surface and ground water.

Watershed and Instrumentation

Daily weather on the FCREW has been monitored extensively. Beginning in 1994, the Oklahoma Climatological Service operated three Mesonet climate stations in the vicinity of the watershed. The National Weather Service maintained four Cooperative Weather Stations at the edge of the watershed, each having over 20 years of data. And, in 2005, 15 Micronet climate stations were relocated from the LWREW to the FCREW and are operated by ARS. Each of these climate stations was also equipped with soil moisture sensors that provide volumetric water content at various depths.

Stream flow on Cobb Creek has been monitored by the USGS since 1939. In 1959, the Bureau of Reclamation constructed a reservoir on Cobb Creek a few miles above the Cobb Creek gauge near Fort Cobb, and a reservoir gauging station was added to monitor pool elevations of the Fort Cobb Reservoir. In 1968, 1969, and 1970, three USGS stream gauges were installed on tributaries to Cobb Creek. Two of these gauging stations were discontinued in 1978, but were subsequently reactivated in 2004. A fourth nested stream gage was added in 2005. At three of the tributary gauging stations, daily discharge, event-based discharge and sediment, and water quality data have been monitored since 2004. In addition to the USGS operated gauging stations, the ARS has been collecting stream-flow grab samples every two weeks at 15 locations to establish stream water quality conditions. Two existing groundwater wells in the watershed have been equipped with automated recorders. Plans call for three more wells to be drilled in the near future. All five wells will be used to monitor groundwater elevation and water quality.

Watershed Research

Initial CEAP-related research efforts focused on the development of spatially-distributed land use and physiographic data management system for hydrologic model applications, and on SWAT model calibration and validation for FCREW conditions. The watershed data management system, called “Sustaining the Earth’s Watersheds: Agricultural Research Data System” (STEWARDS) was developed. With regard to the SWAT modeling activity, it was found that the model performed best when custom-calibrated with weather data from the dense network of Micronet stations. A subsequent model application showed that significant reduction in expected sediment yield in the main channel could be achieved by implementing best management practices on the most erosion prone land in the upper part of the watershed. However, the magnitude of the reduction decreases as one contemplates the impacts further downstream along the main channel.

Other CEAP research activities conducted in the FCREW included: the development of a spatially distributed land use data set for 2005 conditions using Landsat satellite imagery; a rapid geomorphic assessment of tributaries feeding Fort Cobb reservoir to determine the state of stream bed and bank erosion; a sediment source tracking study to discern relative contributions of sediments derived from stream banks and overland flow; a bi-weekly water quality sampling of the tributaries entering the lake; and a study implementing the soil management assessment framework to investigate the impacts of land management on selected soil properties and microbial populations. The land use study indicated that 43% of the land area in the FCREW was devoted to the production of winter wheat, while about 34% of the area was in grass and pasture. Land area devoted to summer crops (corn, cotton, peanuts, soybeans, etc.) was found to be about 13%. The rapid geomorphic assessment was conducted in February 2006 and indicated that significant reaches of streams feeding into the lake were unstable and may be a significant source of sediments. Results from the geomorphic assessment were used to identify a suitable stream reach to conduct the sediment source tracking. Data for the sediment source tracking were collected in April of 2006, and preliminary findings indicated that about 50% of the sediments in the stream may be from stream banks and the remaining 50% contributed by overland flow. Preliminary results from the bi-weekly stream sampling to date show seasonal and spatial differences in nitrogen, phosphorus and sediments within and between the streams.

c) Climate Research, 2004-2007

With regard to seasonal climate forecast applications, the spatiotemporal mismatch between the forecasts and the space and time scales of hydrologic or crop models was a significant impediment to their incorporation in decision support systems. Methodologies were developed to downscale the forecasts in space; disaggregate them in time to match the time step of hydrologic and crop models; and to develop probabilistic guidance reflecting the information content in the seasonal climate forecasts. For U.S. regions with good seasonal forecast utility, these methodologies supports the development of climate forecast-conditioned decision support. The SWAT model was applied to a subwatershed of the LWREW to quantify impacts of seasonal and multiyear climate variations on surface runoff, and determine conditions under which seasonal climate forecasts offer best opportunities for water resources management. It was found that the combination of wet seasonal precipitation forecasts and wet antecedent conditions had the least dampening effect on the forecast signal and produced the greatest decision-support potential for water resources management. Climate research focus since 2005 has shifted towards addressing implications of seasonal climate forecasts, multi-year climate variations, and climate change for applications and impact assessments in agriculture, conservation, and water resources management.

An analysis of over 50 years of observed weather and calculated runoff and sediment yield on the FCREW quantified multiyear precipitation variations and the high sensitive runoff and sediment yield response to precipitation variations. Based on these research findings, recommendations were made with regard to model calibration and the assessment of conservation measures under variable climate. A comparison of sediment yield measurements in the 1940s and in 2004-2007 revealed that changes in land uses and implementation of a variety of conservation measures led to a significant reduction in sediment yield. Research was also conducted on multi-decadal precipitation trends and development of methodologies to assess climate risk in the presence of a non-stationary climate.

d) Staff and Facilities, 2004-2007

The 2004-2007 period was relatively uneventful compared to the late 1990s when substantial changes occurred in staffing and facilities. Dr. H. S. Mayeux retired in the fall of 2006 and Dr. J. L. Steiner assumed the position of laboratory director in 2007. Also, in 2006, Dr. M. W. Van Liew relocated to Helena, Montana, and the vacated position was filled the same year by Dr. D. N. Moriasi. With regard to facilities, the ARS Chickasha field office had outlived its utility and the property was transferred to Oklahoma State University in September 2006.

Concluding Comments

The three USDA-ARS experimental watersheds on the Washita River have served for over 40 years as an important outdoor laboratory for assessing environmental impacts of flood retarding structures, soil and water conservation practices, and land management in the Southern Great Plains. Five major research periods and themes are recognized. First, the effects of flood retarding structures on watershed hydrology and sediment yield were assessed during years 1961-1978. Second, the research focus during 1978-1985 was on controlling the impacts of non-point source pollution on water quality using best management practices in large watersheds. Third, mathematical model development and application for water quality and watershed hydrology were emphasized in 1985-1992. During 1992-2004, which was interrupted in1996 by a laboratory merger, research addressed potential hydrologic impacts of global climate change, development of remote sensing technologies for large-scale soil moisture measurements, and analyses of climate variability and trend and their impacts of watershed runoff and sediment yield. Seasonal climate forecasts were also assessed in terms of their potential utility for decision support in agriculture and water resources management. And, last, research over the last four years (2004-2007) emphasizes the development and evaluation of procedures for assessing the environmental and societal benefits associated with federally funded conservation practices, particularly within the context of varying climate. Techniques were also developed to downscale seasonal climate forecasts to support farm-level planning and management tools. Much of the watershed data supported multi-agency, multi-disciplinary research involving flood reduction, soil and water conservation, agricultural water quality, sedimentation, erosion, energy fluxes, soil moisture, and remote sensing. Investigations of watershed processes on the experimental watersheds also recognized early-on the need to link watershed research across a range of scales, and to target non-point source controls and best management practices to critical source areas. Long term research is essential to properly evaluate the impacts of land management and climate on water quantity and quality. Expectations are that the Little Washita River Watershed, together with the more recent Fort Cobb Watershed, will continue to provide valuable land use, management and conservation data for research and development of new conservation technologies that promote the protection and sustainable utilization of soil and water resources in the Southern Great Plains.

Acknowledgments

This brief history of the Little Washita River and Fort Cobb Reservoir Experimental Watersheds and related climate, water resources and conservation research would not have been possible without the help from those who have built and managed these experimental outdoor facilities, and those who have conducted research and developed new technologies with the data collected on these watersheds. The authors recognize their outstanding and sustained contributions to experimental watershed sciences, and their contributions to this review of watershed research by ARS in the Washita River Basin, Oklahoma.

History of the Grazinglands Research Laboratory 1948 to 1996

By William A. Phillips and Samuel W. Coleman

After a productive era of military use, the majority of the original Fort Reno land was transferred to the U.S. Department of Agriculture and was placed under the control of the Agricultural Research Administration (ARA). In cooperation with the Oklahoma Agricultural and Mechanical College, now Oklahoma State University, a large livestock experiment station was established using the corrals and barns left by the Army Quartermaster. In 1953, the ARA was reorganized into ARS. Literally, hundreds of technical publications and many more semi-technical and popular articles would be published from research conducted at Fort Reno.

Beef cattle have always been the major species studied at El Reno. Detailed studies of beef cattle breeding and genetics, nutrition, and reproduction were conducted with the goal of economically increasing the production of quality beef from feed sources other than those needed for humans. Later forage production would gain prominence in the program, but in the early years, animal production was the primary research focus. Sheep and swine reproduction, breeding and nutrition research were also conducted at El Reno. Sheep studies were intended to increase the number of lambs produced per ewe and to improve meat quality and wool production through breeding and nutrition. Similarly, swine research was conducted to improve health, growth, litter size, and meat quality in pigs.

Whether the location would continue was debated during the first few years of the station's existence. A congressional hearing was held at Fort Reno on April 24, 1954 to help the US Congress decide the fate of the location. The following is a record of the remarks by Dr. T. C. Byerly, Chief of Livestock and Poultry Husbandry Branch of the Agricultural Research Service at the congressional hearing "Lands on Fort Reno Military reservation, Oklahoma" El Reno, Oklahoma. These remarks summarize the early history of the location as it transitioned from an Army Post to a research facility and demonstrate the extent of cooperation between ARS and Oklahoma A&M.

> Our beef cattle program at Fort Reno station includes one long time project in breeding. This project is part of a broad program in which we are cooperating with 38 states and Hawaii. Our Oklahoma cooperators have provided purebred Herefords and Angus herds of the finest blood lines. These cattle vary in size, in type and in rate of gain. Our major problem is in the development of methods for the selective breeding of cattle which will result in cattle of preferred size and type with maximum rate of gain. The amount of feed required to maintain a brood cow for a year is pretty much fixed, but how much beef we market per brood cow, whether directly as feeder calves or indirectly as feedlot fed cattle is determined by percentage calf crop, inherited capacity to gain and the feed used.
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> Now at Fort Reno, we have a natural range and environment so suited to beef cattle that it is easy under natural conditions to obtain a good calf crop. This is the envy of all our neighbors that are in this area. In the total South and Unites States

the calf crop may be no more than 60%. We have to find out through research how we can bring the calf crop of the United States above the 90% level.

A minor but aggravating problem in beef cattle, dwarfism, is also under study at Fort Reno. While present losses from dwarfism probably do not exceed 1% of our calf crop, the loss amounts to $15 million a year. The frequency of dwarfism is increasing. Dwarfism is inherited. We can eliminate it through progeny tests. These are slow, but we are using them. Dr. Doyle Chambers of the Oklahoma Agricultural Experiment Station is seeking a diagnostic method based on hormonal production which might help identify cattle carrying the genetic factors for dwarfism and thus save time and expense of progeny testing, and an essential portion of that work is conducted at Fort Reno.

Our research program with swine at Fort Reno livestock research station is yielding outstanding results. Jim Whatley from Oklahoma A&M, who serves as project leader, has developed breeding lines of pigs at Stillwater and tested combinations of these lines with lines developed at other Federal and State experiment stations at Fort Reno. This project is a part of the research program of the Regional Swine Breeding Laboratory, cooperative among the North Central States, Oklahoma and the United States Department of Agriculture. Its objectives are the development of breeding methods which farmers can use to produce pigs with big litters of vigorous, fast gaining pigs which when marketed will yield fine carcasses without excess lard. Results of this research indicate that one need not be seriously concerned about sacrificing rate and efficiency of gain in the selection of hogs with improved meat qualities and carcass value.

Finally, we do some wheat pasture research at Fort Reno. For the last winter, of course, we know there was good wheat pasture. At Fort Reno again we are on the blessed side, the wheat pasture gives us good gains and gives no wheat poisoning. And those of you, who know the Panhandle country west of here and Texas, know that this is a major problem. What is the reason we have wheat pasture poisoning in one place and not another, we do not know. In order to find out we must have wheat grown in areas in which the disease does not occur and in areas in which disease does occur.

An area of crop land at Fort Reno is being used for propagation of selected forage plants adapted to the Southern Great Plains. This cooperative work of the Agronomy Department and the Oklahoma Experiment Station is of very great importance in reseeding work, in range improvements, and in the development of more productive pastures, and at present, is certainly significant with respect to the acres diverted from the production of cash grain crops.

But even if we could duplicate soils, grasses, climate and facilities. It would not be enough. We also have at Fort Reno a team of research workers exceeded in

> competence nowhere else in the world. Dwight Stephens, our superintendent, whom you all know, his station staff for whom he sets the pace in output with respect to quantity, quality and imagination; Doyle Chambers, Jim Whatley, Bill Pope, Doc Whitehair, and others who do the planning and analysis work for Fort Reno at Stillwater, and these are only part of the team
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Although Dr. Byerly's comments at the Congressional hearing were made in 1954, his description of the type of research and the relationship between ARS and Oklahoma State University would continue and many of the individuals who were stationed or conducted research at Fort Reno would go on to productive careers as researchers and as administrators. Fort Reno became a training ground for many of our future top research scientists, department heads, college deans, and ARS administrators.

The following are some of the names that appeared on publications describing research conducted at Fort Reno during the 1950'a and 1960's; R. M. Ahring, Doyle Chambers, L. V. Cundiff, D. Ely, M.B. Gould, J. C. Hiller, B. J. Johnson, D. B. Laster, W. G. Luce, B. D. Morrison,, J. E. McCroskey, R. E. Nelson, I. T. Omtvedt, L. S. Pope, C. M. Taliaferro, F. A. Thrift, R. Totusek, D. G. Wagner, L. E. Walters, J. A. Whatley, J. V. Whiteman, R. L. Wilham, S. P. Wilson, and J. E. Zimmerman. This is not complete and many others conducted their master and doctorate research at Fort Reno and received their degrees from Oklahoma A&M, which later became Oklahoma State University.

Swine, sheep and cattle breeding projects used the majority of the land resources during the 1950's and 1960's, but animal nutrition research was growing and became an important aspect of Fort Reno research program. Reports published during the 1950's and 1960's describing the research conducted at Fort Reno were often titled 'Feeding and Breeding test'. Cross breeding of beef cattle to improve carcass quality, increasing the number of calves per cow, evaluating the method of processing on the feed value of barley and milo, cross breeding in sheep to increase lambs per ewe and lambing more than once per year, rearing pigs in confinement, and increasing the utilization of wheat pasture were just some of the topics covered in these annual reports. Regional livestock producers were also invited to attend field days, where they could see the animals and learn the latest results.

Innovative use of resources and facilities left by the military and the availability of surplus World War II military property were used by the Fort Reno staff to develop corrals and barns to support both the state and federally funded research programs at El Reno. The former Quartermaster Horse Veterinary Hospital, located east of the parade field and headquarters area was converted into a swine research center with farrowing facilities for 120 sows and confinement feeding facilities for over 600 pigs. These facilities supported the bulk of the swine research conducted by the Oklahoma Agricultural Experiment Station. Barns used by the military to house horses were converted to feedlot or individual feeding pens for beef cattle research. Residential housing used by Army Officers and Non-Commissioned Officers now housed herdsmen, technicians, farmers, maintenance workers, and station's administrative staff. From its beginning until 1984, the vast majority of the station's staff was employed by Oklahoma A&M or Oklahoma Agricultural Experiment Station.

Administratively, the location was operated as a joint venture between Oklahoma Agricultural Experiment Station and ARS. All activities on the location were conducted under the supervision of a Station Superintendent. Dwight Stephens filled that role for the longest period. He was know as “Mr. Fort Reno”, being the Station Superintendant from the beginning of the cooperative effort until the mid-1970s. Mike Gould and Bob Sprowls would later serve in that capacity with Bob Sprowls being the last state employee that served as Station Superintendent. In the mid-1980s, the ARS research program had grown to the point that a federal employee was needed to direct the million dollar operation. David Meyerhoeffer was appointed as Station Superintendent and he ushered in a new era. Dr. Meyerhoefer was the first ARS employee to serve as Station Superintendent and was the last individual to hold that title. Dr. Meyehoeffer had transferred from an ARS lab in Louisiana to El Reno in 1974 and served as the liaison between Oklahoma A&M researchers and USDA researchers, directed the daily activities of the farm, feedmill, and maintenance crews until his retirement in 1992. Later the position of Station Superintendent would be changed to Operations Manager and was an ARS staff position.

Development of the ARS scientific program

In 1970, ARS decided to increase its presences in El Reno and hired Dr. Floyd Horn to head up a program in forage improvement and utilization. Dr. Horn had just graduated from the University of West Virginia with a Ph.D. in Animal Nutrition. He would later rise through the ranks to become the Administrator of ARS. His work with wheat pasture bloat and the evaluation of Old World Bluestem, an introduced warm season grasses, helped pave the way for substantial increases in the ARS budget for the El Reno location. Working closely with Oklahoma State University, he sought increases in areas not addressed by state researchers. Throughout the 70s and early 1980s, Oklahoma State University had five major research programs at El Reno: 1) beef cattle breeding; 2) beef cattle nutrition; 3) beef cattle reproduction; 4) sheep breeding and production; and 5) swine breeding and production. These programs occupied most of the rangeland and farming operations used to support the large number of animals necessary for these studies, while the ARS program used more laboratories facilities and small plot techniques. A service lab was developed to determine forage chemical composition and in-vitro digestibility of samples generated from selection studies at state and ARS location throughout the Southern Great Plains. Thus began the forage evaluation and grazing research program.

The 1970s were a time of change and growth at El Reno. The administrative part of ARS was reorganized in the 1970s. Dr. Horn was appointed Research Leader and El Reno was administratively under the Oklahoma-Texas Area Office located at College Station, Texas and regional offices at New Orleans, LA.

Six scientists were added to the staff during the 1970s. They were D. C. Meyerhoeffer (Animal Physiologist), W. A. Phillips (Animal Nutritionists), S. W. Coleman (Animal Nutritionist), K. B. Leinning (Animal Physiologist), L. C. Pendlum (Animal Nutritionist), and U. G. Bokhari (Agronomist). These researchers conducted research that addressed 1) decreased beef cattle reproduction due to heat stress, 2) decrease in stocker calf immunity due to stresses associated with weaning and transportation, 3) utilization of new introduced warm season grasses in summer grazing programs, and 4) increasing the efficiency at which forages are converted to lean red meat. Kay Leinning left in 1981 to begin a new career in the ministry, Larry Pendlum left in 1981 to join industry, and Unab Bokhari would leave El Reno to conduct research overseas.

The 1980s were an era of changes in ARS's working relationship with Oklahoma State University, restructuring of ARS's Administration (local, area and regional), the addition of visiting scientists and research associates to the staff, and local ARS staff turn over. Woody Barton, ARS Chemist form Athens, GA, spent a year long sabbatical in 1980 working with Sam Coleman on the development of Near Infrared Reflectance Spectroscopy (NIRS) to rapidly determine the chemical composition of forages. In 1981 with additional funding, El Reno began a cooperative project with Dr. Gerald Horn, Animal Scientist at OSU, to determine the utility of wheat straw as an animal feed. As part of the package, ARS began research to improve soil integrity and fertility via wheat straw residue management and application of no-till conservation practices in winter wheat production. This was the beginning of no-till wheat research at El Reno and the utilization of wheat straw to conserve soil moisture in livestock-cropping enterprises. Drs. Thanh Dao and Srinivas Rao were assigned to this portion of the project.

During the 1980s, staff changes and additional funding added needed disciplines and initiated new research programs. In the 1980s, David Forbes became the first research associate at El Reno. He was a key element in the development of a team led by Sam Coleman to address the plant-animal interface. This team, which included new ARS scientist Scott Christiansen and Tony Sevjcar, was recognized world wide for its discoveries. After leaving El Reno, David developed a distinguished research program within the Texas A&M Experiment Station.

During the 1980s. the animal physiology group was formed with the addition of Mike Zavy and Paul Juniewicz to the staff. They concentrated on the animal's response to stressfully events. Three research associates, Brain Hughes, Steve Helmer, and Shelia Rodriguez, worked in the animal physiology group and a digestive physiologist, Bob Gallavan, was added to the group. Steve Hart and Chuck Streeter, Animal Nutritionists, were added to the staff and assigned to find ways to increase the conversion of forage fiber to lean meat.

A no-till wheat production group was added to develop sustainable continuous no-till wheat production systems. Thanh Dao, soil scientist, and Srinivas Rao, Agronomist, comprised the team.

Name	Beginning Date	Separation Date	Title
Floyd Horn	1971	1984	Animal Scientist/LD
Davie Meyerhoeffer	1973	1992	Animal Scientist
Bill Phillips	1976		Animal Scientist/LD
Sam Coleman	1976	1999	Animal Scientist/LD
Kay Leinning	1978	1981	Animal Physiologist
Larry Pendlum	1978	1981	Animal Scientist
Unab Bokhari	1978	1982	Agronomist
Woody Barton	1980	1981	Chemist (Sabbatical)
Chuck Streeter	1981	1983	Animal Scientist
David Forbes	1981	1984	Research Assoc.

Steve Hart	1982	1991	Animal Scientist
John Doyle	1982	1985	Animal Scientist
Scott Christiansen	1982	1987	Agronomist
Srinivas Rao	1982		Agronomist
Thanh Dao	1982	1995	Soil Scientist
Paul Juniewicz	1982	1984	Animal Scientist
Mike Zavy	1982	1992	Animal Scientist
Tony Svejcar	1983	1987	Range Scientist
Bob Gallavan	1985	1993	Animal Physiologist
Hudson Glimp	1985	1987	Animal Scientist
Jerry Volesky	1988	1995	Range Scientist
Danny Mowery	1988	1993	Agronomist
Brain Hughes	1988	1990	Research Assoc.
Steve Helmer	1988	1990	Research Assoc.
Shelia Rodriguez	1989	1991	Research Assoc.

Research scientist that were on staff at GRL from 1948 through 1996

The forage and livestock research program reached its pinnacle, in terms of number of scientists, in 1983 when 11 scientists, three support scientists, and one research associate comprised the staff. Each of these scientists had cooperators at state experiment stations across the country and several graduate students and undergraduate interns were trained at El Reno each year.

In the mid 1980s, OSU transferred all of its beef cattle research to newly acquired facilities near Stillwater and terminated its sheep research at El Reno. In response, ARS designed and conducted more extensive system-scale research using both sheep and cattle. Two beef herds were established using ARS funds. Both herds were part of regional projects involving other ARS and State locations. The sheep flock was expanded to 1,200 ewes to conduct breeding, reproduction and production research. A new feed mill was completed (1981) through ARS funding and other major facility improvements were made to accommodate the expanded research mission.

The 1990s brought even more changes in staff and the very existence of the location was questioned. Steve Hart transferred to Langston University, Mike Zavy transferred to the OU Health Science Center, Danny Mowery died in an accident while attending a meeting in Florida, Bob Gallavan left for graduate school, Jerry Volesky transferred to North Platte, Nebraska, and Thanh Dao transferred to Bushland, Texas. The threat of closure in 1992 and again in 1993 stifled the research program and decimated the research staff. By 1993 the staff at El Reno had been reduced to 3 scientists (Coleman, Phillips and Rao). It would take the rest of the decade to recover the momentum generated in the 1980s and to bring the facility back to its previous prominence.

What's in a name?

Fort Reno has gone through many name changes. Of course, Fort Reno Research Station is the best known name and is used most often by those that were here from the beginning. Even on county land maps, the lab is referred to as Fort Reno Oklahoma Agricultural Experiment Station. In an attempt to reflect the mission of the location, its name was changed to Fort Reno Livestock Research Station, then Southwestern Livestock and Forage Research Laboratory; later the regional connotation was dropped and Livestock and Forage Research Laboratory was used; to show the increased emphasis on forage research, Forage and Livestock Research Laboratory was used. Finally Grazinglands Research Laboratory was coined by Floyd Horn and that name has been used for over 20 years. However, the broad mission of the location has not dramatically changed over the years. In general the mission has always been to develop forage based livestock systems that enhance the assimilation of plant energy and protein into livestock weight gain while conserving the natural resources of the Southern Great Plains.

What's unique about the Southern Great Plains and Grazinglands Research Laboratory?

The Southern Great Plains is a unique region, located in the transition zone between the cow-calf production regions of the southern and eastern United States and the highly concentrated cattle finishing and processing areas located in Texas, Oklahoma and Kansas. Over 21.7 million head of cattle are finished in region's 1400 feedlots and processed by highly efficient processing plants located in close proximate to the feedlots. Processed meat is then redistributed across the Unites States.

What are significant accomplishments of the animal, plant and soil scientists at GRL?

Instrumental in the development and application of near-infrared spectroscopy (NIRS) analysis of forage and feeds. This technology has provided rapid and accurate estimates of the nutritive value of forages, hay and mixed feed. Forage testing labs throughout the world now use NIRS to provide their customers with detailed information about the nutritive value of feeds. This technology has saved livestock producers millions of dollars by increasing the efficiency at which feed is converted to lean red meat.

National leader for integration of sheep and cattle grazing system to more effectively utilize forage resources and increase gross returns and to add diversity to the grazing enterprise. Research conducted at El Reno demonstrated that sheep selected different plants than cattle and that grazing sheep and cattle together reduced the internal parasite infestation in both species. Sheep can be added to a beef production grazing system without purchasing additional land and can increase the gross returns to the enterprise. However, it was proven that predator control was a crucial management component for a successful integrated operation. They also developed production systems by selecting for out of season breeding in cross breed ewes that resulted in lambs being born in the fall rather than in the spring. They then incorporated the utilization of winter wheat pasture to finish fall born lambs in time to be sold on the peak-priced spring market. This lamb production system was adopted and used successfully by sheep producers throughout the winter wheat belt.

Animal scientists at El Reno have shown how the animal's response to environmental, physical and social stressors hampers the animal's ability to fight infections and develop adequate immunity. The cow-calf and stocker component of the US beef cattle industry used this information to change timing of vaccination, pre- and post-shipping management and nutrition to decrease the cost of sickness in stocker calves. In cooperation with other ARS locations and state experiment stations from Florida to Montana, these scientists have been able to quantify the interaction of beef cattle genotype and the production environment. This information has been used by the beef cattle to better match animal genotype to the production environment. One example was dispelling the myth that calves with greater than 50% Brahman breeding perform poorly on winter wheat pasture.

Scientists in this unit were leaders in the development of non-till wheat production systems and demonstrated the risk associated with trying to grow a second crop during the summer in a continuous wheat production system. The importance of fertilizer placement in no-till wheat production has helped wheat producers utilize N fertilizer more efficiently. While growing legumes, such as soybeans, during the summer in a continuous wheat production system, the practice is risky when rainfall is less than normal.

The research team at El Reno has been able to introduce Jose Tall Wheatgrass, Lincoln Smooth Brome, Manska Intermediate Wheatgrass, and many varieties of fescues from US and Asian seed stocks to complement annual wheat pasture production systems. Wheat pasture is the most dominate stocker production enterprise in the southern Great Plains and is planted on over 12 million acres annually. These perennial cool-season grasses were used in a unique and innovative management system. The team found that perennial cool-grasses are better used as complementary forage to winter wheat rather than a replacement. The typical Nov to May grazing season on wheat pasture can be lengthen by 70 days if perennial cool season grass pastures are used as intensively grazed pasture prior to winter wheat grazing in November and after wheat grazing has ended in May. Perennial grasses can be established on fragile sites that are prone to erosion, but can still contribute high quality forage for stocker production. This system has added diversity to stocker cattle enterprises. The team also learned that for perennial grasses to persist reducing summer warm season grass encroachment is important and that the cost of gain on perennial grass pastures is less than on wheat pasture. These two factors have been key pieces of information for producers in formulating stocker enterprise budgets. The combination of perennial cool-season grasses and winter wheat is currently being used to reduce the amount of feed grain needed to produce finished beef by added more of the needed body weight gain with forages prior to entering the feedlot

- In response to the societal desire to purchase beef that was not raised in confinement, ARS scientists at GRL developed a system that produces high quality beef on pasture using less grain inputs. This systems been coined ‘grain-on-grass’ and can be used to produce value added beef products that are consumed locally. The system is made up of two components. First, the intensive stocking of warm season pastures to harvest the grass at it highest quality. Secondly, high energy feed is provided in a self-feeder to meet dietary energy needs as forage quality declines. Calves can transition from all forage to a high-energy grain based diet at their own pace. Calves achieve market weight at about the same time as calves placed in a typical confinement feedlot, but the carcass has less external fat. Also calves finished under ‘grain-on-grass’ management have distributed their waste material each day on the pasture, which provides N for forage production next summer.

Merging of Two Laboratories

As noted in the prior chapter of this history, in 1996 the Durant laboratory was merged with the Grazinglands Research Laboratory and Dr. J. E. Quisenberry was appointed director of the Grazinglands Research Laboratory. During his 3 year reign, he oversaw renovation of the Headquarters and Laboratory Building, which had been converted to offices and laboratories in stages over the previous 25 years. Other capital improvements involved roads, fences, animal feeding and handling facilities, forage sampling and processing facilities, and animal nutrition and forage quality laboratories. During the renovation process, the animal and plant scientists focused on reporting research findings, participating in profession societies meetings, editing peer reviewed journals, and planning future research.

In 1999, Dr. Herman Mayeux transferred from the National Program Staff to El Reno as Laboratory Director, and Dr. Quisenberry transferred to Hawaii. After seven years, Dr. Mayeux retired and Dr. Jean Steiner was appointed as Laboratory Director and Brad Venuto was appointed as Research Leader for the Forage and Livestock Unit. The Forage and Livestock unit is currently made up of, two scientists transferred from Durant (Robert Williams and Charles McKown) and two scientists transferred from other ARS labs (Bryan Kindiger and Mike Brown), three new scientists (Brad Venuto, Brian Northup and Paul Bartholomew) and two long-time Grazinglands Research Unit scientists (Bill Phillips and Srinivas Rao).

Post-merger scientific staff changes within the Forage and Livestock Unit included the transfer of Sam Coleman to assume leadership of the ARS lab at Brooksville, Florida; and the addition of Lisa Appeddu to continue Coleman's program to measure forage intake of grazing animals. However, Appeddu left in 2002 to teach at Southwestern OSU in Weatherford, OK, that position was abolished. During the post-merger period, a satellite team of two scientists was established at Langston University. Robert Williams, Plant Physiologist from the Durant Lab, and Paul Bartholomew, a newly hired Research Agronomist, form the team to conduct research to develop more sustainable forage based systems for limited resource land owners.

By 2008, the Forage and Livestock Research Unit had a total of 9 scientists whose research was described in three major projects in National Program 101: Food Animal Production and National Program 215: Rangeland, Pasture and Forages. The current staff includes Paul Bartholomew, Mike Brown, Bryan Kindiger, Charles McKown, Brain Northup, Bill Phillips, Srinivas Rao, Brad Venuto, and Robert Williams.

The research thrusts and achievements of the Forage and Livestock unit on the late 1990s and early part of the 21st century are reflected in the summary statements of the current projects below.

Project Summary NP 101: Development and Assessment of a System to Produce Grass-Fed Beef for the Southern Great Plains

Consumers have expressed an increasing desire to know how and where their food is produced, and they are willing to pay more for meat products that are produced by an ecologically sound system that promotes animal well-being. Over the last 50 years, annual U.S. beef production has doubled, largely due to increasing use of cheap and abundant feed grains. Feed grain production depends heavy on fossil fuel input, and as a result our present day beef production system has been shifted from pastoral management using free solar energy in the form of forages to industrialized agriculture using feed grains. We must transition our present beef production enterprises from dependency on fossil fuel inputs to forage resources (pasture and rangeland), which are renewable and sustainable. Forage resources can be converted to high-value human energy and protein sources via grazing livestock through production systems that are economically viable, ecologically sound, and socially just. We propose to take the existing 120- to 150-d forage-based component of our beef production system and extend the grazing season by adding new forage resources at strategic points. The end result will be the production of beef with less feed gain and fossil fuel inputs. To accomplish this goal, we must develop sustainable year-long grazing systems and match the right animal with the forage resource to produce a high-quality animal product that has consumer appeal.

Project Summary NP 215: Integrating Forage Systems for Food and Energy Production in the Southern Great Plains

Millions of stocker cattle are brought into the southern Great Plains annually for post-weaning gains before entering feedlots for finishing. Winter wheat and warm-season perennial grasses are the primary forage base for this process. Minimal forage diversity results in seasonal forage deficits and increased economic and environmental risk. It is the primary constraint to implementation of sustainable forage/livestock production systems in the region. Integrating alternative and multi-purpose crops for forage or bioenergy production will add new sources of income and greatly benefit land owners and resource managers in this region. This project will provide management guidelines for replacing the traditional two-component forage production system with multi-component, multi-purpose systems. Perennial cool-season grasses will be developed and identified to fill forage gaps between the winter wheat and perennial summer grazing periods. The research will provide legumes for forage during summer fallow period in continuous wheat production and develop protocols for growing annual and perennial legumes alone and in mixture with perennial grasses for biomass or forage production. The research will mitigate inherent management risks by addressing changes in water availability and nitrogen dynamics. Nutritional risks to livestock grazing winter wheat, including bloat and nitrate poisoning, will be mitigated by identifying alternative wheat cultivars. Remote sensing technology for *in-situ* forage quality assessment will enable producers to quickly monitor the nutrient supply of grazing livestock. This project will diversify the current two dimensional forage-based system, enhance flexibility and efficiency, and reduce economic and environmental risks under variable climate, market and policy conditions.

Sustainable Forage Production for Low-Input Farming Systems is a research project with an overall goal to identify improved forage production techniques that will contribute to decreased costs of livestock production and increased income on limited-resource farms. The purpose is to develop low-input forage production techniques that are appropriate for resource-poor producers, and that will increase livestock carrying-capacity, improve early- and late-season forage production and reduce or eliminate expenditures for off-farm feed supplies. This purpose will be met by evaluating combinations of forages grown in mixtures or sequences, and by developing low-input management methods that will enable their use as a productive and persistent complement to, or replacement for, unimproved or degraded pasture.

Conclusion

The one constant thread that runs through the history of the 6,800 acres that is now referred to as USDA-ARS Grazinglands Research Laboratory is “change is constant”. Dr. J. Rex Johnston, former Area Director for the USDA-ARS Oklahoma-Texas Area, never referred to a situation as a problem, but would frame it as an opportunity. Many opportunities have been presented to Fort Reno since its beginning in 1874. Because it has had a dedicated staff that was willing to re-invent itself, it has prevailed. The Grazinglands Research Laboratory is a national treasure that will continue to provide national service to its citizenry through world-class agricultural research.

Appendix I

List of Great Plains Agroclimate and Natural Resources Staff

Southern Great Plains Watershed Research Center at Chickasha (1961-2001)
National Agricultural Water Quality Laboratory at Durant (1969-1996)
Great Plains AgroClimate and Natural Resources Research Unit at the Grazinglands Research Laboratory at El Reno (1996-2007)[1]

Name	Location	Begin Date	Separation Date	Title
Ahuja, Laj R.	D	1979	1991	Soil Scientist
Allen, Paul B.	C,D	1961	1985	Hydraulic Engineer
Allison, Lowell E.	C	1968	1971	Soil Scientist
Barnes, Bill B.	C,D,E	1962	2004	Hydraulic Engineering Technician
Bingham, Samuel C.	C	1965	1991	Hydraulic Engineering Aid
Blanchard, Bruce J.	C	1961	1975	Hydraulic Engineering Technician
Boswell, Thomas W.	C	1962	1985	Hydraulic Engineering Technician
Bowers, Sid A.	D	1971	1973	Soil Scientist
Boxley, William M.	C	1966	1991	Engineering Technician
Brown?				
Broadie, Donald A.	C	1965	1972	Hydraulic Engineering Aid
Busteed, Phillip R.	E	2008		Hydrologist
Byles, Brenda	D,E	1987	-	Physical Science Technician
Campbell, James	D,E	1991	2008	Information Technology Specialist
Clay, Betty (Morrison)	D	1982	1996	Mathematician
Coleman, Gerald A.	C	1961	1994	Hydraulic Engineer
Collins, Paula J.	C	1968	1970	Keypunch Operator
Curtis, W.L.	D	1971	?	Air Condition & Refrigeration
Mechanic				
Daniel, John A.	D,E	1992	-	Geologist
Daughtry, Susan	E	2001	-	Secretary (Office Automation)
Davis, Robert J.	D	1971	?	Microbiologist
Deason, Glen A.	D	1971	1971	Chemist
DeCoursey, Donn G.	C	1961	1974	Supvry Hydraulic Engineer
Dillow, David W.	D	1973	1976	Biological Technician
Edens, Carlton D.	C	1961	1985	Hydraulic Engineering Technician
Ferandez, Glenn	D	1992	1993	post-doctoral Hydrologist
Few, Roy	Dc,E	1990	-	Geologist
Finley, Ansel C.	C	1972	1977	Engineering Technician
Ford, Don	E	2007	-	Mathematician
Frere, Maurice H.	D,C	1971	1979	Supvry Soil Scientist

[1] Abbreviations: C – Chickasha, D – Durant, Dc - Durant, duty station Chickasha, E - El Reno

Galindo, Donnie J.	C	1968	1979	Engineering Aid
Gander, Gene A.	C,D	1967	1996	Mathematician
Garbrecht, Jurgen	D,E	1988	-	Research Hydraulic Engineer
Golden, Betty L.	C	1965	1978	Clerk-Stenographer
Gosdin, Lou E.	D	1969	?	Clerk-Stenographer
Goss, Don W.	C	1967	1971	Geologist
Gregory, Donald E.	C	1967	1978	Engineering Technician
Hackworth, Douglas	E	2005	2006	Mathematician
Hale, Dorothy T.	C	1976	1978	Clerk-Typist
Hartman, Monroe A.	C	1961	1971	Supvry Hydraulic Engineer
Hauser, Victor L.	D	1970	1975	Research Agricultural Engineer
Heathman, Gary L.	D,C	1982	2004	Soil Scientist
Heavin, L. E.	C,Dc	1973	1985	Engineering Aid
Henry, Gayla E.	C	1975	1976	Clerk-Typist
Huckleberry, Richard	D,E	1972	2003	Physical Science Technician
Hunt, Charles G.	C	1962	1979	Engineering Technician
Hunt, Dolly R.	C	1961	1978	Administrative Officer
Igo, Frank A.	C	1963	1981	Engineering Technician
King, Gordon Pat	D,E	1989	-	Soil Scientist
Lawson, Michael L.	C	1966	1967	Hydraulic Engineering Aid
Lehman, Oliver R.	D	1972	?	Soil Scientist
Leonard, Terry J.	C	1966	1980	Hydraulic Engineering Aid
Lewis, R. Brance	D	1974	1975	Agricultural Engineer
Matlock, Alvin Leon	C	1968	1977	Engineering Aid
Mayeux, Herman S.	E	1999	2006	Supvry Rangeland Management Spec
McBride, Landy J.	D	1976	1977	Plant Physiologist
McHenry, Roger. J	D	1980	1982	Supvry Soil Scientist
McIntyre, Sherwood	D,E	1980	-	Ecologist
McLemore, Jerry Leon	C	1968	1993	Engineering Aid
Menzel, Ronald G.	D	1969	?	Suprvy Soil Scientist
Middleton, Dawcett G.	D	1970	?	Physical Science Technician
Miller, Gary E.	C,D	1969	?	Engineering Technician
Miller, Gary E.	C,D	1965	1969	Engineering Technician
Moore, Burl D.	C	1974	1977	Peripheral Equipment Operator
Moore, Jesse G.	C	1971	1977	Engineering Aid
Moran, Q.L.	D	1976	?	Biological Aid
Moriasi, Daniel	E	2007	-	Research Hydrologist
Naney, James W.	C,D	1961	1990	Hydraulic Engineering Technician
Nicks, Arlin D.	C,D	1961	1996	Agricultural Engineer
Ogle, George	C	1968	1971	Engineering Aid
Olness, Alan E.	D	1970	?	Soil Scientist
Padgham, Wilber W.	C	1960	1972	Agricultural Research Technician
Pardue, Gordon D.	D,E	1973	2007	Physical Science Technician

Peters, Richard	C	1968	1971	Engineering Aid
Pionke, Harry	C	1968	1974	Soil Scientist
Potter, Donna G.	C	1970	1974	Keypunch Operator
Price, Harold W.	C	1961	1979	Hydraulic Engineering Technician
Quisenberry, Jerry E.	E	1996	1999	Supvry Research Agronomist
Rhoades, Edd D.	C ,Dc	1961	1979	Research Agricultural Engineer
Robinson, Steve	D			post-doctoral Soil Scientist
Rogers, Billie J.	D	1971	1996	Clerk-Stenographer
Romo, Francis T.	C	1961	1962	Hydraulic Engineering Aid
Ross, John D.	D,E	1973	-	Mathematician
Rossel, Fredrick	D	1998	1999	post-doctoral Hydrologist
Salter, John M.	C	1962	1965	Hydraulic Engineering Aid
Schiebe, Frank R.	D	1980	1996	Supvry Hydraulic Engineer
Schneider, Freddie J.	C	1966	1967	Hydraulic Engineering Aid
Schneider, Jeanne	E	1999	-	Meteorologist
Schoof, Russell R.	C	1961	1985	Hydraulic Engineer
Scott, Ira L.	C	1966	1978	Research Aid
Seely, Edward H.	C	1963	1976	Hydraulic Engineer
Sharpley, Andrew	D	1980	1995	Soil Scientist
Shelby, Bertha B.	C	1961	1973	Clerk-Typist
Shockey, Windell R.	C	1961	1976	Agricultural Research Technician
Smith, Mark	Dc,E	1992	-	Hydraulic Technician
Smith, Samuel J.	D	1971	1995	Soil Scientist
Southwell, Virgil D.	C	1968	1985	Engineering Aid
Starks, Patrick	D,E	1992	-	Soil Scientist
Steiner, Jean L.	E	2001	-	Supvry Soil Scientist
Troger, William W.	D	1973	1996	Botanist
Troup, B. Ray	C	1961	1962	Engineering Draftsman
Van Liew, Michael	E	2000	2006	Research Hydrologist
Vangsnes, Sherman R.	C	1961	1969	Engineering Technician
Verser, J. Alan	C,Dc,E	1991	-	Hydrologic Technician
Watson, Ray	C	1966	1992	Engineering Technician
Welch, Norman H.	C	1962	1992	Soil Scientist
Williams, Robert D.	D,E	1978	-	Plant Physiologist
Wolfkill, Wanda	C	1973	1974	Clerk-Typist
Workman, Oscar Don	C	1968	1978	Physical Science Technician
Worsham, Ronald L.	D	1973	1976	Biological Technician
Wyant, Cluade B.	C	1966	1981	Agricultural Aid
Yamamoto, Mutsuo	D	1972	?	Chemist
Yang, M.S.	D	1976	1976	Soil Scientist
Yost, Cody, Jr.	C	1961	1965	Research Geologist
Young, Linda B.	D	1972	1996	Physical Science Aid
Zhang, Xunchang (John)	E	2000	-	Hydrologist

Appendix II

Laboratory Directors associated with the watershed, water resources and climate research program on the Washita River Basin, Oklahoma

1961-1979, Southern Great Plains Watershed Research Center at Chickasha, OK

Hartman, Monroe A.	1961 - 1971
DeCoursey, Donn G.	1971 - 1974
Rhoads, Edd D. (Interim Location Leader)	1974 - 1975
Frere, Maurice H.	1975 - 1979

1969-1996, National Agricultural Water Quality Laboratory at Durant, OK

Menzel, Ronald G.	1969 - 1980
McHenry, Roger. J.	1980 - 1982
Schiebe, Frank R.	1980 - 1996
Williams, Robert D. (Acting Laboratory Director)	1996

1996-2007, Grazinglands Research Laboratory at El Reno, OK

Quisenberry, Jerry E.	1996 - 1999
Mayeux, Herman S.	1999 - 2006
Steiner, Jean L. (Acting Laboratory Director)	2006 - 2007
Steiner, Jean L.	2007 – present

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