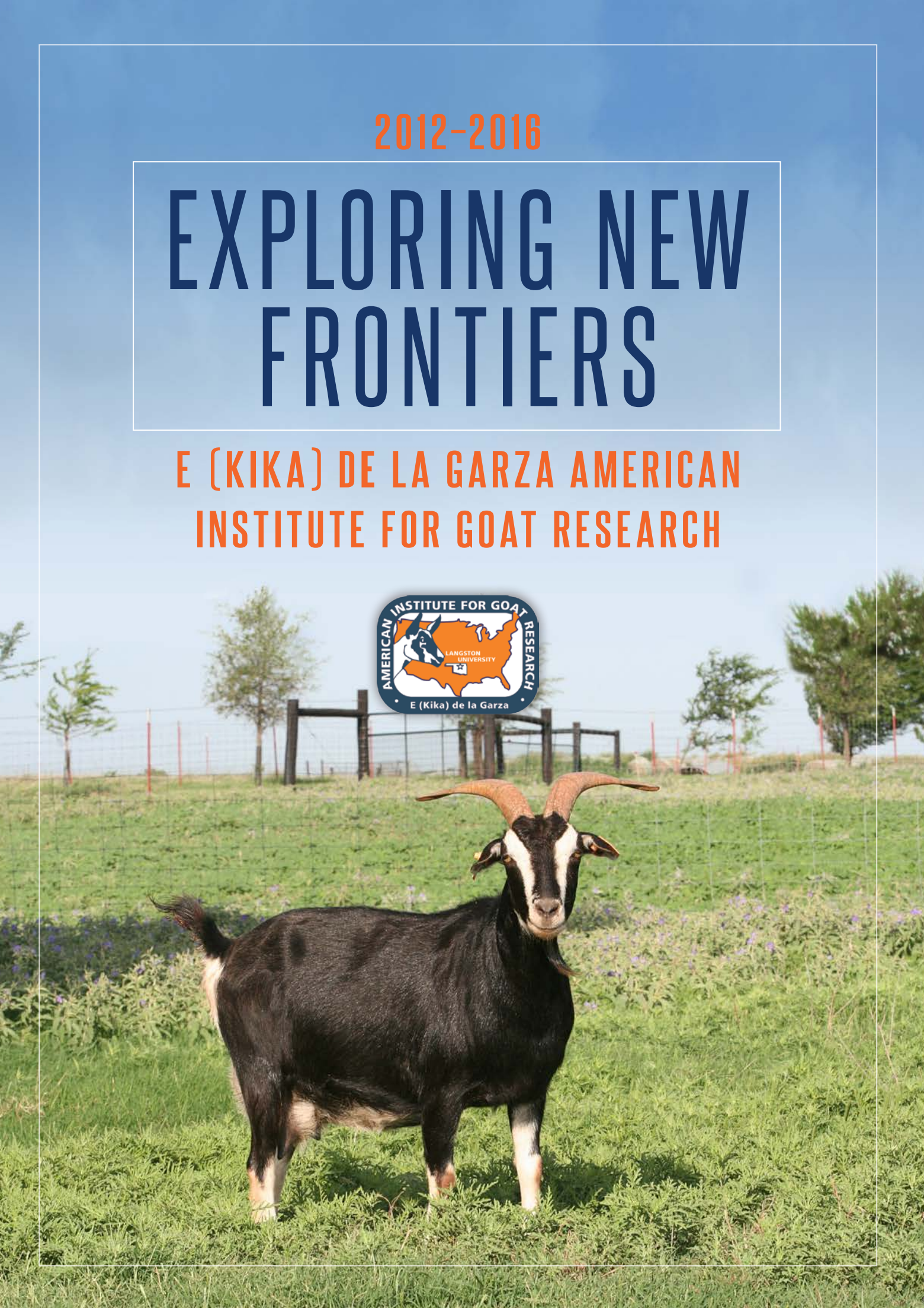
2012-2016

EXPLORING NEW FRONTIERS

E (KIKA) DE LA GARZA AMERICAN INSTITUTE FOR GOAT RESEARCH



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EXPLORING NEW FRONTIERS

E (KIKA) DE LA GARZA AMERICAN INSTITUTE FOR GOAT RESEARCH

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This publication, issued by Langston University as authorized by the Director, E (Kika) de la Garza American Institute for Goat Research, was printed by Oklahoma University Printing Services at a cost of $18,515 / 2,000 / January, 2017.

WELCOME

The five-year report of activities of the E (Kika) de la Garza American Institute for Goat Research is presented here. Through this report, you will find that this institute has proved itself again to be the United States' premier institution for goat research, extension, and international activities. Over the past five years, we have reached a new milestone in our core foundational programs and expanding new programs. Within this report, you will find a synopsis of our major accomplishments. Our Institute scientists and extension specialists have led the way in publishing pertinent research findings, developing user-friendly technology for information dissemination to producers, and implementing development-centered assistance programs internationally. If you are not familiar with our exciting and forward-looking research programs, dynamic extension and outreach activities, and life-changing international activities, you soon will be. Our passion is enhancing goat productivity and improving the lives of goat producers worldwide. We hope that this report will ignite some of those same passions in you.

MISSION

The mission of the E (Kika) de la Garza American Institute for Goat Research is to develop and transfer enhanced goat production system technologies, with impacts at local, state, regional, national, and international levels. The Institute strives to fulfill this mission through excellence in a results-driven, highly productive research program; an effective, client-oriented extension approach; and dynamic international activities that stress development and human capacity building. Cutting-edge research focuses on providing new information relevant and usable by producers and researchers alike. Enhancing information exchange and producer skill levels through hands-on workshops, field days, print and e-book publications, and web-based information and interactive components is the goal of the extension program. Care for goat producers worldwide is engendered through international activities that encompass research, human capacity building, and village development. These programs, along with knowledgeable and caring personnel and a dedication to the improvement of the lives of goat producers around the world, have made the E (Kika) de la Garza American Institute for Goat Research a recognized leader in the arena of goat production technologies.

Dr. Tilahun Sahlu is Director of the E (Kika) de la Garza American Institute for Goat Research.

DIRECTOR'S MESSAGE

As of 2016, the E (Kika) de la Garza American Institute for Goat Research, previously known as the American Institute for Goat Research and the E (Kika) de la Garza Institute for Goat Research, is more than 30 years old. During this relatively short period of time, U.S. goat production has evolved from being mainly a backyard hobby into a full-fledged industry encompassing meat, dairy, and fiber production. Along the way, the fledgling industry faced many challenges and periods of uncertainty, but throughout exhibited steady, significant progress and growth. Over the years, the E (Kika) de la Garza American Institute for Goat Research has stood by goat producers and has striven to provide them with essential and relevant information, through our excellent research and extension programs, vital to the growth and viability of the industry.

Specific areas of focus and associated outputs shift with changing needs, but the commitment to goat production and goat producers is unwavering.

The Institute's research, extension, and international programs have had tremendous achievements during the past five years. The Institute conducts research and extension activities in a wide array of areas and includes all major types of goats raised in the U.S., i.e., meat, milk, and(or) fiber. Through research and extension, the Institute has worked to mitigate production constraints faced by goat producers, no matter what the cause, and will continue to do so. Currently, that means looking at potential impending climatic change and finding ways to support the goat industry in maintaining high production levels.

To achieve a strong research program, the faculty of the Institute has aggressively sought extramural support that provides funds for equipment, supplies, and personnel to conduct research. The most important grant program for the Institute in the last five years has been the 1890 Institution Capacity Building Grant Program. Funding received through this and other programs has greatly enhanced our present and future research

and extension capabilities. Efforts are continuing to establish a small ruminant meat laboratory and processing unit. This would be in addition to the small ruminant skin pilot processing plant, the first at a university in the U.S., demonstrating a firm commitment to the wide range of technologies of interest to our clientele. This facility is a complement to our Animal Fiber Laboratory used to characterize quality of mohair and cashmere fiber as well as our dairy processing laboratory and creamery. Moreover, an assisted reproduction technologies laboratory was established at the Institute, imparting capability to perform gamete retrieval, evaluation, and storage, artificial insemination, embryo transfer, and early pregnancy diagnosis. The newest facility enhancement, funded by the U.S. Department of Agriculture, National Institute of Food and Agriculture (NIFA), is a research barn with 35,000 square feet of

In the last few years there has been considerable attention to publishing large extension and international books and relatively complex and long-term research projects.

Spanish goats of the Institute.

covered area. It consists of units for studies with animals maintained individually as well as in groups. There are rooms for research on body composition and feed utilization. Moreover, the facility includes sorely needed covered space for feed storage and equipment maintenance and repair.

Our superb extension program serves as the link between our clients and the Institute in disseminating information and in learning of producer concerns. One constant of our extension program during the last three decades has been our annual Goat Field Day, held the last Saturday in April, and to which the reader is cordially invited. Other important extension activities include workshops, production handbooks, and our quarterly *Goat Newsletter.* In addition to traditional extension methods, the Institute now places a strong emphasis on disseminating information through its website, *http://goats.langston.edu*, which I hope you will visit. Our *Meat Goat Production Handbook*, first and second editions, and the *Meat Goat Production Basics* have been major success stories. Moreover, because of the increasing number of Spanish-speaking individuals raising goats, the basics

book was translated to Spanish. The meat goat production web-based certification program has reached not only producers in this country but also many international producers. A corresponding *Dairy Goat Production Handbook, Basics* and *Dairy Goat Production, Basics* in English and Spanish, and web-based certification program were recent outputs in 2016.

During the past five years, the Institute has strived to maintain a strong international program. International activities range from training of visiting scientists to international research to agricultural development projects, most notably our recent Ethiopia Sheep and Goat Productivity Improvement Program. A publication entitled *Methods of Livestock Research on Smallholder Farms*, available in print and on the Institute's website since the Fall of 2014, was developed from a number of the international projects supported by the U.S. Agency of International Development and the U.S. Department of Agriculture. The Institute is proud of its contribution to the development of scientific expertise in other countries and of its projects that directly assist poor farmers in lesser developed nations.

This report highlights the progress and contributions made by the E (Kika) de la Garza American Institute for Goat Research to the industry in the last five years. During that time there have been great achievements, which include new and improved facilities, acquisition of the latest research equipment, and productivity as measured by extramural funding, manuscripts published in peer-reviewed journals, and most of all high impact research, extension, and international activities. These activities have all focused on enhancing the Institute's ability to serve its clientele. As you peruse this report I hope you will be as pleased with the steady progress made at the Institute in the last five years as I am. I also hope that you will be as confident as I am that the Institute is ready to respond to whatever future challenges await and that the achievements of the next five years will be equally impressive.

To more effectively address a broadening clientele, Spanish versions of some extension publications have been developed.

Apart from addition of an 80-acre area just north of the South Farm, a significant enhancement is a new research facility to the east of the South Barn for research with goats housed individually and in groups.

New research facility site, Spring 2015.

HISTORY OF THE INSTITUTE

The E (Kika) de la Garza American Institute for Goat Research, previously known as the American Institute for Goat Research and more recently as the E (Kika) de la Garza Institute for Goat Research, was founded at Langston University in 1984 to generate and disseminate technical information on goats, advance the knowledge of goat production, and enhance the utilization of goat products.

The first facilities of the Institute were built in 1985/86 and included many of the buildings at the Main Farm today, such as the lactation and maternity barns, arena, feed mill, and milking parlor. In 1987/88, storage, machinery, dairy processing, metabolism, and surgery facilities were added. During the early period of the Institute's history, the foundation animals were acquired, with 70 Alpine kids arriving in 1985 and 60 Angora goats in 1986. These goats were used in the initial research conducted at the Institute in support of dairy goat and mohair industries. Spanish goats for cashmere research were added in 1990, and in 1991 a small number of Tennessee Stiff Leg goats were introduced.

As the Institute grew in stature and reputation, and as research supporting the meat goat industry increased, facilities and animals expanded further. In 1995, a group of Boer goat bucks was obtained for use in crossbreeding. In addition to grading up with Boer in the late 1990's, 20 full-blood Boer doelings from Texas were procured in 1999 and 2000. The Institute now hosts a herd of purebred and high percentage Boer goats, which has been aided by the use of some of the top-producing Boer bucks at the annual Meat Goat Buck Performance Test.

Groundbreaking for new research facility, Fall 2014.

In support of the dairy goat industry, the Institute has made improvements at the Main Farm. In 1992, a creamery was established that allows research of goat dairy products. In 1995, a Dairy Herd Improvement Laboratory was established and received certification. In 1998, a modern 10-stanchion computerized milking parlor was installed, which was recently upgraded in early 2011. Other recent improvements include establishment of permanent, irrigated pastures for grazing dairy does as well as development of the West Pasture area allowing for increased grazing research. In addition, in 1999 a grant was received for an indirect respiration calorimetry system, which was installed in 2000 at the North Barn. There has also been considerable other interior and exterior renovations of the North Barn.

The South Barn was built in 1995, providing an excellent research venue for more detailed research into meat goat production. The South Barn is also the site of the Buck Performance Test held annually at the Institute for many years. The performance test began as the Angora Buck Performance Test in 1994 and was shifted to the Meat Goat Buck Performance Test in 1997. Further refinements have been made to the South Barn complex over the years including the installation of a Calan gate feeding system in 1998, employment of an automated feeding system for groups of goats in 2002 with additions in 2013 and 2014, inclusion of a large tissue grinder for body composition research in 2004, drilling of a well at the South Farm for irrigation in 2003, a gradual expansion and improvement of pastures surrounding the facility, and in 2001 the investment into more permanent fencing for increased conduct of controlled grazing experiments. In 2009, a pilot goat leather tannery was established at the facility.

A new 35,000-square foot research facility was recently constructed at the South Farm. It has 12 group pens capable of holding groups of up to 12 animals depending on the particular study. These pens are equipped with an automated FIRE feeder which enables the feed consumption and eating behavior of each animal in the pen to be measured, and the pens can be used for bunk feeding trials as well. The barn has a room with 36 elevated 4' x 4' stainless steel pens for nutrition studies. Stainless steel enables these pens to be used for mineral studies. The barn has a covered working facility suitable for vaccinating, sorting, ear-tagging, foot-trimming, etc. It will save labor and provide safe working conditions. The facility includes rooms for use of metabolism cages for collection of feces and urine and for the respiration calorimetry system for studies of energy metabolism. There is a room and equipment for measuring animal body composition (bone, meat, and fat). The barn has an area for storing and working on farm equipment, feed storage, a field laboratory, and offices.

Animal handling/working area in new research facility.

The South Farm has also been expanded by the addition of 80 acres of land to the north between the location and college campus. The area is presently infested with cedar trees and will need development before usage. The Institute needs more land as our animal numbers have increased over the years due to increased number of research projects.

> **Core research and extension facilities have been maintained with some improvements, and major goat breeds at the Institute still are Alpine, Angora, Boer, and Spanish..**

The laboratory facilities of the Institute have also grown over the years. The expansion of research at the Institute along with accompanying increases in the amount and sources of extramural support has facilitated enhancements of laboratory facilities through the purchase of equipment and upgrading of current instruments. A notable event in the past decade was moving both laboratory and office facilities to the new Agricultural Research, Education, and Extension Center, which in 2010 was officially named the E. L. Holloway Agricultural Research, Education, and Extension Center in honor of past-president Dr. Ernest L. Holloway's commitment to agriculture.

The Institute has also broadened methods of disseminating information through its extension program. National symposia were held in 1991, 1992, and 1993 on meat, dairy, and fiber-producing goats, respectively, each with published proceedings. The Institute's Goat Field Day has continued

to be an annual event with proceedings published and distributed. In the mid-1990's, the Institute established a presence on the Internet with a website, which was redesigned in 2000 and can be found at *http://goats.langston.edu*. The website provides a convenient means of providing access to new technology packages. Examples are Goat Field Day proceedings and the online meat goat certification program.

In 2016 the website was enhanced and moved to its current web address, becoming part of the campus website. The new website is easier to use, more visually appealing, and matches the University website.

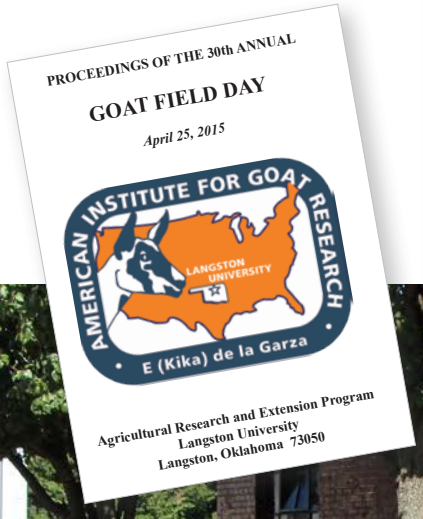
International activities of the Institute have also continued to grow, with an increase in the number and scope. Since 1998, the Institute has received funds for 25 international grants involving countries in Africa, the Middle East, and Armenia. International projects have expanded from being strictly research oriented to now include training and agricultural development components and considerations.

Eastern side of new research facility site, Summer 2016.

The Institute's rich history of growth and achievements in research, extension, and international activities is a testimonial to the hard work and dedication of Institute personnel. The Institute's future will surely see continued success in all three areas as it continues to provide leadership and support to goat industries and producers both here and abroad.

The Institute's website has increased in importance to disseminate information and was revised and meshed with that of the University.

In 2015, the Institute held its 30th annual Goat Field Day.



Small numbers of goats are easily moved short distances with a Gator and trailer.

RESEARCH FARM

The Research Farm of the E (Kika) de la Garza American Institute for Goat Research provides the livestock, facilities, equipment, and support personnel that are used in the Institute's research, extension, and training activities. The Farm currently has approximately 400 fenced acres of land, most of which is used for grazing or harvested forage production. Physically the Farm can be divided into four components. The 120-acre Main Farm is located on the west side of the Langston University campus and is home to the Alpine dairy herd. The 240-acre South Farm, located 3/4 of a mile south of campus, has most of the Spanish, Boer, Boer crossbred, Angora, and Tennessee Stiff Leg goats. The North Farm area consists of the North Barn research facility and about 30 acres, being situated just north of the Main Farm. The West Pasture area encompasses roughly 30 acres used primarily for grazing studies.

There are resources to conduct studies under a variety of conditions for extrapolation to commom production settings.

While the Institute's goats are largely raised on pasture, there are numerous research studies that employ the excellent pen facilities of the Research Farm. There are individual Calan Gate feeders at both the Main and South Farms and automated feeding system units at the South Farm that allow housing and studying goat groups while still gathering needed individual animal intake data. The indoor pen facilities at the Main Farm are employed mostly for lactation studies, and those at the South Farm for meat goat research. There are also metabolism crate facilities for nutrition/physiology research at both the South Farm and North Farm areas. Many pastures have been cross-fenced for flexibility when

Ground hay is fed alone or mixed with other feedstuffs in many studies.

Recent upgrades of dairy goat facilities increased the ease with which feeding and management studies are performed.

conducting grazing research at the Main Farm primarily with the Alpine herd and at the South Farm and West Pasture area with meat– and fiber-producing goats.

A creamery for goat milk and dairy product research and technology transfer is housed at the Main Farm. The Main Farm also includes a feed processing facility, milking parlor, indoor arena with seating space for 150 people, 16-stall maternity, environmentally controlled nursery with capacity for 300 kids, and an assisted reproductive technologies laboratory.

LIVESTOCK

The number of livestock fluctuates from year to year and within years depending on needs for research and extension activities. Generally, numbers vary from 1,000 to 1,600, being lowest before kidding and greater thereafter. Presently, there are sizable herds of Alpine, Spanish, Angora, and Boer goats. The Institute hosts a herd of purebred and high percentage Boer goats, which has been genetically improved by the use of artificial insemination with top sires commercially available. There is a small herd of Tennessee Stiff Leg goats as well. Lastly, Great Pyrenees and Anatolian livestock guardian dogs are kept for goat protection from predators. Breeding of goats in the last five years has in most cases been natural, although use of artificial insemination has been used with greater emphasis with the dairy herd and recently with our other meat and fiber breeds. Intermittently, the Institute has also included and cared for sheep as a valuable species for comparative research.

While most of the Farm's does follow their natural Fall breeding cycle, the Research Farm has a yearly program of out-of-season breeding to

provide animals for birthing centers of the State Fairs in Tulsa and Oklahoma City.

FACILITY ENHANCEMENTS

As the Goat Institute has kept on growing during the recent five years, the Research Farm has incorporated a number of important facility enhancements that have increased the research and extension capabilities of the Institute.

Main Farm

Presently, dairy goats are machine-milked in a parlor with 10 parallel stations designed for rapid exit. The parlor is equipped with an up-to-date ICAR-approved system. The parlor capacity was chosen to match the attached Lactation Barn that has 8 pens, each fitted with 10 Calan Gate feeders. This allows for an entire pen to be milked at once, decreasing labor required for milking and increasing efficiency of data collection. Animals are identified electronically through a 'reading bay' that communicates with the computerized milk recording system featuring greater sensitivity in the recording of the amount of milk produced. Other parameters related to milk production that are important in commercial and research settings are also recorded automatically: milk production, milking flow rate, time to milk each animal, and station number. Several improvements in the new milking system software allow for additional management information that can be digitized as well. The milking system is also equipped with a sampling system for monitoring of milk composition by Dairy Herd Improvement (DHI) standards and equipment.

During 2015, the existing Calan Gate feeders were upgraded with new electronic cards that have a better sensitivity and animal specificity when allowing feeder access. The one-piece fiberglass

The milking parlor remains the conerstone of most dairy goat studies.

Pasteurization of milk is one of the hygienic practices at the Research Farm.

Each year there is linear appraisal of the Alpines.

feeders were replaced with two-piece units having a lightweight removable pan at the bottom. Several floor scales were purchased to replace old equipment. A security camera system allows monitoring from seven sites for more effective control of farm activities as well as providing an additional surveying mechanism for animal well-being assurance.

The simple and inexpensive preweaning nursery for Alpine kids improved management and growth of replacements.

Fences have been maintained and new metal posts added for goat containment while in pastures. Six hundred feet of new cross-link type fencing has been added to outside pens. Three new 12' x 42' (14' high) resting shelters manufactured of structural steel tubing with a white UV-resistant polyethylene cover that provide ample shaded areas for goat comfort during high temperature days have been added to the pre-existing five canopies. Dairy pastures continue to be seeded with a variety of forages for forage-based dairy goat production system research, in addition to studies conducted in confinement facilities. Over the years there has been continual upgrading of the animal movement facilities near the Lactation Barn.

Our 4-year old feed processing center has been upgraded with more sophisticated and custom-made batch controller technology that automatically controls feed allocation activities. The new equipment has capabilities to deliver on the basis of rations programmed into the system six bulk ingredients (mostly concentrates and protein supplements such as corn, oats, wheat middlings, and soybean meal) stored in upright metal silos and 14 micro-ingredients such as minerals and vitamins. Connected to our new machinery, we have a large 250-kg feed mixer with a ribbon elevator for chopped roughage addition and an upgraded pre-weighed liquid molasses delivery system. A new Weigh-Tronix ZM301 wall mount indicator has been installed as a remote display for the Davis mixer scale. The overall new setup has improved the capability for preparing 'total mixed rations' and decreased time devoted to feed mixing. Forty new heavy-duty mobile feed containers were purchased for ease of ration storage and research feed movement inside farm facilities.

A total of 600 square feet of new moisture-resistant ceramic flooring has been installed in the Reproduction Lab and the two Main Arena bathrooms. Re-surfacing of the milk tank room and milking parlor floors with a high-impact linoleum surface was accomplished. Two new heaters provide comfort in the milk tank room and dairy parlor.

The Maternity facility has been provided with a 300-kg capacity floor scale, an electronic insect zapper, a set of 10 portable light-weight panels for improved animal trafficking, and a camera monitoring system with internet capabilities that allows extramural monitoring of goat condition.

A new outdoor 100-kid pre-weaning nursery facility (5,760 square feet) of manufactured structural steel tubing with a white 1,600-square foot UV-resistant polyethylene canopy was constructed to improve outside care of kids during wet (heavy parasite) and summer (hot and dry) months. The area features a crushed limestone/soil surface, loose gravel alley, fence-hanging metal hay racks, water troughs, and kid bar concrete bucket holders for efficient milk feeding. Each of the 32' × 10' wire panel-enclosed pens is provided with a polyethylene hutch for shelter. In an effort to reduce the number of milk-transmitted caprine arthritis encephalitis (CAE) cases, a new stationary automatic pasteurizer and heat treatment unit for colostrum, capable of handling 30 gallons of milk, was added to nursery operations. The kid nursery that features 30 double-deck metal cages, with each level providing 15 square feet of floor space with a sanitary liquid and solid waste tray, has also been upgraded with new wooden cabinetry, two portable 3-gallon automated temperature control pasteurizers, and a freezer to store CAE-negative colostrum for healthy kid feeding.

The Assisted Reproductive Technology Laboratory is outfitted with a biosecurity hood, two goat embryo incubators, pH meter, autoclave, semen/colostrum densitometer, two bioscopes, a microscope with photographic recording capabilities, water bath, needle vacuum aspirator, three table-top centrifuges, refrigerator, programmed cryogenic system, three liquid nitrogen tanks for storing frozen semen, electro-ejaculator for the collection of buck semen, three ultrasound portable machines, vaginal secretion impedance measuring probe,

The Assisted Reproductive Technology Laboratory opened a new area benefiting research and extension activities.

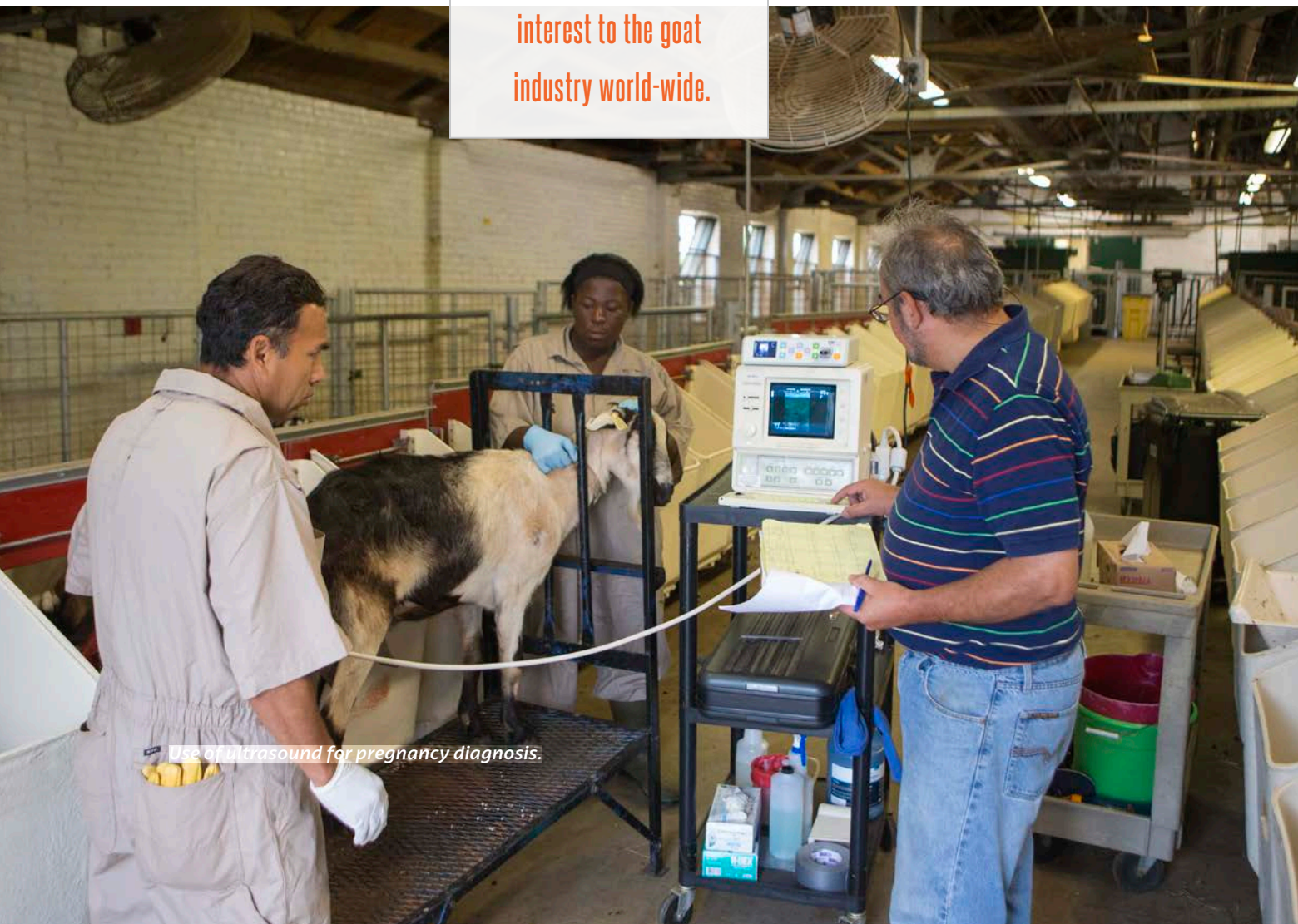
Dr. Erick Loetz, Research Farm Manager, has led implementation of the Assisted Reproductive Technology Laboratory.

Automated cell counter for spermatozoa evaluation.

and complete laparoscopic insemination equipment. All these items and associated tools and consumables provide trained farm personnel with the capacity to perform: estrus/ovulation synchronization, out-of-season-breeding, semen collection and evaluation, optimum breeding time, artificial insemination (transcervical and laparoscopic), embryo collection and evaluation, embryo transfer, ovarian oocyte pickup and evaluation, embryo culturing, hormone (progesterone and LH) evaluation using ELISA kits, ultrasound A and B mode imaging (transrectal and transabdominal), and oocyte/sperm and embryo freezing capabilities.

Capability of the Assisted Reproductive Technology Lab has been enhanced with the purchase of a new photo imaging system that partners with an also new more sophisticated stereoscope. A small portable ultrasound imaging system has been purchased to provide ambulatory capabilities for early pregnancy diagnosis under field conditions. An automated cell counter now is used for more efficient and accurate spermatozoa counts and live/dead cell differentiation for semen evaluation. A new reproductive probe with imaging capabilities of internal cervical anatomical features enriches instruction of artificial insemination techniques in goats. A state-of-the-art laparoscopic cradle, in addition to a hysteroscope and image monitor, enhances the teaching and research capabilities of the lab.

New reproductive technologies are of interest to the goat industry world-wide.



Use of ultrasound for pregnancy diagnosis.

Notable enhancements at the South Farm include new fence and hay feeder designs.

South Farm

The South Barn was originally constructed in 1995 with 12 indoor/outdoor pens, each with an indoor area of 400 square feet and a similar area outside. Six of these pens were used in the first few years for an Angora Buck Performance Test that, in 1997, became a Meat Goat Performance Test. In 1999, these six pens were fitted with 53 Calan Gate feeders so that individual feed intake could be measured on buck performance tests. The other six pens were used for research and normal management practices of the Farm. In 2002, an automated feeding system for groups of goats was installed in four of these six pens and further expanded in 2013 and 2014 to include an additional two and six units, respectively. These automated feeding units are constructed by Osbourne Industries Inc., Osbourne, Kansas, with the 'FIRE' acronym for Feed Intake Recording Equipment. They were originally developed for swine. The Institute made many modifications to improve usage with goats and sheep over the years that the company has adopted. All six automatic no-freeze animal watering troughs serving these 12 pens were replaced. The South Barn houses a Pilot Tannery for processing of goat hides for leather research. The tannery equipment includes a tanning drum, fleshing machine, dry shaver, wet shaver, and a staking machine. There is a 250-square foot, environmentally controlled meeting room for extension and teaching activities, such as associated with tanning, artificial insemination, other multi-purpose workshops, and the annual Goat Field Day.

Initially, the South Farm had a small number of very large pastures. Now, however, it hosts many small-sized pastures for grazing experiments and rotational grazing. There are 16 1-acre pastures with various cool season grass pastures and a number of other small pastures with warm season forages. Besides increasing grazing research capacity, this

has facilitated enhanced animal management by allowing grouping of animals in accordance with their production stage and nutritional requirements. To further enhance capacity for forage research and production, a well was drilled for irrigation in 2002. Better hay consumption with less wastage and reduction of feed contamination with soil and fecal matter was promoted with the purchase of 40 large metal round hay bale metal racks. Hay racks position the lower part of the bale 12" above the ground and were custom made to allow 360° goat access yet preventing goats from getting caught in the structure. The racks were commercially constructed using powder-coated technology to prevent rusting.

All animal containment fencing was replaced with a new type of fence design that that considers goat anatomy and prevents animals from getting caught in the fence and injuring themselves. All approximately 2.5 miles of farm access roads are, on a yearly basis, resurfaced with crusher run gravel material for appropriate and safe road vehicle traffic.

The South Farm has a fenced, mortality composting area established through funding awarded the university through a USDA 1890 Institution Capacity Building Grant. The mortality composting area has a 3-bin roofed, wooden mortality composting structure with a concrete floor and graveled work area. Several examples of low-cost alternative type compost bins are also located in the mortality composting area. The mortality composting area is mainly used for training and instructional purposes.

New Research Facility Complex

In response to the continued interest in studies that provide information on goat

The feed mill facilities allow feeding/nutrition studies with multiple total mixed rations and concentrates designed for specific animal needs and basal dietary forages.

State-of-the-art feed mixing facilities are important for research with lactating dairy goats consuming total mixed rations.

production, the need for physical improvements in contemporary animal research facility needs as well as the necessary support personnel safety and comfort, construction of a new modern research facility was started in 2014 and finalized in 2016. This was accomplished through several years of detailed planning with the Long Range Facility Planning division of Oklahoma State University. The project was funded by the U.S. Department of Agriculture National Institute of Food and Agriculture (NIFA). The new research facility complex covers a total area of approximately 35,000 square feet. It is located just to the east of the pre-existing South Barn. It includes innovative floor planning for optimum goat traffic, appropriate care and welfare for research animals, parking areas, and two lagoons for water disposal. Of the total surface area, about 60% is dedicated to housing of livestock in groups, with indoor and outdoor areas. Another 18% is to be used for individually maintained animals. The new complex will be endowed with equipment using the most recent technological advances that generate promising changes and opportunities for goat production research.

The covered portion of group pens (400 square feet indoors and the same outdoors) have concrete flooring and are fitted with automatic no-freeze waterers and FIRE feeding units noted earlier. The FIRE feeders are controlled by a computerized system that recognizes individual animals via an RFID electronic ear tag and delivers feed from two metal feed bins outside through an auguring system. The FIRE feeders collect data on the number, time, and length of feeder visits and feed consumption per visit and day. The pens are divided by metal panels with a reinforced plastic panel in the middle. In addition, the pens include front panels designed

Planning of the new research facility began in 2000 when a hay storage barn in the old equipment yard of the Main Farm was lost to a storm.

Drs. Tilahun Sahlu, Arthur Goetsch, and Marvin Burns inspect the pen feeding section of the new research Farm.

LANGSTON UNIVERSITY

Moving Spanish does and kids at the South Farm.

Accurate weighing of diets is essential to feeding and nutrition trials.

to allow feeding through bunks located in the alleyway for some studies.

The group pen area includes two large industrial roof-hanging fans for temperature control and ventilation. All roofing has moisture barriers, and there is mesh netting to prevent bird entrance and maintain hygienic conditions. Alleyways were engineered to maximize efficiency and safety when animals are moved.

There is an individual feeding room, with an area of 1,800 square feet, that contains 36 elevated individual metal pens, each 4 × 4 feet with plastic-coat expanded metal flooring over a waste collection tray designed for easy cleaning. A room of nearly 1,400 square feet has a commercial 'tub' working system with an alleyway, scale, and sorting gate for routine animal care as well as research activities. Metabolism crates are situated in a room for collection of feces and urine, which is adjacent to a room with crates used with the indirect respiration calorimetry system measuring consumption of oxygen and emission of carbon dioxide and methane, previously housed in the North Barn.

In addition to the areas mentioned, about 12% of the new facility will be used for hay grinding, hay and feed commodity storage, and a garage mechanical shop. About 10% of the remaining area is in two rooms dedicated for use of the tissue grinder unit for body composition research, previously situated in the 'Hangar' of the South Barn since 2004 until the Pilot Tannery was established in 2010.

The new facility will greatly expand the potential scope and quantity of future research.

North Barn

The North Barn has undergone many small improvements over the years in animal pens, watering systems, and animal management areas. Recently, modifications in one area of the facility were made for stringent control of temperature and humidity to achieve specific heat load index values for evaluating resilience of sheep and goats to different environmental conditions. The North Barn has been used in studies assessing feed intake, digestion, and efficiency of nutrient utilization. The 4-animal head-box respiration calorimetry system has been used in the facility extensively since 2001. It is to be transitioned to the new facility at the South Farm described above and expanded to a 6- or 8-animal system. Plans are being made for future use of the North Barn, which may be in raising of and studies with young dairy kids.

Hair sheep in a central sire-performance test at the South Barn.

The recently procured 80-acre area adjacent to the South Farm provides opportunities for unique research, such as relating to internal parasitism considerations for land not previously grazed by small ruminants.

Land

The Institute has had some usage in the last five years of two fenced 40-acre plots with typical Oklahoma grassland located at the northernmost section of Langston University campus. Moreover, an 80-acre semi-wooded area was recently purchased for additional grazing areas. It is located on the northern boundary of the South Farm and is currently under development.

Landscaping

There has been much attention given to landscaping at the Main Farm, North Barn, and South Farm to beautify the area and create a pleasant working environment. Use of low-maintenance native flora has been emphasized. Twenty-five ornamental trees were planted in different areas of the farm. A small (200 square feet) flower garden was created at the Main Farm. The area of the Main Farm lawn used during the annual Goat Field Day was uprooted, leveled, and replanted to improve its quality and provide a flat, gently sloping terrain.

Machinery and Equipment

There have been a number of machinery and equipment additions necessary for research and extension functions of the Institute that are highlighted below.

- Portable large round bale (1,200 lb) hay grinder.
- Portable welder generator with 4 × 6 foot trailer fitted with acetylene and oxygen tanks.
- Large round bale hay trailer/wagon with 11-round bale capacity.
- Skid loader equipped with a light-duty grapple implement for use with tree limbs and other debris.

- Two new 1/2 ton 4-wheel drive F150 pickup trucks (one with camper shell).
- 1/2 ton Dodge Ram pickup truck with a back powered lift.
- Dually F350 1-ton truck for trailer usage.
- Power/steam cleaner with 3,000 PSI delivery.
- Two low deck utility trailers to move/haul goats.
- 300-gallon pasture sprayer for fertilization and herbicide application.
- John Deere 830 Mower/hay conditioner.
- 12-wheel hay rake with 20-foot spread.
- 468 John Deere round hay baler with net wrapping capability.
- 20-hole grain drill for use with small and large seeds and capacity for fertilizer application.
- Two 997 John Deere zero-turn mowers with 72" decks.
- Tractor mower with a 48"-deck.
- Brush hog with 15-foot span.
- Revolving hoof trimming table.
- Off-the-road utility vehicle fitted with a canopy and wind shield.
- Two water softener tanks were replaced with up-to-date systems.
- Two washer and two dryers for farm clothes cleaning.
- Portable cabinetry and storage for veterinary instrumentation.

Research at a number of on-campus locations as well as at off-campus farms and sites in Oklahoma and surrounding states makes for challenging and ever-changing vehicle and equipment needs.

PERSONNEL

Research Farm personnel both care for livestock and serve as support personnel for research conducted by Institute scientists. The number of permanent employees of the Research Farm has varied

Large round bales both purchased and produced at the Research Farm are important to the nutritional management plan of the Institute.

Laparoscopic artificial insemination.

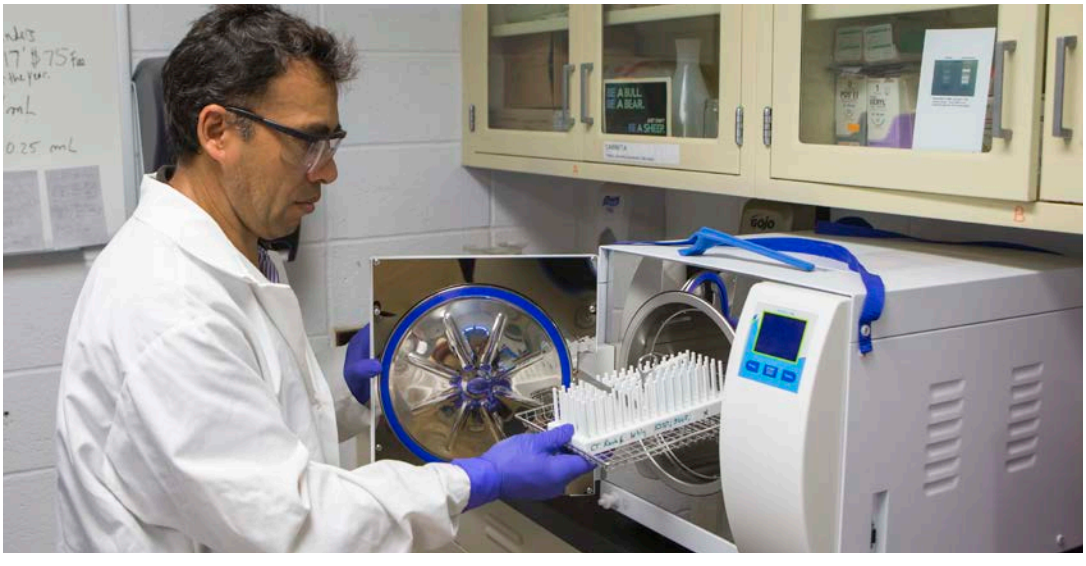
over the years, with a Manager, Assistant Manager, Supervisor, and 12 to 14 support animal technicians. Farm personnel are strategically trained to better accomplish routine and new research-related job assignments. In addition, students are an important part of the Farm personnel, working part-time to both support their schooling and gain valuable experience in small ruminant production. Typically, the Research Farm employs eight to ten students at any given time depending on research needs.

ANIMAL WELFARE

Existing animal care and well-being Research Farm policies are routinely re-emphasized to reflect contemporaneous concerns and compliance with legislation on the humane treatment of animals. Trained personnel oversee the enforcement of policies designed to ensure animal welfare. All research projects performed at the Research Farm undergo prior scrutiny and approval by an Institutional Animal Care and Use Committee. Under the guidance and leadership of a licensed veterinarian, several health programs are in place to ensure animal health and control of potential zoonotic diseases. Furthermore, Institute researchers training in animal care and use and in ethics using the Collaborative Institutional Training Initiative.

BIOSECURITY

In recent years, the threat of foreign animal diseases entering the U.S. and impacting the U.S. livestock industry has remained an important concern. Due to these threats, and to safeguard the Institute's animals, in 2001 Langston University formed an Internal Biosecurity Committee. As a result of committee recommendations, Langston University adopted and implemented biosecurity measures suggested by the United States Department of Agriculture and the Animal and Plant Health Inspection Service. A high capacity ecologically friendly incinerator to dispose of biological products aids in the biosecure disposal of livestock mortality.



Mr. Miguel Rojas using an autoclave in the Assisted Reproductive Technology Lab.

Laboratory Coordinator Mr. Kesete Tesfai with the nitrogen-carbon analysis system.

CENTRAL LABORATORY

The Laboratory of the E (Kika) de la Garza American Institute for Goat Research fulfills an important role in the Institute's overall research program. The centralized laboratory receives samples from Institute staff and Visiting Scholars and has the responsibility of returning to researchers accurate results from many different types of assays. To perform this function takes a wide variety of laboratory equipment, well ordered and organized laboratory facilities and procedures, and, most importantly, dedicated personnel. Throughout the past five years and before, the Institute's laboratory has striven to keep pace with scientific advancements and the growth and complexity of the Institute's research program.

INSTRUMENTS

The modern laboratory equipment found today at the Institute is much more computerized, automated, and complex than that of a decade ago. These instruments have benefited the Laboratory in reducing turnaround time for sample analysis and in enhancing data accuracy. In order to efficiently complete analyses of a large number of samples, many automated pieces of equipment are required. Some of the existing instruments are two gas chromatographs with automated samplers for determining concentrations of long-chain fatty acids in tissue, food products, and blood and short, volatile fatty acids in ruminal fluid and blood. An automated glucose/lactate analyzer allows simple and rapid determination of these important blood constituents.

A large muffle furnace with a timer is used to quantify ash as well as preparing samples for analysis of specific minerals using an inductively coupled plasma emission spectrometer. Two Parr 6300 bomb calorimeters are used to determine energy concentration in a variety of samples, particularly important for studies in which energy metabolism is assessed via an indirect open-circuit respiration calorimetry system. Other pieces of equipment include a stainless steel refrigerator, water purification system, perchloric acid hood, deionized water system, acid neutralization system, humidifier for animal fiber analyses, CFX96 BioRad real-time quantitative PCR detection system, Experion automated Electrophoresis Station with printer and

vertex station for protein and RNA electrophoresis, Molecular Imager® Gel Doc™ XR + System with Image Lab™ Software (which includes Gel Imaging system, darkroom, UV transilluminator, epi-white illumination, camera, and Image Lab software), Transilluminator UV/white light, mini-plate spinner model MPS-1000, Microcentrifuge-16K with adaptor, mini-centrifuge, CO_2 incubator, and tissue homogenizer. There is a video monitor with the microscope in the fiber/histology unit used for follicle assays for a high speed of measuring fiber follicle activity as well as minimizing user fatigue.

There have been a number of pieces of equipment added and ones procured as replacements and(or) upgrades over the past five years. An example of this is an Agilent 1200 Series HPLC that has been used primarily in amino acid analysis. Its function has been enhanced by addition of a fluorescence detector. The old digestion unit used for preparing samples to be analyzed for amino acids was replaced two years ago with a CEM Discover SP-D closed vessel microwave digestion unit. A new ANKOM 2000 fiber analyzer for quantifying fractions of neutral and acid detergent fiber was purchased to replace an older, well-used unit, as well as to take advantage of enhancements in equipment technology.

A number of recent experiments have dealt with water, some relating to resilience to low drinking water availability and others involving quality, such as high levels of salt and other minerals. A Model 2020 Osmometer of Advanced Instruments, Inc., for measuring plasma osmolality by freezing-point depression, was added in 2012 for this research area.

The project addressing progress in selection for resistance to internal parasitism generated a huge number of samples for fecal egg count and need for upgrading of relevant laboratory capability

Determining fecal egg count.

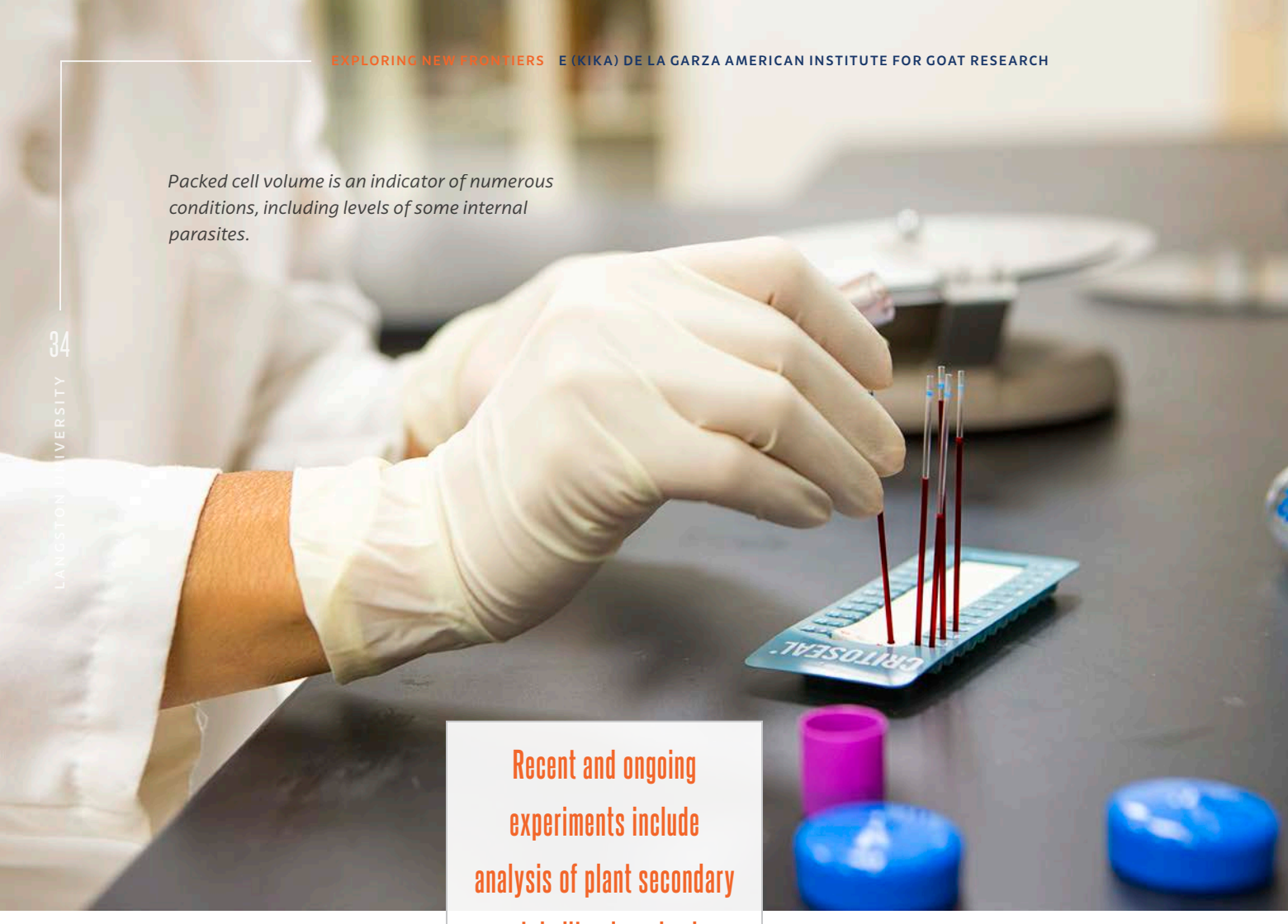
Analyzing blood samples for multiple components.

Many assays require dilution of samples and reagents, necessitating automated equipment like a Hamilton Microlab Diluter obtained a few years ago. Similarly, two Mettler Toledo balances (Model MS104TS) and one XS-Precision Balance have been acquired to accurately weigh samples and chemicals. Moreover, some analyses require separation of fluids into fractions of different densities by centrifugation. Examples would be 'spinning' of blood to derive plasma or serum, depending on whether or not an anticoagulant was used. But for other procedures, very high speeds of rotation, or revolutions per minute, are required. In this regard, recently a high speed Allegra 64R centrifuge was purchased.

Current research projects include an emphasis on blood constituent levels, necessitating use of new pieces of equipment.

A Cyclone mill was procured to decrease particle size of dry samples to a very fine state in preparation for analyses. One very important assay conducted on dry as well as wet samples is for nitrogen, often converted to crude protein by multiplying by a factor such as 6.25 assuming that nitrogen is 16% of protein in a sample. The Institute's capacity for this determination was recently markedly upgraded by addition of a Leco TruMac Nitrogen and Carbon Analyzer. Another important piece of equipment in most labs is the spectrophotometer, although there are many different types used for a multitude of analyses. For such work the Laboratory replaced an old, outdated unit with a Genesys 10S UV-Vis spectrophotometer. And, a BMG Labtech SPECTRO star® Nano microplate reader, also with colorimetric quantification, was obtained for use with small sample sizes and large numbers of samples. This unit is part of a clinical chemistry lab, along with a Vet Axol unit of Alfa Wassermann and YSI 290 Biochemistry Analyzer. The Institute's analytical capacity was also improved by addition of an Elan2 Digital liquid nitrogen generator. Liquid nitrogen is often used to rapidly ('snap') freeze samples to stabilize composition. Moreover, it is used in tanks to store semen for use in assisted reproduction techniques such as artificial insemination.

One of the areas of research receiving appreciable attention in the last five years is internal parasitism. The number of samples that have been analyzed for fecal egg count (FEC) is tremendous. Because of the need for conducting the assay within a few days after sample collection and the large number of animals sampled at many times,



Packed cell volume is an indicator of numerous conditions, including levels of some internal parasites.

Recent and ongoing experiments include analysis of plant secondary metabolites in redcedar foliage and individual fatty acids in dairy goat milk.

frequently there have been as many as six people working to determine FEC, some preparing samples and others at microscopes counting. In accordance, a few years ago three new microscopes were acquired. There has been considerable capacity building in the Laboratory for research in the general area of immunity, primarily in regard to its importance in resistance to internal parasitism. An Attune® Acoustic Focusing Cytometer was purchased for immunophenotyping leucocytes and analyzing other cell culture samples. An EVOS FL fluorescence and transmitter light microscope was obtained for imaging fluorescently labeled cells. Moreover, an inverted VistaVision microscope now allows observation and enumeration of cells in culture flasks or dishes.

A current research project of the Institute deals with use of goats for control of redcedar trees. There is considerable variability in consumption of redcedar foliage by goats, in terms of individual trees, seasons of the year, and many other factors. One characteristic of cedar trees that may influence intake by goats is the level of plant secondary metabolites, particularly terpenes. Near-infrared spectroscopy can be used to determine levels of many compounds and two years ago a Near Infrared SpectraStar® unit of Unity Scientific was obtained for quantification of cedar terpenes, in particular monoterpenes. However, in future years it is quite likely that this unit will be used for many other analyses.

To facilitate research on goat leather, several pieces of equipment were added to the laboratory. A Tippman Model CL7 7-ton pneumatic die cutter along with Progressive Service Die Company dies made to ASTM test specifications can be used to cut leather for specific strength tests. Prior to testing, the cut leather samples must be maintained at a specific temperature and humidity level for which the lab uses an Associated Environmental

Systems Model LH6 temperature/humidity chamber. This temperature/humidity chamber has also been used to prepare goat fiber samples for analysis. An MTS Criterion Model 42 Electromechanical Load Frame with pneumatic grips tests leather strength and elasticity. Finally, to evaluate the surface of leather a Motic DM-143-FBGG stereomicroscope/camera combination was purchased. This stereomicroscope contains a built-in camera that connects to a laptop computer to record digital images.

ASSAYS

The varied research conducted at the Institute means that the Laboratory receives samples of many different types, i.e., feedstuffs, forage, digesta, tissues (typically meat), blood, animal fiber, fecal material, urine, skin biopsies, and milk. Furthermore, current research trials often call for analyses outside of routine laboratory procedures. For example, while most assays for feedstuffs, digesta, feces, etc. are basic ones such as dry matter, ash, nitrogen, energy, fiber and so on, increasingly, specialized assays such as purification and determination of condensed tannin content, estimation of bacterial flows through purine determination, individual amino acid concentrations, mineral analyses, or determination of indigestible feed components are conducted. Tissue samples, in addition to some common analyses, are routinely analyzed for total lipids. Moreover, levels of specific fatty acids are sometimes determined in both meat and milk samples. Ruminal fluid is sampled in many experiments and concentrations of ammonia, volatile fatty acids, and purines can provide indicators of diet digestibility and quality. Blood samples are analyzed by a wide range of assays such as urea, glucose, lactate, albumin, cholesterol, creatinine, total protein, triglycerides,

The array of analyses conducted continues to expand.

Proper sample labeling is of utmost importance to laboratory analysis.

fatty acids, various hormones, hemoglobin, and oxygen saturation.

Fiber yield, diameter, and length are assayed from mohair produced by Angora goats and cashmere from Spanish goats. Hair follicle activity determined from skin biopsies provides data on seasonal fiber growth patterns.

PERSONNEL

Skilled, trained personnel are required to perform the range of assays conducted in the Laboratory and to run and maintain the instruments. The number of permanent personnel in the lab has been two in most of the past five years, but recently an additional technician was added. Besides the routine work in the laboratory, its personnel sometimes become closely involved in particular experiments when possessing unique needed skills. Moreover, periodically laboratory personnel receive training, either at the Institute or elsewhere, in operation of specific pieces of equipment or in conduct of new assays.

In addition to the permanent laboratory staff, undergraduate students, typically two to four, work in the lab part-time. Also, Visiting Scholars, graduate students, and research faculty participate in laboratory analyses. With the appreciable amount of research and laboratory assays conducted, as well as the large number of people working in the lab, protocols developed for specific experiments and a 'Laboratory Request Form' are important tools for maintaining organization and achieving accurate and fast results.

Undergraduate and graduate students, Visiting Scholars, and research faculty participate in laboratory analyses.

Microwave digestion of samples for amino acid analysis.

Undergraduate students gain valuable practical and technical experience through summer internships with the Institute.

STUDENT INVOLVEMENT

The E (Kika) de la Garza American Institute for Goat Research has continued to involve agriculture students in every phase of its research and extension programs in the last five years.

Personnel within the Institute teach the majority of the Animal Science curriculum including AS 3123 Animal Nutrition, AS 3433 Feeds and Feeding, AS 4123 Small Ruminant Management, AS 4133 Animal Breeding, AS 4333 Applied Statistics, and AS 4513 Large Animal Production. Many undergraduate students in Animal Science have been hired as interns or student workers at the Goat Research Farm, Central Analytical Laboratory, Dairy Foods Laboratory, Dairy Herd Improvement Laboratory, and Pilot Creamery.

Other students help scientists with field work or computer programming such as coding behavior videos.

The Institute and undergraduate Animal Science programs have become closely linked and intertwined over the years.

During the summer, some students were employed full-time to help conduct research projects. These students assisted research scientists in sample and data collection and analyses with great interest and enthusiasm. The students have been trained hands-on in laboratory safety, good laboratory practices (GLP), good manufacturing practices (GMP), etc., as top priorities in laboratory and research environments.

Advanced technologies and sophisticated methodologies in animal research and laboratory analyses have been acquired by the students under the guidance of research scientists. As an initiative to establish undergraduate research at Langston University, some students were assigned to independently

Part-time employment of undergraduates benefits students and the Institute.

Undergraduate student worker in the Dairy Herd Improvement Laboratory.

Graduate students from other countries conducting 'sandwich' research adds another dynamic aspect to the Institute's program.

conduct portions of research projects and present research findings at regional conferences. Laboratory skills and research techniques learned should be of benefit in the pursuit of advanced degrees in animal sciences and other agriculture-related fields.

The work experiences in actual research and extension projects have not only enhanced their knowledge in animal husbandry but also increased interest in animal research. The involvement of students in research and extension also presented a means of financial aid for their education as they prepared for future careers in animal and agricultural industries.

In addition, research involving M.S. and Ph.D. students and Postdoctoral Research Associates has been a focus of the Institute. Five Ph.D. students from the U.S., Canada, Ethiopia, and Brazil and one M.S. student from the U.S. have conducted part or all of their degree research at the AIGR. Eleven Puerto Rican undergraduate students in Animal Science completed summer internships as partial fulfillment of requirements for graduation. Also, there were four undergraduate summer internships as a part of a research project conducted in the Oklahoma State University Department of Animal Science.

All of these undergraduate and graduate students actively participated in extension activities conducted by AIGR extension specialists as well. They have become an integral part of the

Body condition score training by Dr. Lionel Dawson.

AIGR research and extension programs in research conduct, information dissemination, technology transfer, and career development.

Undergraduate and graduate students and Post-doctoral Research Associates also have opportunities to assist in preparing for and conducting producer-oriented workshops such as tanning goatskins and cheesemaking and the Institute's annual Goat Field Day. Through these activities, these individuals develop extension and communication skills, learn how outreach activities are designed and presented, and interact with goat producers thereby learning more about goat production and the issues important to the goat raising community.

CENTER OF VETERINARY HEALTH SCIENCES COLLABORATION

It is sometimes challenging for goat producers to locate a veterinarian willing and who has had prior experience working with goats. The Institute has been collaborating with the Boren Veterinary Teaching Hospital in the Center of Veterinary Health Sciences at Oklahoma State University (OSU) since 1984 to remedy that situation.

OSU veterinary students gain experience with goats at the Research Farm not available otherwise and the Institute and regional goat producers also benefit greatly.

2016 undergraduate interns from Puerto Rico.

Ms. Luana P. S. Riberio, "sandwich" Ph.D. student from Brazil, working in the lab.

Dr. Lionel Dawson of the OSU College of Veterinary Medicine brings first-, second-, third-, and fourth-year veterinary students to the Institute for training in management and health care of goats. The relationship with the veterinary school expanded in 1998 when Langston University began providing partial salary support for Dr. Dawson for veterinary care, participation in extension and research activities, and training of future veterinarians. Also in 1998, the veterinary school curriculum began including small ruminants.

Training activities at the farm for first-year students include handling, examination, injections, foot trimming, sedation, castration, FAMACHA© scoring, and body condition evaluation. Second-year students can take an elective course in small ruminant medicine course taught by Dr. Lionel Dawson, which is completed by nearly 40% of the students. Third-year students with interest in goats are exposed to procedures such as foot trimming, venipuncture, FAMACHA© scoring, and ultrasonography.

In the senior year, on a weekly basis students are provided with clinical training in management and diagnosis and treatment of diseases. Some of the procedures done at the farm are vaccination, evaluating and treating sick animals, artificial insemination (transcervical and laparoscopic insemination), sedation, and surgeries (rumen cannulations, ceasarian section, etc.).

As a result of this collaboration, there has been a significant increase in the number of veterinarians graduated in the last 15 years with experience in goat health care and who are willing to help goat producers and FFA and 4H groups.

Eleven Puerto Rican undergraduate students have conducted internships in four summers.

Puerto Rican undergraduate interns working on a mortality composting study.

Dr. Roger Merkel instructs student interns on the process of tanning goatskins.

PERSONNEL

FACULTY, STAFF, RESEARCH SCIENTISTS, AND EXTENSION SPECIALISTS

Dr. Lionel J. Dawson

- D.V.M. from Madras Veterinary College; M.S. from Iowa State University
- 1998–present
- Animal health management and reproduction

Dr. Dawson is a veterinarian with Oklahoma State University. In July of 1998, Dr. Dawson's participation in research and extension activities of the Institute became official, through contracting of a portion of his time. Dr. Dawson is responsible for general herd health management and he participates in both research and extension activities.

Dr. Terry A. Gipson

- Ph.D. from the University of Illinois
- 1998–present
- Animal breeding and genetics

From 1991 through 1993, Dr. Gipson was a Postdoctoral Research Associate with the Institute. Dr. Gipson's activities during this time were primarily in breeding for year-round cashmere production. In 1998, Dr. Gipson joined the Institute as an Associate Research Professor with a split extension-research appointment. Currently, Dr. Gipson is the Goat Extension Leader and coordinates the goat component of the outreach program. Some of Dr. Gipson's responsibilities include coordination of the annual Goat Field Day, editing of the Goat Newsletter, organization of producer workshops, and supervising the meat goat buck performance test. Some of his recent research has concerned extended lactations in dairy goats, selection for residual feed intake in Boer goats, and rumination as an indicator of animal well-being.

Dr. Arthur L. Goetsch

- Ph.D. from New Mexico State University
- 1998–present
- Ruminant nutrition

Dr. Goetsch joined the Institute in 1998 as a Research Scientist and was later appointed Research Leader. Dr. Goetsch's research has been in a variety of areas related to the profitability of goat production. This research has addressed various feeding management practices for all types of goats in the U.S. in various stages of production, including Alpine, Angora, Boer, and Spanish genotypes and goats while suckling, growing, in late gestation, and lactating. Particular emphasis has been given to factors affecting efficiency of nutrient utilization. Dr. Goetsch has contributed to the training numerous graduate students and many visiting foreign scientists, he has been involved in considerable collaborative international research. Moreover, Dr. Goetsch has been an Associate Editor for the journal Small Ruminant Research since 2006.

Dr. Steven P. Hart

- Ph.D. from Virginia Polytechnic Institute and State University
- 1991–present
- Animal management and nutrition

In 1991, Dr. Hart joined the Institute as an Assistant Research Professor. From 1995 to 1997 Dr. Hart served as Interim Director for the Institute. Dr. Hart's current appointment is for both

research and extension. Dr. Hart has conducted research with grazing-based dairy production systems, control of internal parasites in goats, and vegetation management with goats. Dr. Hart was very involved in the Mohair Producers of Oklahoma organization and has served as Director of the Oklahoma Meat Goat Association.

Dr. Erick Loetz

- Ph.D. from Oklahoma State University
- 1987–88; 2001–present
- Farm operations management and assisted reproductive technology

Dr. Loetz re-joined the Institute in 2001 as Research Farm Operations Manager. His duties entail maintaining efficient use of resources and implementation of operations management, including evaluation of logistics and coordination of farm activities. Dr. Loetz maintains a seasonal calendar of operations and ensures compliance with University policies and regulations. The management practices are for humane care for all animals and also include coordination of farm personnel and facilities. Dr. Loetz is a member of the Langston University Animal Care and Use Committee. He provides yearly training in laparoscopic artificial insemination for Oklahoma State University veterinary students as well as various international visitors in the areas of management and goat reproduction. Currently, Dr. Loetz is involved in research on estrus and ovulation hormonal control of seasonal reproduction and embryo transfer, and is working to establish a goat in vitro fertilization program.

Dr. Roger C. Merkel

- Ph.D. from North Carolina State University
- 2000–present
- Animal management and nutrition and use of livestock in developing countries

Dr. Merkel joined the Institute in 1997 as a Postdoctoral Research Associate. Dr. Merkel's principal project involved browse utilization by goats. In 2000, Dr. Merkel became an Assistant Professor and was promoted to Associate Professor in 2009. Dr. Merkel's duties entail both research and extension. Dr. Merkel also coordinates or leads many of the international activities of the Institute.

Dr. Ryszard Puchala

- Ph.D. from Warsaw Agricultural University, Poland
- 1995–present
- Ruminant nutrition and physiology

Dr. Puchala was on sabbatical with the Institute in 1992–1995, working in the area of amino acid requirements for fiber growth. In 1995, Dr. Puchala was appointed as an Assistant Research Professor. Dr. Puchala has performed research in

Dr. Steve Hart has had integral roles in extension and research of the Institute for the past 25 years.

Dr. Yoko Tsukahara spent one month at the Institute for training during her Ph.D. program in 2009 and then returned in 2011 for a 5-year period working on Institute research projects.

the areas of hormonal and nutritional regulation of fiber growth. He has been the lead person in use of the respiration calorimetry system to determine energy requirements and characterize energy metabolism of goats as well as for other equipment systems used for evaluating goat behavior.

Dr. Tilahun Sahlu

- Ph.D. from South Dakota State University
- 1986–present
- Ruminant nutrition

Dr. Sahlu was appointed Assistant Professor at Institute in 1986, and in 1991 was promoted to Associate Professor and appointed Research Leader. He was promoted to Professor in 1994, and in 1998 became Director. Dr. Sahlu has placed a strong emphasis on research/extension activities in developing areas of the world to improve livestock productivity for enhanced food security. Dr. Sahlu has directed numerous collaborative projects with international institutions. He served for more than five years as an Associate Editor for the journal Small Ruminant Research.

Dr. Zaisen Wang

- Ph.D. from University of Western Australia
- 2004–present
- Ruminant nutrition and human cancer research

In June of 2004, Dr. Wang joined the Institute as a Caprine Production Scientist, working in the area of internal parasitism in goats, particularly in regards to the role of and means of modification of immunity. Recently, anthelmintic properties of plant extracts have been studied, using in vitro procedures, such as egg hatch and larval development tests. Based on the findings, there are plans to investigate the anthelmintic efficacies in animal models.

Dr. Steve Zeng

- Ph.D. from Clemson University
- 1992–1999; 2001–present
- Food technology

Dr. Zeng worked as a Dairy Extension Specialist/Food Technologist at the Institute from 1992 to 1999. Thereafter, for two years Dr. Zeng worked as a Food Scientist/Research and Development Manager for Galaxy Nutritional Foods in Orlando, Florida. In 2001 Dr. Zeng rejoined the Institute as an Associate Professor/Dairy Product Specialist, with both research and extension duties. In 2009 Dr. Zeng became Department Head for the Department of Agriculture and Natural Resources, but continues participating in activities of the Institute.

GRADUATE STUDENTS, POSTDOCTORAL RESEARCH ASSOCIATES, VISITING SCHOLARS, AND SCIENTISTS ON SABBATICAL

Ms. Marie-Eve Brassard

- 2013
- Native of Canada
- Visiting Graduate Student
- The grazing activity energy cost in meat goats

Mr. Asrat Tera Dolebo

- 2013–2014
- Native of Ethiopia
- Visiting Graduate Student
- Feedstuff associative effects in meat goats

Mr. Worede Zinabu Gebremariam

- 2013–2014
- Native of Ethiopia
- Graduate Student
- Selection of hair sheep and meat goats for resistance to internal parasitism

Mr. Mesfin M. Gobena

- 2014–present
- Native of Ethiopia
- Graduate Student
- Selection of hair sheep and meat goats for resistance to internal parasitism; Resilience in sheep climatic stress factors

Dr. Yong-qing Guo

- 2013–2014
- Native of China
- Postdoctoral Research Associate
- Internal parasitism and immunity in goats

Mr. Ali Hussein

- 2015–present
- Native of U.S.
- Graduate Student
- Resilience in sheep climatic stress factors

Ms. Courtney Jones

- 2013–2014
- Native of U.S.
- Graduate Student
- Economics of selection of hair sheep and meat goats for resistance to internal parasitism

Dr. Sebastián Paez Lama

- 2015
- Native of Argentina
- Sabbatical
- Supplementing meat goat kids with tree legume leaves

Dr. Shirron LeShure

- 2015–present
- Native of U.S.
- Postdoctoral Research Associate
- Monitoring the wellbeing of goats; Minimizing methane emission by goats

Dr. Mengistu Urge Letta

- 2014–2015
- Native of Ethiopia
- Sabbatical
- Resilience in sheep and goats to climatic stress factors

Dr. Haiying Liu

- 2016–present
- Native of China
- Postdoctoral Research Associate
- Minimizing methane emission by sheep and goats

Dr. Raquel Vasconcelos Lourencon

- 2016–present
- Native of Brazil
- Postdoctoral Research Associate
- Comparison of biological control of redcedar with goats to conventional methods of control

Ms. Amanda Manley

- 2010–present
- Native of U.S.
- Graduate Student
- Residual feed intake in Boer goats

Dr. Bridgit S. Muasa

- 2014
- Native of Kenya
- USDA Borlaug Fellow
- Assisted reproductive technologies in goats

Ms. Luana P. S. Ribeiro

- 2015–2016
- Native of Brazil
- Visiting Graduate Student
- Body condition of dairy goats before kidding and during lactation

Mr. Miguel Angel Rojas

- 2016–present
- Native of Bolivia
- Invited Scholar
- Animal management and reproduction

Dr. Mohammed Sawalhah

- 2014
- Native of Jordan
- Postdoctoral Research Associate
- Redcedar control with goats

Ms. Nhayandra C. D. Silva

- 2014–2015
- Native of Brazil
- Visiting Graduate Student
- Feeding regimes for lactating dairy goats

Dr. Zewei Sun

- 2012–2013
- Native of China
- Postdoctoral Research Associate
- Internal parasitism and immunity in goats

Dr. Dereje Tadesse

- 2015–present
- Native of Ethiopia
- Postdoctoral Research Associate
- Resilience in sheep climatic stress factors

Dr. Yoko Tsukahara

- 2009 and 2011–2016
- Native of Japan
- Postdoctoral Research Associate
- Goat research and production and their importance in development projects; Fencing needs and feeding behavior of goats; Selection of hair sheep and meat goats for resistance to internal parasitism

Dr. Chrilukovian B. Wasike

- 2014
- Native of Kenya
- USDA Borlaug Fellow
- Residual feed intake in lactating dairy goats

Dr. Sahlu explaining goat foraging behavior in regards to a woven wire fence during a visit to Puerto Rico.

Ms. Hirut Yirga

- 2015–2016
- Native of Ethiopia
- Visiting Graduate Student
- Use of brackish and saline drinking water by sheep and goats

STUDENT INTERNS

Mses. Michelle Montes Rivera and Rebekah Domenech

- 2012
- Native of Puerto Rico
- Visiting Undergraduate Student Interns
- Goat production practices

Ms. Erin Parkinson

- 2013
- Native of U.S.
- Undergraduate Student Research Intern
- Internal parasitism and immunity in goats

Mses. Marie Negron, Eva Pacheco, and Alexandra Reyes

- 2013
- Native of Puerto Rico
- Visiting Undergraduate Student Interns
- Goat production practices; Mortality composting

Mses. Mirene Rosas Feliciano, Nicole M. Irizarry Lariuz, and Andrea Paola Ríos Lugardo

- 2015
- Native of Puerto Rico
- Visiting Undergraduate Student Interns
- Goat production practices

Mses. Carla Linera, Yahaira Lebrón, and Cristina Coriana

- 2016
- Native of Puerto Rico
- Visiting Undergraduate Student Interns
- Goat production practices

CENTRAL LABORATORY PERSONNEL

Kesete Tesfai (Laboratory Coordinator): 1990–present

Cleovis Watson III (Technician): 1997–present

Mehari Futur Technician: 2015–present

RESEARCH FARM PERSONNEL

Blaise Tohou Bah (Extension Technician): 1999–2015

Morgan Brown (Technician): 2016–present

Nathan Brown (Technician): 2012–present

Glenda Bryant (Technician): 2010–present

Angelica Corpeno (Technician): 2014–present

Glenn Detweiler (Research Farm Manager): 1991–1996; (Research Technician): 1997–2012

Logan Gibbs (Technician): 2015–2016

Abiel Haile (Extension Technician): 2016–present

Johnny Goodwin, II (Technician): 2014–present

Jerry Hayes (Technician, Acting Farm Manager, Assistant Farm Manager): 1990–present

Dinah Jaja (Technician): 2016–present

Erick Loetz (Farm Manager): 1987–1988; 2001–present

Amanda Manley (Technician): 2012–present

Dr. Merkel's recent emphasis has been on goat production manuals and certification programs.

Collection of ruminal fluid for microbial assays.

Nico Mauney (Technician): 2015–present

Bethany Morris (Technician): 2014–2015

Natalie Paige (Technician): 2016–present

Ryan Piersing (Technician): 2013–2016

Italo Portugal (Supervisor and Research Technician): 2007–present

Billy Snelling (Technician): 1997–2012

Henry Stevenson, Sr. (Technician): 1990–present

Henry Stevenson, Jr. (Technician): 1990–present

Filemon Vasquez (Technician): 2007–2012; 2013–2014

OTHER PERSONNEL

Denise Loveless (Executive Secretary): 1981–2016

Eva Vasquez (Technician): 1998–present

Sonya Simpson (Special Assistant to the Dean): 2016–present

Mimosa tree leaves consumed in a cut-and-carry vs. browse supplementation study.

RESEARCH OVERVIEW

The last five years of research activities of the E (Kika) de la Garza American Institute for Goat Research have been considerable and are the product of many factors. The most important is the people involved. Even with many personnel changes, there has been continual excellence demonstrated by a dedicated team of individuals.

PRODUCTIVE PERSONNEL

The number of permanent faculty in the Institute involved in research is not large in comparison with animal science departments in many other Land Grant universities. Hence, to achieve a strong research program, research faculty of the Institute aggressively seek extramural support to provide funds for research equipment and supplies, and very importantly support for Graduate Students (with programs in collaboration with the Animal Science Department of Oklahoma State University), Postdoctoral Research Associates, and established scientists on sabbaticals, who all are often termed "Visiting Scholars." In an earlier section of this report, names and countries of origin of Visiting Scholars over the last five years are listed. These Visiting Scholars have made a large contribution to the high-quality research that has been realized and hopefully will also be achieved in the future.

Though efforts of permanent faculty and Visiting Scholars are integral, it is important to recognize the equally essential contributions of other research personnel of the Institute, notably those of the Research Farm and Laboratory. Only with the hard work of these dedicated people can a highly productive research program be realized. Farm and laboratory personnel work closely with the researchers. In fact, for the purpose of proper training of Visiting Scholars and most appropriate research conduct, as well as because of periodic high labor demands, researchers participate in many laboratory and farm activities. Relatedly, with so many people involved in specific experiments, often from different parts of the world with various previous experiences and training in research, procedures to maintain organization such as detailed research protocols are employed.

> Participation of people from so many countries makes the Institute's program the only one of its kind in the world.

ANIMALS FOR RESEARCH AND EXTENSION

The Institute currently has herds of Alpine, Angora, Spanish, and Boer goats, along with a small number of Tennessee Stiff Leg. Sometimes we are

asked why other breeds are not used. In part this is because of the considerable resources required for maintaining adequate numbers of the different types of goats necessary for planned experiments. There is great care taken to have enough animals for the large number and wide array of experiments conducted, but yet not to expend limited resources on animals not being used in research. Another consideration is the types of animals within the different breeds or breed types. The intent is to have animals typical of those of clientele so that research findings are relevant and of value to the majority of farms, rather than to have the most elite herds.

The Institute is unique in regards to its focus on goats. However, in a number of projects and experiments, other species have received attention. In some cases this relates to comparisons of treatment effects with different species. For example, a dietary supplement might have a different effect with goats than with sheep, similar to various breeds or production stages of goats. Recently there have been a number of projects that include attention to sheep, one which required establishing a small flock of hair sheep. Such projects have facilitated a significant increase in the clientele base of the Institute.

PROJECTS WITH PURPOSE

As noted before, a unique aspect of the Institute's research program is that a large proportion is made possible by grants, many of which are through various USDA programs. Hence, although the broad or general direction of the research program is known, specific topics of investigation in 2- to 4-year periods partially depend on the faculty's ability to obtain grant funds for novel and unique ideas. Researchers are strongly encouraged to seek extramural support funds, but there is care taken to ensure that proposed activities fit with the general direction of the program. An example of this exists in grant projects involving sheep. The competitiveness of proposals submitted for funding consideration was increased by giving attention to sheep rather than study only with goats.

> Although the Institute seeks support from all possible sources, that from programs of the USDA NIFA has been most important.

In the subsequent section, research projects are listed. Although dissemination of

Taking GPS readings for measures on the redcedar control project.

Microbial assays on a ruminal methane emission study.

Desirability of project proposals to be novel and unique has resulted in very diverse sets of research topics being addressed at any one given time.

information generated from all of these projects occurs, some entail strong extension components, examples being "Sustainable small ruminant projection through selection for resilience to internal parasites," "Comparison of control of redcedar with goats to conventional methods of control," and "Establishing a pilot tannery and capability for goat leather research at Langston University." Likewise, there are projects listed in our international section that entail significant research components.

The first research project listed is funded through the USDA National Institute of Food and Agriculture (NIFA) Evans-Allen program. Through such projects the Institute receives "hard" federal funds, most used for personnel and infrastructure support. Other projects can be viewed as providing "soft" funds for specific projects. These projects arise from submission of proposals to competitive grant programs. Reviewers or review panels deemed the topics and research activities proposed to be of high merit, with resultant information of considerable potential value. Many projects have been supported by the USDA 1890 Institution Capacity Building Grant (CBG) program. This program has been of immense importance to the Institute in enhancing research capacity. In addition to this key grant program, proposals are submitted to others with purposes matching objectives of specific studies we would like to conduct.

The great majority of research conducted at the Institute is collaborative. Many of the CBG projects entail involvement of researchers of USDA Agricultural Research Service institutions as well as 1890 and 1862 Land Grant universities. Such collaboration is of great benefit by expanding the scope of measurements to increase the depth and breadth of knowledge gained. In addition to other institutions collaborating in Institute projects, our

researchers participate in many projects of other organizations with similar benefits.

CRITICAL INVESTIGATIONS WITH CUTTING EDGE METHODOLOGIES

All research protocols are reviewed and approved by the Langston University Animal Care Committee. There have been numerous different research methodologies employed and experiments conducted in the last five years. State-of-the-art techniques are adopted or developed whenever they hold promise to yield information needed for particular topics.

Performance Studies

Experiments categorized as "Performance" in nature usually entail measures of live weight gain or milk production, although, often measures designed to help explain the presence or absence of treatment responses are included. Performance experiments are necessary to determine if treatment effects occur under typical field conditions and have been conducted in confinement and grazing settings. Confinement environments have been with individual housing, group feeding, or group housing with individual feeding through use of Calan gate feeders or an automated feeding system. Calan gates are situated at the Main Farm Lactation Barn and the South Barn Meat Goat Buck Performance Test area, allowing goats to reside in groups but facilitating collection of individual animal feed intake data. These facilities have been heavily used in production experiments over the years. The South Farm now includes automated feeding system units in 24 pens, 12 in the South Barn and 12 in the new research facility at the South

Recent confinement and pasture studies have investigated effects of different lengths and times of access to diets and supplemental feeds on ingestive behavior and performance.

Exploring various ways of assessing gas exchange of grazing animals.

FAMACHA© score is an integral component of internal parasite management schemes.

Farm. This feeding system has benefits compared with Calan gates of less labor and greater information concerning the feeding behavior of goats, although feed in the pelleted form works best.

In many confinement studies with both meat and dairy goats, animals behavior is also being characterized by video recording with CCTV cameras and infrared lighting.

Because most goats are raised on pasture, there are many small pastures for research on goats while grazing. Examples are 16 cool season grass pastures at the South Farm, 12 mixed vegetation paddocks at the West Pasture area, some with the tree legume mimosa, and a number of plots with different monocultures or mixed swards for nearly year-round rotational grazing of dairy goats at the Main Farm. In these trials vegetation conditions are thoroughly characterized, examples of which are herbage mass and chemical and botanical composition. In addition to assessing animal performance, many other measures are made to gain an understanding of factors responsible for differences in performance.

Equipment for monitoring behavior generates great numbers of observations over very short periods of time.

Product Studies

The meat goat industry continues its growth in part because of the increasing demand for goat meat. It follows then that some Institute experiments have focused on harvest or slaughter characteristics. Carcass measures include dressing percentage, fat thickness, loineye area, weights of different primal meat cuts, and concentrations of constituents such as fat and protein. Relatedly a large tissue grinder, presently situated in the new research facility at the South Farm, was obtained to assess body composition in an earlier CBG project entitled "Nutrient requirements of goats: composition of tissue loss and gain."

The Institute Laboratory has state-of-the-art Fiber and Histology sections for use in trials concerning animal fiber production, both mohair and cashmere. Assays conducted in the Fiber Lab include length, diameter, and yield. In the Histology Lab, activity of fiber-producing follicles and other follicle characteristics are determined, which in many cases has answered questions not adequately addressed by measures only of the Fiber Lab. There are few other institutions in the world with such capabilities for detailed study of animal

Equipment for monitoring heart rate, protected with a fabric "coat" on a young Spanish goat.

The respiration calorimetry system remains a key component of many studies in both grazing and confinement settings.

fiber production. Moreover, the Institute now possesses capability for research and extension in the goat skin and leather area through the CBG project "Establishing a pilot tannery and capability for goat leather research at Langston University."

Although the Institute has been heavily involved in production and management research, there has been research addressing the use of goat milk and its products. A state-of-the-art dairy products laboratory exists for both research and extension activities. The consumer of goat milk deserves the highest quality and the longest shelf-life of products purchased. In addition to evaluation of milk composition, various types of cheese are frequently evaluated for texture profiles in addition to the above parameters. Studies on goat milk powder, condensed milk, and yogurt occur as well. Findings from these studies will be disseminated to goat milk producers, researchers, regulatory personnel, as well as the general public.

Nutrient Use Studies

Feed intake is a key determinant of animal performance and, thus, is measured in most Performance trials and in essentially all experiments termed as "Digestibility" in nature. Digestibility indicates the amount or concentration of a feed or feed constituent that enters the animal and is available for metabolism. The metabolizability of diets is frequently determined by collection of urine in addition to feces and also measuring ruminal methane emission to account for those additional losses of energy and nutrients.

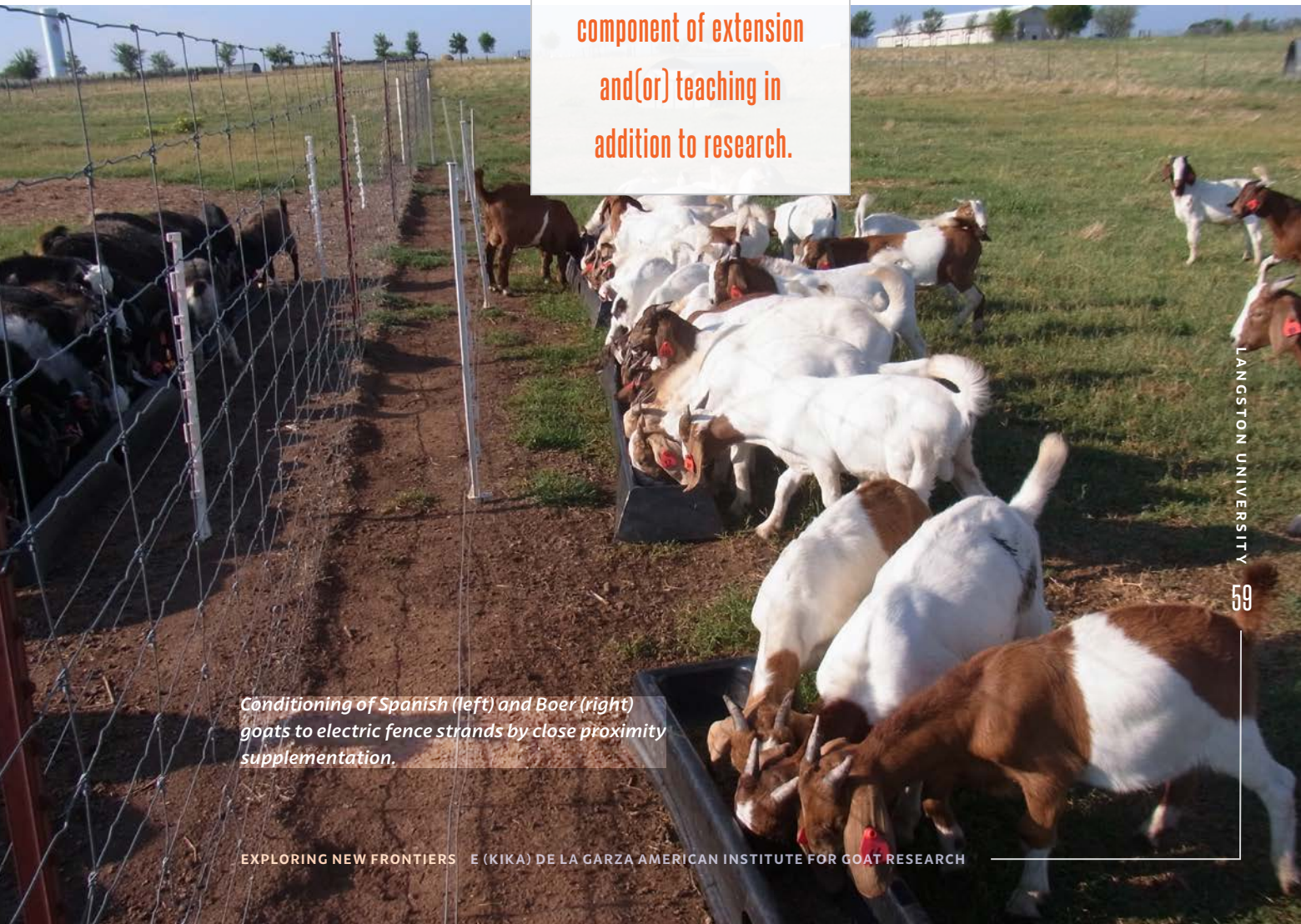
The Institute has been involved in cutting edge research concerning energy expenditure and efficiency of energy metabolism in typical production environments. In 1999, a USDA equipment grant was received for a 4-animal indirect, open-circuit

respiration calorimetry system. This system has been extensively used since 2000 on many projects for assessing heat energy production and ruminal methane emission. In this regard, the current CBG project "Sustainable control of greenhouse gas emission by ruminant livestock" is being conducted to build upon earlier research showing capacity to markedly decrease ruminal methane emission by goats through feeding condensed tannins in lespedeza forage. This project will also compare effects with goats to those with sheep. In addition to direct study of energy metabolism, this equipment is being coupled with heart rate monitoring for use of heart rate to indirectly measure energy use by goats when in free-moving settings, such as while grazing as well as under group confinement conditions. The GPS collars with motion detectors and a leg activity monitoring system are used to fully characterize grazing behaviors like time spent grazing, resting, standing, and walking and horizontal and vertical distances traveled. The GPS collars also allow study of how animals use certain areas of a pasture over different periods of time. These equipment systems have facilitated a characterization of factors influencing the sizeable amount of energy that ruminants expend in the act of grazing compared with confinement or pen settings.

Laboratory Assays

In the majority of experiments to which these preceding paragraphs pertain, samples of feedstuffs, digesta, excreta, and(or) blood are collected and subjected to various laboratory analyses. The Institute has equipment and trained personnel for conducting numerous assays to fully describe chemical composition of feedstuffs, digesta, and excreta and metabolites and hormones in blood. These

A number of projects of the Institute are 'integrated,' entailing an appreciable component of extension and(or) teaching in addition to research.



Conditioning of Spanish (left) and Boer (right) goats to electric fence strands by close proximity supplementation.

Characterizing feeding behavior by video recording with CCTV cameras.

measures are integral in the quest to fully understand underlying physiological bases for observed production responses and to project future impacts with other experimental or field conditions.

On-farm Research

In addition to research conducted at facilities located at the Langston University campus, the Institute has recently conducted a considerable amount of research at off-campus locations. Some of these activities have been on goat and sheep farms in not only Oklahoma but also Kansas, Missouri, and Arkansas. Relatedly, primarily through research conducted on the USAID-supported international project Ethiopia Sheep and Goat Productivity Improvement Program (*http://esgpip.langston.edu*), a project supported by the USDA Foreign Agricultural Service (FAS) was conducted in 2012 to 2014 to develop a publication entitled *Methods of Livestock Research on Smallholder Farms.* Hardcopies were distributed in the Fall of 2014, and the publication is available at *http://goats.langston.edu/methods-livestock-research-smallholder-farms*.

> Internal parasitism in small ruminants has become increasingly important, which is being addressed through a variety of approaches.

High Impact Topics

There has been a wide array of research areas addressed in 2012 to 2016, evidenced by the list of projects and in the publication section. All major types of goats produced in the U.S. are considered, i.e., ones raised for meat, milk, and(or) fiber, both cashmere and mohair. The increasing demand for goat meat and declining mohair industry in recent years have resulted in an expansion of research topics, but because the future is unknown, all goat industries will continue to receive attention. The Institute has and will in the future conduct research to increase levels and efficiencies of goat production, enhance utilization of goat products, and improve use of goats for specific purposes such as vegetation management. There is intent to increase economic returns to those raising goats or processing their products, as well as providing other benefits such as enhanced sustainability of livestock production systems.

One of the factors influencing specific research topics is obviously the expertise and knowledge of permanent research faculty of the Institute. A major focal point is nutrition and feeding practices, although certainly the research program has not been limited to this area. Numerous physiology, reproduction, management, breeding, parasitology, milk and milk product quality, udder health or mastitis, and fiber quality studies have been performed, facilitated by broad fields of knowledge of the permanent faculty. In this regard, frequently grant proposals are submitted which, if approved, include funds to support a Visiting Scholar with unique expertise required for completion of the project. For research in the foreseeable future, it will continue to pertain to areas of importance to the various goat industries in the U.S. The close link and coordinated, complementary research and extension programs of the Institute allow identification of researchable areas of potential practical importance to present and future goat producers and product users.

Most research conducted at the Institute is applied in nature, which is felt most appropriate considering the needs and states of the various goat industries in the U.S. However, for most rapid long-term progress, underlying physiological mechanisms

Some of the climatic stressor trials require frequent weighing.

or processes must be thoroughly understood, rather than merely noting whether or not a production response to a particular treatment occurs. Therefore, our research by design in most cases entails many somewhat basic or fundamental measures. Another research consideration to be mentioned is that some activities yield findings of immediate potential use by clientele. On the other hand, other topics are quite complex and not presently well understood, requiring much study before field application. If important enough, then a stepwise approach is taken to address such issues.

Goat Management

Goat production in the U.S. continues to grow; however, much less research has been conducted with goats than other livestock species. Many factors limit levels and efficiencies of production by goats and restrict economic returns. A series of experiments in the USDA Evans-Allen project "Factors influencing goat production and products in the south-central U.S." is addressing various goat feeding and management practices, relevant health issues, and milk product technologies in order to enhance productivity for increased profit and lower costs to consumers of goat products.

Internal Parasitism

Increasing resistance of internal parasites to commercial anthelmintics poses a serious challenge to goat production in many areas of the U.S. and world. The Institute has been actively involved in research in this area. Some experiments have evaluated anthelmintic activity of substances such as garlic, sericea lespedeza, copper oxide wire particles, copper sulfate, and cayenne pepper, as well as various levels and combinations of commercial anthelmintics. The CBG project "Effects of selected nutritional components on immunity to *Haemonchus* in goats" was conducted to address the physiological aspects of the issue. Moreover, an experiment with lactating Alpine does was performed to test if only allowing pasture access when the leaf surface moisture level (e.g., dew) was below a certain threshold would prevent or minimize ingestion of the infective larval stage of *Haemonchus*

The redcedar control project tackles one of the region's major factors limiting value of grazingland and takes advantage of the wide array of vegetation that goats consume.

Mr. Marcio White and Dr. Raquel Lourencon observe a drone that collects data from a redcedar management trial.

Sampling milk of Alpine goats for composition analysis.

contortus. A number of field studies have been conducted with FAMACHA© to minimize development of parasite resistance.

Because of the development of resistance of internal parasites to commercially available anthelmintics, alternative management practices are needed. Selection of sheep and goats resistant to internal parasites is one such practice with promise, but that has not been well studied on a practical basis. The CBG project "Sustainable small ruminant production through selection for resistance to internal parasites" is being conducted to investigate progress that can be made over a 3-year period in selection of different breeds of hair sheep (Katahdin, Dorper, St. Croix) and goats (Boer, Kiko, and Spanish) at farms in Oklahoma, Missouri, Kansas, and Arkansas and the Langston University farm. Female selection is on-farm, based on fecal egg count and FAMACHA© eye color score, whereas a centralized performance test at Langston University entailing an artificial challenge with infective larvae of *Haemonchus contortus* is being used to select males for breeding. The major goals of the project are to 1) determine early progress in selection of small ruminants for resistance to internal parasitism 'on-farm' and 'on-station' in the southeast and south-central US, 2) characterize 'on-farm' and 'on-station' performance due to selection of small ruminants for resistance to internal parasites, and 3) develop and implement a new second generation central sire performance test for small ruminants at Langston University. The performance test focuses on resistance to internal parasites, but also retains attention to feed intake, average daily gain, and efficiency of feed utilization. In addition to effects on performance, genomic analyses are being conducted to develop means of early-life prediction of resistance.

Fencing

Considerable benefits can be realized by co-grazing cattle and goats, such as greater total production per unit land area if dietary overlap is minimal, improved vegetation conditions for cattle grazing, and possibly decreased internal parasitism in goats. One of the factors preventing more cattle producers from co-grazing with goats is need for different types of fencing. Thus, the Institute conducted the CBG project "Establishing a Langston University testing center for electric fence modifications of cattle barb wire fence for goat containment." The major goal of the project was to develop an accurate and repeatable method of testing effectiveness of various means of modifying cattle barb wire fence with one or more electric fence strand additions for goat containment. This entailed gaining an understanding of the many factors and conditions that influence the behavior of goats during the process of adaptation and while being used in the evaluation of the degree of prevention or deterrence of exit imparted by various fence treatments. Furthermore, identification of the most appropriate experimental design(s) was an important objective. Such an evaluation method would entail a standardized system of use during the evaluation period as well as earlier for adaptation and preparation of animals. The capacity for unbiased comparisons of different fencing options will allow producers to use lowest cost, simplest, and most effective methods available, also with consideration of low maintenance requirements. Through use of optimal methods of changing a cattle barb wire fence to also contain goats, producers will then be able to benefit from co-grazing of cattle and goats through profit in goat production, improved vegetation conditions for cattle, less expense incurred in vegetation management, and low or no need for use of commercial anthelmintics with goats.

Applying blood to a special storage card for later DNA analysis.

Producers as well as Institute scientists benefit from on-farm research.

Goats for Cedar Control

The CBG project entitled "Comparison of control of redcedar with goats to conventional methods of control" is now in its second year. Redcedar is an invasive tree species causing serious problems in the eastern U.S. as well as in Oklahoma where 6,000 acres of rangeland are lost each week due to its invasion. Almost 20% of the state's grazinglands have been lost to the invasive species to date. Clipping cedars is expensive and the effect is short-lived because small trees too small to be clipped grow rapidly. Burning gives variable control, 20 to 70%, depending on burn parameters, but has the risk of all prescribed burns. Herbicides may be directly applied to the base of individual trees, which is time consuming. This project compares control by browsing with goats to other conventional methods of redcedar control for degree of effectiveness, costs, and other considerations at three sites in Oklahoma and one in Missouri. In addition, because goats at most locations only consume cedar during January and February, foliage is being for constituents such as terpenes and tannins to determine if these may be factors limiting the intake of redcedar.

> The research and extension program addressing skin and leather of goats is an example of how the Institute strives to identify gaps in knowledge and areas of interest and benefit to clientele.

Feed Efficiency

Feed represents a major cost in production of goats as well as other livestock species. Hence, producers continually strive to improve efficiency of feed utilization. However, in beef cattle, it has been noted that selection for growth rate and the ratio of live weight gain to feed intake (or the converse) can result in increased mature size, which may not be desirable depending on production conditions. Hence, the CBG project "Boer goat selection for residual feed intake" was conducted. Selection for residual feed intake can improve efficiency of feed utilization without increasing mature size. The project also provides an example of linkages between research and extension at the Institute, with many of the activities conducted in concert with the annual Meat Goat Buck Performance Test.

Skin and Leather

Although most attention in the production of meat goats is directed at the primary product, meat, considerable potential exists for economic returns from skin. Therefore, the Institute conducted the CBG project "Establishing a pilot tannery and capability for goat leather research at Langston University." Little is known about the quality characteristics of leather produced from U.S. goat skins. Objectives of the project were to: 1) establish a pilot tannery and capability for goat leather research at the Langston University campus; 2) determine effects of goat breed, diet, and age on skin chemical composition and mechanical properties of the resulting leather; and 3) evaluate environmentally friendly tanning methods on U.S. goat skins.

Milk and Milk Products

The Institute has maintained a strong research program with goat milk and milk products. The CBG project "Impact of subclinical mastitis on quality and production of goat milk and cheese" was conducted. Subclinical mastitis in dairy goats creates an economic loss for dairy goat producers because it reduces milk production and minimizes cheese yield and quality. Langston University's Grade-A dairy herd was used for assessing the status of subclinical mastitis. Milk quality as affected by subclinical mastitis was determined in the Institute's dairy food lab. The resulting goat milk was manufactured into cheese to investigate effects on cheese yield, quality, and texture in the pilot creamery. Also, the Institute played a coordinating and facilitating role in the project ""Enhanced safety and product

> The importance of real-time indices of animal wellbeing and health to level and efficiency of production provided an impetus for the CBG project with rumination.

Ms. Hirut Yirga centrifuging samples on her study of the use of brackish and saline water by goats and sheep.

Dr. Yoko Tsukahara (center) and other Institute scientists collect data at a sheep farm in southwestern Missouri.

quality from on-farm thermization/pasteurization of goat milk in the Middle East" supported by the U.S.-Israel Binational Agricultural Research & Development Fund (BARD) program. In this project, an inexpensive pasteurization unit suitable for use on small farms in the Middle East was developed and evaluated for future distribution and use in the region.

Rumination and Wellbeing

An efficient and productive agricultural system, which delivers a wholesome product to market, is an increasing priority for the American consuming public and for policymakers. American farmers have adopted precision agriculture as one means of increasing efficiency and productivity, and the livestock industry is no exception.

A CBG project entitled "Enhancing health and productivity of dairy goats using smart technology" is currently underway to study rumination time, which is one of many key factors in determining animal wellbeing and in turn, efficiency. In a study in dairy cattle that examined the relationship between rumination time and calving, a nearly 50% decrease in rumination time during the parturition episode and then a quick return to pre-parturition level were observed; however, the recovery rate was considerably slower in disorders associated with parturition.

In another study examining the effect of estrus upon rumination time in dairy cattle, a nearly 20% decrease in rumination time at estrus was noted. These percentage swings are much greater in rumination time than with core body temperature, which is also affected by these events. Thus, rumination time appears to be a reliable target metric for assessing wellbeing, and Langston University is studying these factors, as well as others, that influence rumination time. It is hoped that this technology will assist dairy goat producers in becoming more efficient livestock managers.

From a preliminary study of the project, dairy (Alpine) goats ruminated 310 minutes per day, which was longer than meat-type goats (Spanish) of 249 minutes per day. Diet also affected rumination time with goats consuming a low-quality forage rumination 313 minutes per day, a high-quality forage ruminating 282 minutes per day, or a low-quality forage with supplemental concentrate ruminating 295 minutes per day. Goats that were fasting ruminated 229 minutes per day.

In a subsequent experiment, data is being collected to construct prediction equations for rumination time using the small HOBO® Pendant® G, which is small, lightweight tri-axial accelerometer. A simple lightweight halter has been designed and constructed to house the Pendant® G.

The project "Evaluation and modeling extended lactations in dairy goats" has potential impact through providing a management strategy to deliver a product year-round via extended lactations. Although some dairy goat producers have adopted the management strategy of extended lactations, the basic biological mechanism of extended lactations in dairy goats is not understood. Because cattle and goats respond differently to extended lactations, cattle do not appear to provide an appropriate model for extended lactation of goats. Understanding the biological processes operating during extended lactation in goats will provide tools for better goat management and, by comparison with dairy cows, will increase our understanding of mammary gland biology.

Sheep for a Changing Climate

A CBG project entitled "The genomics of resilience in sheep to climatic stressors" is underway. The future climate is expected to be more variable, with greater frequencies and intensities of very hot periods, droughts, and floods. The current rapid rate of climate change is likely to impose overwhelming pressures on the existing adaptation capacity of ruminant livestock raised outdoors. It is assumed that adaptation to environmental pressures is largely based on genetics and considerable variation exists among and within current sheep populations. Therefore, researchers of the Institute, University of Florida, Kansas State University, and Oklahoma State University

The greenhouse gas project builds upon promising findings of a previous CBG project addressing effects of lespedeza condensed tannins with goats.

Spanish goats with grazing behavior monitoring equipment.

are addressing stress factors expected to increase in importance with climate change, namely limited feed intake, restricted availability of drinking water, and high heat load. Sheep of Dorper, Katahdin, and St. Croix breeds from four areas of the U.S. with markedly different climatic conditions (i.e., ecotypes) are being evaluated under standardized conditions for resilience to these three stressors. In addition, the premise that oldest animals are most genetically fit for specific environmental conditions is being tested. Gaining a better understanding of the genetic basis of adaptation in sheep to stress factors related to climate change should facilitate more effective breeding programs using selection as well as crossbreeding.

An early-in-life test for potential milk and component yield would be of great vaule to dairy goat producers. This is the objective of an USDA Agriculture and Food Research Initiative project entitled "Genome-wide association analysis for the identification of Alpine goats with high milk production."

In this project, DNA from lactating Alpine females is extracted and purified from milk samples sent into the Institute's DHI Laboratory. The phenotypic records gathered from the Institute's and various other contributing DHI Laboratories will be combined with genomic-data from a Single Nucleotide Polymorphism (SNP) analysis and then a genome-wide association study will be conducted tp correlate individual SNPs with production.

Currently, a SNP analysis uses a commercial 52K SNP chip but it is hoped that a result of this project will be a reduced panel SNP chip, which would be available to greatly reduced costs to dairy goat producers.

Need for the USDA FAS-supported on-farm research handbook project became apparent during the USAID-supported Ethiopia Sheep and Goat Productivity Improvement Program.

Small Ruminant Greenhouse Gas Emission

Ruminant livestock account for 15 to 33% of world methane production, which contributes 20% of the irradiative force of greenhouse gases causing climate change and global warming. Hence, the long-term goal of the CBG project "Sustainable control of greenhouse gas emission by ruminant livestock" is to develop practical and sustainable means of minimizing methane emission by ruminant livestock. Previous research with goats at the Institute has shown considerable promise in decreasing ruminal methane emission by feeding the leguminous forage lespedeza and its condensed tannins. But, factors not previously addressed that will receive attention in this project are potential adaptation to tannins and a lessening of methane emission-inhibition with advancing time; effects with sheep; and simultaneous feeding of tannins and other substances that can further decrease ruminal methane emission, namely ionophores and fat sources high in medium chain fatty acids (i.e., coconut oil) and long chain polyunsaturated fatty acids (i.e., soybean oil). Experiments with goats and sheep will quantify effects of singular dietary inclusion of lespedeza, an ionophore, and the different fatty acid sources, with variables of ruminal methane emission, forage intake and digestion, and characteristics of ruminal microbes such as in vitro methane production and numbers of protozoa and total, cellulolytic, and hyper ammonia producing bacteria. A third study will test mixtures of lespedeza, an ionophore, and fat sources.

Applied Livestock Research Methods

A project conducted in 2012 to 2014, supported by the USDA Foreign Agriculture Service (FAS), was to develop a manual for junior researchers in developing countries entitled *Methods of livestock*

Different breeds of hair sheep from four regions of the U.S. during quarantine.

The Institute has an internal review program that all potential publications and proposals must go through before submission.

research on smallholder farms. Resources for on-station livestock research in many developing countries are limited, and it is common for researchers to have little direct interaction with smallholders. On-farm research offers considerable attributes, which include attention to most significant production constraints, opportunities for meaningful studies, and greater adoption by smallholders of advantageous technologies. However, few researchers perform on-farm livestock research, at least partially because of inadequate training and knowledge of the design and conduct of on-farm experiments, statistical analyses and interpretation of resultant data, and preparation of reports suitable for peer-reviewed journals. Thus, a publication was developed as a resource for training in methods of applied livestock research, with special attention to treatments, design, implementation, analysis, interpretation, and peer-reviewed articles. The target audience is junior to mid-level professionals (e.g., M.S.) and graduate students in developing countries. Major sections of the publication include: introduction; on-station vs. on-farm research; topic identification; protocols; experimental design; treatment considerations; experiment implementation; statistical analyses; dissemination with an emphasis on preparation, review, and revision of scientific manuscripts; and literature cited. Furthermore, a key component is the design and analysis of numerous example study scenarios, such as: farmer research groups — missing data, nature of the data; individual smallholder households — household animals on one treatment, household animals on each treatment, missing data and household animals on one vs. each treatment, households with subplots; group or village as fixed vs. random; studies in different seasons or years; year-round performance monitoring — continuous and categorical variables; and

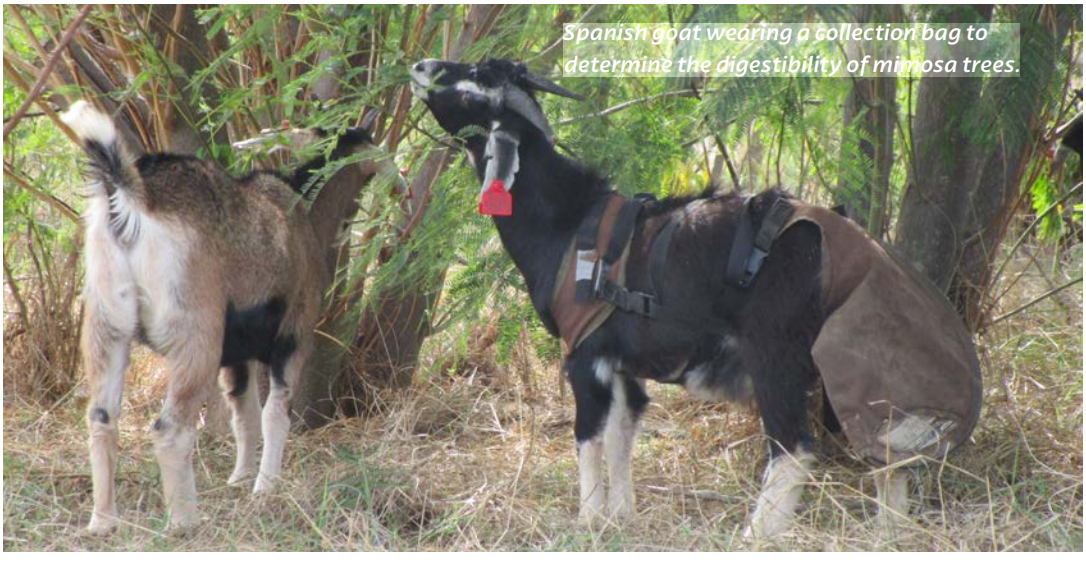
crossovers, switchbacks, and Latin squares. There are also comparisons of P values from different analyses (e.g., SAS® GLM and MIXED and GenStat®). Appendices contain the relevant statistical analysis statements and inputs, results, and simulated data sets. Workshops based on the publication were held during 2013 and 2014 in Kenya, Ethiopia, China (two sites), Jordan, Malawi, Mexico, and India (two sites) to create awareness of the resource, train junior researchers, and receive feedback for publication enhancement, with well over 200 attendees. Hardcopies of the publication are being distributed, and it is available free on the Institute's website at *http://goats.langston.edu/methods-livestock-research-smallholder-farms*.

PRIORITY PUBLICATIONS

Information obtained through research is of value only if transferred to people who can derive benefit from it. In the publication section, it should be apparent that a key mode of disseminating research findings of the Institute is in peer-reviewed articles in scientific journals. Journals felt most appropriate for the studies are chosen. It follows then that since goats are important in many countries throughout the world, the official journal of the International Goat Association, *Small Ruminant Research,* has been used quite often. Presentations are made at scientific meetings, such as of the American Society of Animal Science, with accompanying abstracts. Also, our research findings are transferred in numerous other ways, such as fact sheets, the Goat Newsletter, Proceedings of the Annual Goat Field Day, meetings of producer groups, farm visits, phone calls, emails, etc.

SIGNIFICANT PROFESSIONAL SERVICE AND RECOGNITION

In addition to publication of research findings in journals and presentations at scientific meetings, Institute researchers participate in professional scientific activities. Notable examples are service as Associate Editor for the journal *Small Ruminant Research.* Researchers also serve as ad hoc reviewers for many research papers and service on journal Editorial Boards. We routinely provide reviews (national and international) and serve on national panels for grant programs considering funding of research proposals. Likewise, our scientists have been members and chairmen of committees organizing regional, national, and international scientific meetings. Additional recognition of the researchers has been achieved in the last five years through a number of invitations to prepare literature reviews for scientific journals and books, which can be viewed in the publication section.



Spanish goat wearing a collection bag to determine the digestibility of mimosa trees.


85
89
54

RESEARCH PROJECTS

NIFA (Evans-Allen)

Factors Influencing Goat Production and Products in the South-Central U.S.

- Project number OKLX-SAHLU2012
- Accession number 0228824
- 2012-2017
- T. Sahlu, A. L. Goetsch, R. Puchala, R. C. Merkel, T. A. Gipson, S. P. Hart, S. Zeng, and Z. Wang

USDA 1890 Institution Capacity Building Grant Program

Comparison of Biological Control of Redcedar with Goats to Conventional Methods of Control

- Project number OKLUS-HART2014
- Accession number 1004376
- Integrated-research and extension
- 2014-2017
- $565,784
- S. P. Hart, T. A. Gipson, R. C. Merkel, J. Penningston, C. Clifford-Rathert, and C. Williams

Enhancing Wellbeing and Productivity of Dairy Goats Using Smart Technology

- Project number OKLUTGIP-SON2014
- Accession number 1004177
- 2014-2017
- $300,000
- T. A. Gipson, S. P. Hart, R. Puchala, E. Loetz, L. J. Dawson, and B. Ardrey

Sustainable Control of Greenhouse Gas Emission by Ruminant Livestock

- Project number OKLUA-GOETSCH2014
- Accession number 1004179
- 2014-2017
- $300,000
- A. L. Goetsch, R. Puchala, T. Sahlu, M. Flythe, and G. E. Aiken

Genomics of Resilience in Sheep to Climatic Stressors

- Project number OKLU-GOETSCH2013
- Accession number 1000926
- Integrated-research and teaching
- 2013-2017
- $600,000
- A. L. Goetsch, T. A. Gipson, R. Mateescu, S. Zeng, R. Puchala, M. Rolf, T. Sahlu, and P. Oltenacu

Sustainable Small Ruminant Production Through Selection for Resistance to Internal Parasites

- Project number OKLX-SAHLU12
- Accession number 0230541
- Integrated-research and extension
- 2012-2016
- $600,000
- T. Sahlu, A. L. Goetsch, T. A. Gipson, S. P. Hart, Z. Wang, R. Mateescu, and E. Devuyst

Effects of Selected Nutritional Components on Immunity to *Haemonchus* in Goats

- Project number OKLXWANG10
- Accession number 0223036
- 2010-2015
- $299,950
- Z. Wang, A. L. Goetsch, S. P. Hart, T. Sahlu, and G. Chen

Establishing a Langston University Testing Center for Electric Fence Modifications of Cattle Barb Wire Fence for Goat Containment

- Project number OKLX-GOETSCH10
- Accession number 0223035
- 2010-2014
- $300,000
- A. L. Goetsch, T. A. Gipson, T. Sahlu, and J. Burke

Boer Goat Selection for Residual Feed Intake

- Project number OKLXGIP-SON2008
- Accession number 0215239
- 2008-2012
- $300,000
- T. A. Gipson, C. L. Ferrell, A. L. Goetsch, R. Puchala, and T. Sahlu

USDA Foreign Agricultural Service (FAS) Scientific Cooperation Research Program (SCRP)

Handbook for Livestock Research on Smallholder Farms in Developing Countries

- 2012-2014
- $40,000
- A. L. Goetsch, T. A. Gipson, R. C. Merkel, G. Abebe, A. Patra, D. Zhou, K. Al-Qudah, M. Huerta-Bravo, T. Sahlu, A. Degen, W. Getz, and Y. Tsukahara

USDA Agricultural and Food Research Program Initiative

Genomics-wide Association Analysis for the Identification of Alpine Goats with High Milk Production

- Project number OKLUTILA-HUN2015
- Accession number 1006741
- 2015-2017
- $100,000
- Y. Tilahun, T. A. Gipson, and M. Rolf

Goat dairy product workshops continue to be very popular.

EXTENSION OVERVIEW

The last five-year period has been one of ameliorating and expanding Cooperative Extension activities of the E (Kika) de la Garza American Institute for Goat Research. Our major ongoing activities have been enhanced, including the annual Goat Field Day, Langston Goat Dairy Herd Improvement (DHI) Program, and various goat workshops on artificial insemination, cheese-making, soap-making, and internal parasite control.

The Institute also has published a quarterly newsletter and expanded its website. Other extension activities that have been accomplished include developing and printing a *Meat Goat Production Handbook, Meat Goat Production Basics, Dairy Goat Production Handbook,* and *Dairy Goat Production Basics* and establishing an online certification program for meat goat producers and an upcoming program for dairy goat producers, collaborating in the USDA eXtension initiative, and workshops on goatskin tanning and mortality composting. In addition to these activities, extension specialists have answered innumerable producer requests for goat production and product information via the telephone, letters, and email, and have given numerous presentations at state, regional, national, and international goat conferences for potential, novice, and veteran goat producers.

Fitting and showing at the annual Goat Field Day.

GOAT FIELD DAY

The goal of the annual Goat Field Day is to inform and educate potential, novice, and veteran goat producers on goat management practices. Each year, the Goat Field Day is organized around a theme and speakers are invited to present on the theme in the morning plenary session. Themes for recent Goat Field Days have been:

- 2011 — Healthy Goats, Healthy Herds
- 2012 — State of the Goat Industry
- 2013 — Enhancing Goat Products
- 2014 — Kidding and Kid Management
- 2015 — Taking Control of Marketing
- 2016 — Keeping Your Goats Healthy

Annual attendance at the Goat Field Day has fluctuated around 250 participants, with the highest attendance in 2011. In addition to the morning plenary session, invited speakers lead small-group training sessions in the afternoon. Scientists and staff members of the Institute also lead small group training sessions, which over the years have included basic goat husbandry, body condition scoring for improved management, cheesemaking, dairy

products overview, dewormer resistance, DHI overview and tester training, forage-based dairy goat management, goat production and quality assurance, goat production budgets, goat production record keeping, inbreeding in dairy goats, injection sites and drug availability, international goat activities, Oklahoma milk regulations, pedigree analysis, nutrient requirement web calculators, nutrition for meat goat production, predator control measures, scrapie control information, simulation goat production modeling, soap-making, sustainable parasite control, tanning goatskins, types of fencing for goats, pack goats, and USDA government programs.

In addition to the morning plenary session and afternoon small group sessions, activities are held for the youth of all ages. A full day of activities for youth ages 5 to 12 includes goat education, pony and horseback riding, fishing, face-painting, pot your own plant, games, and many other fun activities.

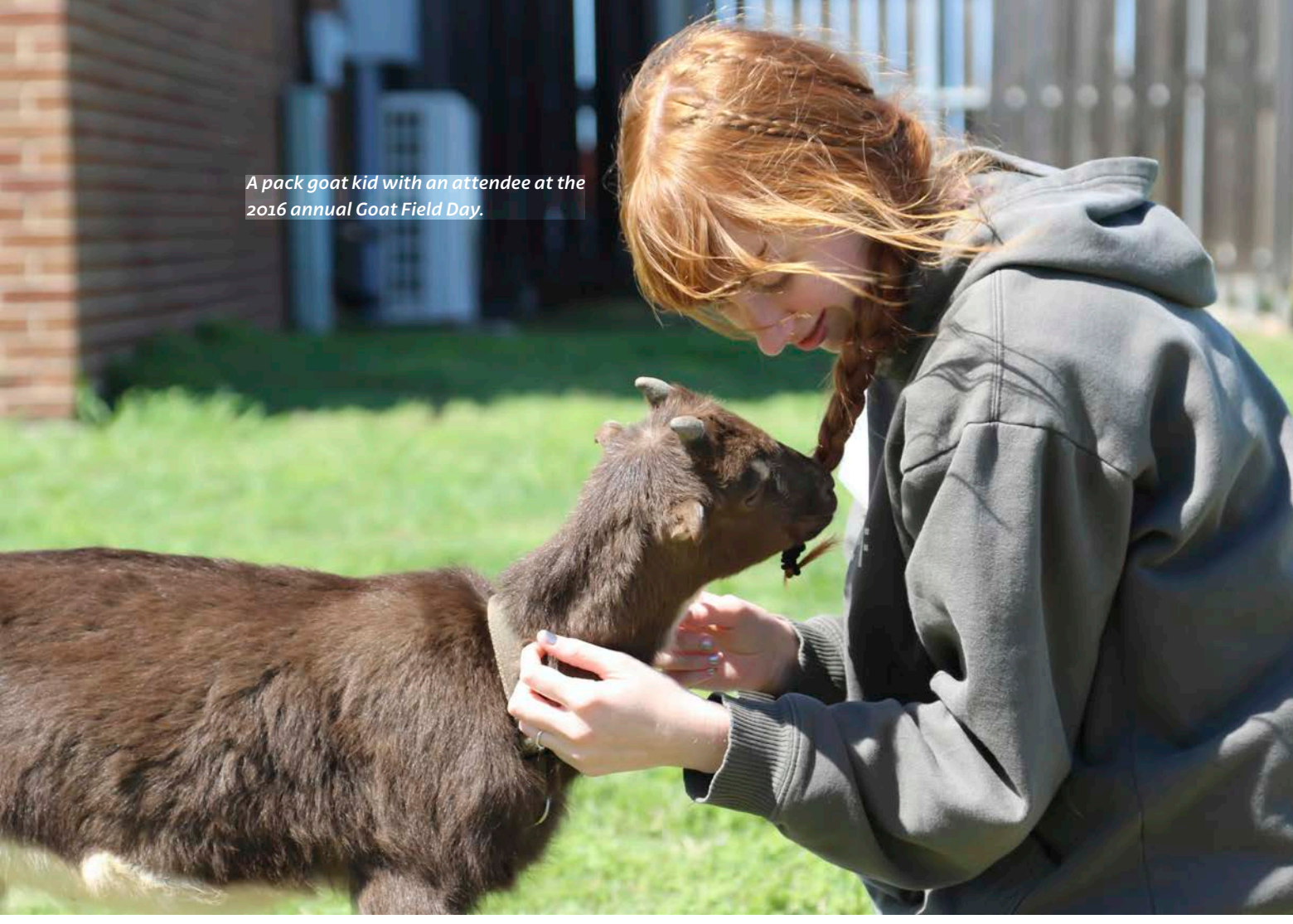
Other youth and interested adults are able to participate in a full day or a half-day clipping, fitting, and showing workshop. Participants have the opportunity for hands-on practice of clipping and fitting a goat and then showing it before a judge in the show ring.

Though other avenues of disseminating information have increased in importance, the annual Goat Field Day remains the 'cornerstone' of the extension program.

GOAT DHI LABORATORY

In 1996, the Langston Goat DHI program was launched under the umbrella of the Texas DHIA. In 2014, the Langston Goat Dairy DHI elected to operate independently. The dairy records processing software that had been initially acquired from Texas DHIA had reached well beyond it capabilities and could not be modernized. Thus, Langston Goat DHI partnered with Dairy Records Management System (DRMS) of Raleigh, NC to conduct the record processing. The Langston Goat DHI program has been very popular with dairy goat producers and has grown significantly since its establishment in 1996. Currently, we have 123 producer herds in 30 states enrolled in the Langston Goat Dairy DHI Program. In 2015, the DHI laboratory processed more than 9,000 samples. Langston University continues to serve the very small-scale dairy goat producer. The average herd size on test with

The goat DHI Laboratory has been a core component of the extension program for many years and contributes to research of the Institute as well.



A pack goat kid with an attendee at the 2016 annual Goat Field Day.

Langston University is 10 animals. This is significantly smaller than the herd size average for the five other processing centers.

For those interested in becoming a Langston goat DHI tester, training is available either in a formal classroom setting or through a 35-minute video (see additional information in the YouTube section). Every tester is required to attend the DHI training session or view the video and take a test. Upon completion of the DHI training, the milk tester can start performing monthly herd tests.

CHEESE MANUFACTURING WORKSHOP

An annual Cheese Manufacturing Workshop has been held in the pilot creamery at Langston University for the past several years. Dr. Steve Zeng, Dairy Product Specialist, and other noted cheese makers have demonstrated basic cheesemaking principles and skills by making Cheddar cheese, Feta cheese, and various soft cheeses (chèvre, cream cheese, etc.) with wholesome Grade "A" goat milk from Langston's goat dairy. This workshop is designed for beginners. Ideas and techniques were also shared with some experienced cheese makers in attendance.

In the last five years, Dr. Steve Zeng, our Dairy Product Specialist, was invited to the prestigious World, American, and U.S. Cheese Championship Contests each year as an Expert Judge. During the championships, Dr. Zeng along with a handful of industrial and academic cheese experts judged thousands of top cow and goat cheeses from the U.S. and around the world. It has been an honor for Langston University that Dr. Zeng was the only expert judge ever representing an 1890 Land Grant University and the dairy goat industry.

Spanish doe and kids.

The *Goat Newsletter* highlights research findings, provides updates on activities and accomplishments, and announces upcoming educational events.

GOAT NEWSLETTER

The Goat Extension program continues to publish a free quarterly newsletter, which highlights research, extension, and international activities of the Institute. The *Goat Newsletter* is mailed to every state in the nation and to 10 countries overseas. Ninety-eight percent of the mailings go to American households. Thirty-five percent of the newsletters are mailed to Oklahoma households. An additional thirty percent of the newsletters are mailed to households in states adjacent to Oklahoma.

ARTIFICIAL INSEMINATION WORKSHOP

The use of superior sires is imperative in improving the genetic composition of breeding stock. Artificial insemination has long been used in the dairy cattle industry and is a simple technology that goat producers can acquire. However, opportunities for goat producers to learn the necessary skills via formal and practical instruction are not widespread. Langston University has instituted a practical workshop for instruction in artificial insemination in goats. Producers are instructed in the anatomy and physiology of the female goat, estrus detection, and handling and storage of semen. Producers participate in a hands-on insemination exercise. An understanding of the anatomy and physiology enables the producer to devise seasonal breeding plans and troubleshoot problem breeders. Learning methods of estrus detection facilitates effective timing of inseminations for favorable conditions for conception and use of semen. Training in semen handling and storage safeguards semen supplies, which can be scarce and costly. The experience

of actually inseminating a female goat empowers the producer to practice their newfound knowledge. Acquiring inseminating skill allows producers to use genetically superior sires in their herds that they normally would not have access to. It also allows producers to save money by conducting the inseminating themselves instead of hiring an inseminator. Annually, two AI workshops are held at the Langston University campus.

MEAT GOAT PRODUCTION HANDBOOK

In 2007, the Institute published the *Meat Goat Production Handbook*, a book designed for use by producers. The book arose from the content of the popular web-based training and certification program for meat goat producers that will be discussed in a later section. The original printing of the *Meat Goat Production Handbook* sold out and Institute scientists worked on developing an expanded second edition of the handbook that was published in 2015. In addition to updates on all of the chapters in the first edition, the second edition added seven chapters of new content. Of note were chapters devoted to the use and care of guardian llamas and donkeys as protectors of goats on pasture. Printed information on the use of those two species of animals as livestock guardians was scarce and this new edition contains useful information to producers considering employing either llamas or donkeys as guardian animals. A full chapter was devoted to fencing for goats, an important and often challenging aspect of goat production. Other new chapters included mortality composting to introduce an environmentally friendly method of dealing with animal losses, pack goats, harvesting and processing goats at home, tanning goatskins, and

Training in artificial insemination continues to be of interest in the U.S., as is also true for other countries.

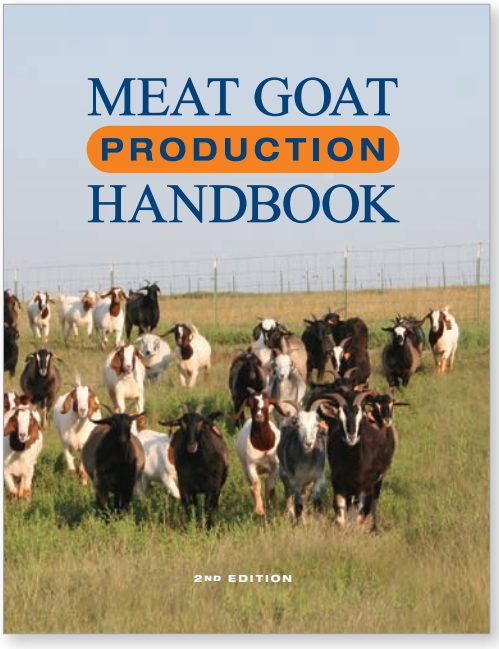
Pack goats at the Institute's annual Goat Field Day.

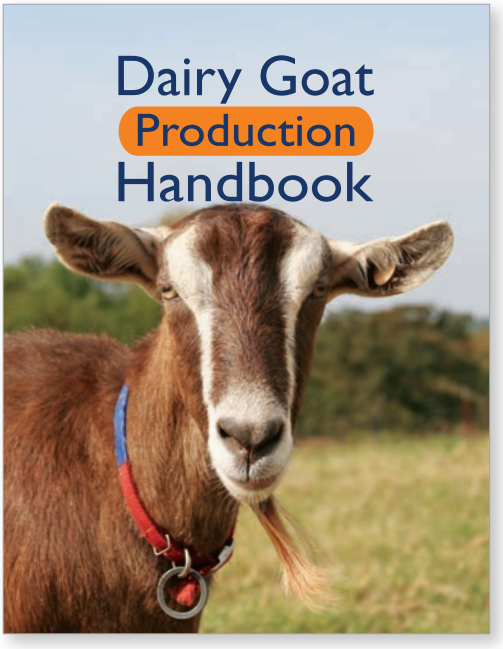
use of genomics in meat goats to help producers understand a technology that will gain in importance in animal selection. As always, issues of food safety and quality assurance are paramount and the second edition contains an updated framework of Best Management Practices for the goat raising community in the context of a Meat Goat Quality Assurance Program. *The Meat Goat Production Handbook* was partially funded by USDA/FSIS/OPHS project #FSIS-C-10-2005.

DAIRY GOAT PRODUCTION HANDBOOK

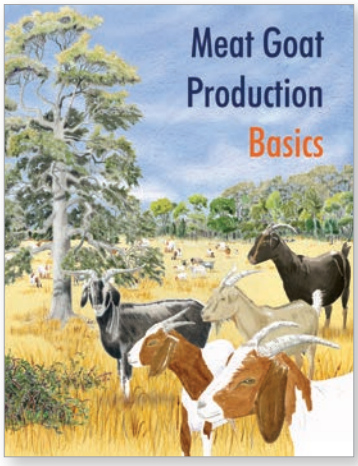
Upon completion of the first edition of the Meat Goat Production Handbook, Institute scientists were asked when a companion handbook for dairy goats would be published. To accomplish that task, Institute scientists sought and received funding to develop and print the *Dairy Goat Production Handbook* through USDA/NIFA Grant #2011-38821-30952 (OKLXMERKEL11; Accession # 226269) with the collaboration of Fort Valley State University in Fort Valley, Georgia. The *Dairy Goat Production Handbook* was printed in 2016 and is now available. The handbook is a comprehensive, science-based, single source of production information for dairy goat producers to assist them increase productivity, improve dairy product safety, boost farm profit, and enhance farm sustainability. Topics and information included in the handbook serve all dairy goat producers, from those who raise only a few dairy goats in their backyard to producers operating large commercial dairies. The handbook contains information on health, production, and management; milking systems and facilities; reproduction and genetic improvement; goat milk regulations and the science behind milk production; business, record keeping, and legal aspects; goat milk products, their safety, and marketing; and organic production. A chapter on Dairy Goat Quality Assurance and HACCP outlines a set of Best Management Practices designed to assist producers in ensuring

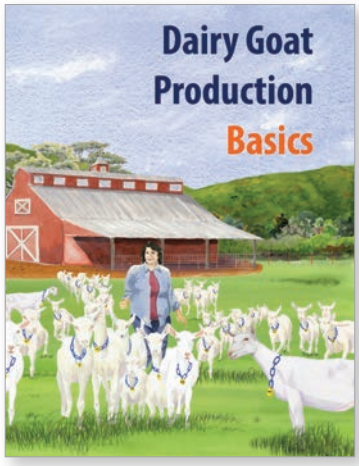
Collaboration with the University of Puerta Rico at Mayagüez has been instrumental in Spanish handbook versions,

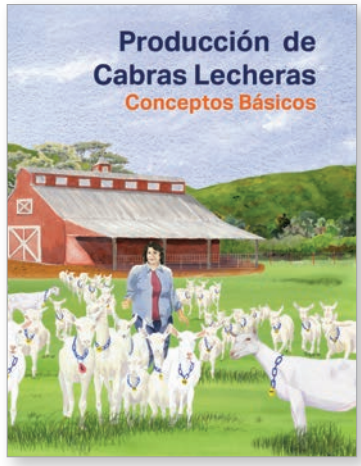




The meat goat and dairy goat handbooks are available at the Institute website in spiral coil and casebound formats.







The basics books available at the Institute are excellent resources for youth and others desiring an easy-to-read format.

the health and welfare of their animals as well as producing safe, wholesome goat milk for consumers and product formation.

MEAT GOAT PRODUCTION BASICS IN ENGLISH AND SPANISH

As companion publications to the Meat Goat Production Handbook, Institute scientists worked with collaborators at Kentucky State University and the University of Puerto Rico at Mayagüez to develop scaled down versions of the handbook in English and Spanish. In these versions information from the most important chapters of the full handbook is condensed and presented in a bulleted, easy-to-read format appropriate for youth and producers who may not wish the additional content found in the full handbook. The Meat Goat Production Basics and Producción de Cabros para Carne Conceptos Básicos were printed and have proven popular. Partial funding to develop the Meat Goat Production Basics was from USDA/NIFA grant #2010-38821-21581 (OKLXGIPSON10).

A major focus of extension activities in the past five years was development and revision of meat and dairy goat production handbooks, including versions for different groups of clientele and in Spanish as well as English.

DAIRY GOAT PRODUCTION BASICS IN ENGLISH AND SPANISH

Just as was done with the *Meat Goat Production Handbook*, scaled down, bulleted and illustrated versions of the *Dairy Goat Production Handbook* in English and Spanish were developed. Once again, scientists at the University of Puerto Rico at Mayagüez were instrumental in the production of the Spanish version of the basics book. The *Dairy Goat Production Basics* and *Producción de Cabros para Leche Conceptos Básicos* were printed in 2016. Partial funding to develop the *Meat Goat Production Basics* was from USDA/NIFA grant #2011-38821-30952 (OKLXMERKEL11; Accession #226269).

CONTROLLING INTERNAL PARASITES WORKSHOP

Internal parasites such as the Barberpole worm, *Haemonchus contortus*, are the leading cause of death in goats in the Southern U.S., accounting for as many deaths as the total of the next three

leading causes in goats. Several factors contribute to the high mortality caused by internal parasites. Goats that originated in dry areas having no internal parasite challenge have been brought to the humid South where there is great parasite challenge. Only a few animals have good genetic resistance against internal parasites. In addition, goats are forced to graze rather than browse, which provides greater opportunity to consume infective larvae and especially so when animals overgraze. Producers are not familiar with monitoring animals for signs of parasitism and do not understand how animals get infected. In addition, internal parasites have developed a high level of resistance to dewormers from their overuse. To address these concerns, the Institute developed a parasite workshop to educate producers about internal parasites. It includes three hours of lecture on biology of the parasite, pasture management to avoid worms, and monitoring parasite infection using the FAMACHA© chart to assess the degree of anemia. This is a cooperative effort with the OSU Extension Veterinarian who addresses dewormer resistance and correct use of dewormers. Producers get hands-on instruction in use of the FAMACHA© card, taking fecal samples, and running fecal egg counts.

SELECTION FOR RESISTANCE TO INTERNAL PARASITES

Because of the development of resistance of internal parasites to commercially available anthelmintics, alternative management practices are needed. Selection of sheep and goats resistant to internal parasites is one such practice with promise, but that has not been well

Internal parasitism is addressed via annual workshops and the integrated CBG project assessing progress through selection of sheep and goats for resistance.

Ms. Eva Vasquez in the DHI Laboratory.

studied on a practical basis. To study this important topic, Institute scientist received funding through USDA/NIFA Grant #2012-38821-20176 (OKLX-SAHLU12) to conduct an integrated research and extension project investigating selection of animals with resistance to internal parasites. This project used three breeds of hair sheep (Katahdin, Dorper, and St. Croix) and goats (Boer, Kiko, and Spanish) at farms in Oklahoma, Missouri, Kansas, and Arkansas and the Langston University farm. Female selection was done on-farm based on fecal egg count and FAMACHA© eye color score, whereas a centralized performance test at Langston University entailing an artificial challenge with infective larvae of *Haemonchus contortus* was used to select males for breeding. In addition to effects on performance, an economic analysis was conducted, as well as genomic analyses to develop means of early-life prediction of resistance. The major goals of this project were to 1) determine early progress in selection of small ruminants for resistance to internal parasitism 'on-farm' and 'on-station' in the southeast and south-central U.S., 2) characterize 'on-farm' and 'on-station' performance due to selection of small ruminants for resistance to internal parasites, and 3) develop and implement a new second generation central sire performance test for small ruminants at Langston University, focusing on resistance to internal parasites, but also retaining attention to feed intake, average daily gain, and efficiency of feed utilization.

YOUTUBE CHANNEL

Created in 2005, YouTube is a video-sharing website on which users can upload, view, and share videos. The Goat Program at Langston University has created its own YouTube channel (*https://youtube.com/user/tagluo1*). The following are the YouTube videos that now are available. Additional videos will be added to the channel in the future.

Artificial Insemination (AI) in Goats (length 8:47)
This video describes the steps involved in artificial insemination in goats.

AI Kit (length 6:28)
This video describes the equipment needed for artificial insemination in goats.

Basic Hoof Care (length 10:48)
This video explains basic hoof care for goats.

Body Condition Scores in Goats (length 2:11)
This video describes how to evaluate body condition score in goats.

YouTube videos are an effective means of transferring useful technologies, and those pertaining to goat production are no exception.

Buck Effect (length 1:53)
This video describes the buck effect and its use in estrus synchronization.

Estrous Synchronization in Goats (length 5:08)
This video explains estrous synchronization for artificial insemination in goats.

Langston DHI Tester Training — Part 1 (length 9:24)
This video describes how to conduct proper DHIA testing procedures for milk sampling.

Langston DHI Tester Training — Part 2 (length 9:48)
This video describes how to conduct proper DHIA testing procedures for milk sampling.

Langston DHI Tester Training — Part 3 (length 9:19)
This video describes how to conduct proper DHIA testing procedures for milk sampling.

Langston DHI Tester Training — Part 4 (length 8:28)

Spanish doe on pasture.

> eXtension provides a convenient way that personnel of multiple institutions can collaborate and pool information for the benefit of producers and others wishing to know more about goats.

This video describes how to conduct proper DHIA testing procedures for milk sampling.

Semen Tank (length 6:39)
This video explains semen tank handling and semen storage for artificial insemination in goats.

Signs of Does (female goats) in Estrus (length 0:35)
This video shows an example of signs of estrus (flagging) in goats.

eXtension.org

In 2008, Langston University was a member of a group of goat extension specialists and researchers who met in Atlanta and formed a Goat Community of Practice (CoP) for eXtension (pronounced e-extension). eXtension is an Internet-based educational partnership of the seventy-four 1862 and 1890 institutions of the Land Grant university system that helps people improve their lives by providing access to objective, research-based information and learning opportunities. In 1994, the USDA debated Cooperative Extension's survival in a new customer-driven marketplace. In 2001, a decision was made to transform the way Cooperative Extension delivers its mission and message through technology (eXtension). In 2004, the Cooperative Extension System adopted an assessment to provide project start-up funds and in 2007, launched the full system at *http://extension.org*. eXtension was created to provide 24/7/365 access to information to help people make life-improving decisions; educational products and programs at any time, from any place, in any format on any

Internet-ready device; complementary resources to the community-based Cooperative Extension System; increased visibility to Cooperative Extension by reaching new audiences and expanding partnership opportunities; collaborative development of Internet-based educational materials with minimal duplication; and sustained connections between CoP and Communities of Interest (CoI). A CoP is a group of specialists and others who are knowledgeable in the subject area, in this case goats. The Goat CoP's membership includes goat specialists at all the major universities, plus regional and county extension agents with goat knowledge. A CoI is a group of clientele, in this case goat producers or just anyone who wants to learn more about goats. The first year, the CoP met to develop materials for the website and in March of 2009, the Goat extension site was launched. Generally, the CoP meets two to three times per year to update eXtension web content.

NUTRIENT REQUIREMENTS OF GOATS

Under a research project which developed equations for energy and protein requirements for goats, as well as prediction of feed intake, an extension sub-project developed a website calculation system for "Nutrient Requirements of Goats" (*http://goats.langston.edu/Nutrient-Calculators*). Most calculators were based on studies of the project reported in a Special Issue of the *journal Small Ruminant Research*. For calculators with score inputs (i.e., grazing and body conditions), pictures are available to aid in determining most appropriate entries. Realistic examples are given, as well as discussion of appropriate and inappropriate

The goat nutrient requirement calculation website has been valuable to goat producers, in college classes, and for training of professionals in other countries.

Mr. Jerry Hayes demonstrating hoof trimming at the annual Goat Field Day.

usage. However, for the experienced user there is an option to hide text and examples and to view only inputs and outputs.

In 2005, a calculator for calcium and phosphorus requirements was added to the existing calculators for metabolizable energy, metabolizable protein, and feed intake for suckling, growing, mature, lactating, gestating, and Angora goats. Also in 2005, the interface of the calculators was unified into a single calculator with the English measurement system used. This will encourage the use of the calculators by American producers. The least-cost ration balancer was modified so that it incorporates the least-cost feed percentage into the diet. Also, calculators are equipped with printable version commands to obtain inputs and outputs in hard copy format.

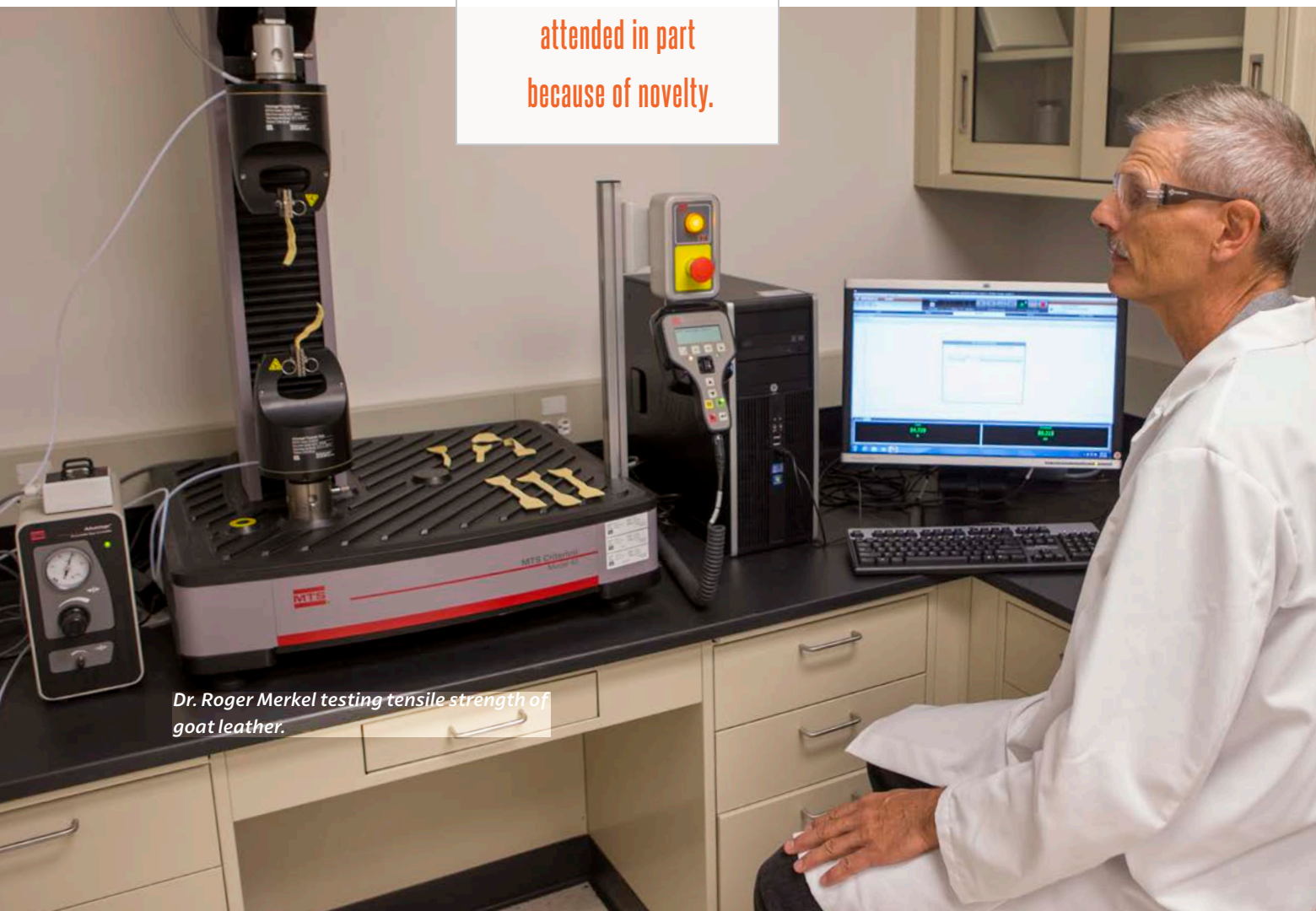
Langston University's popular web-based nutrient calculator is now available for free on the iPad. To install this version, simply go the App Store and search for "Goat Nutrient Calculator." Once installed on your iPad, you will be able to calculate the nutrient requirements for any goat in any age, breed, or stage of production, as well as calcium and phosphorus requirements.

The original web-based nutrient calculators were developed under a research project and were only accessible via the website (*http://goats.langston.edu/Nutrient-Calculators*). This iPad version is the first stand-alone version of the calculators available.

The web-based version has a feed library and a least-cost ration balancer so that rations can be formulated to meet nutrient requirements. Currently, the iPad version does not have these attributes but it is planned to update this version with those capabilities with the next release.

For these calculators to be of value, they must be readily accessible and reasonably simple. It is hoped that this iPad version will enjoy widespread usage and enhance feeding practices for goats.

Tanning goatskin workshops are well-attended in part because of novelty.



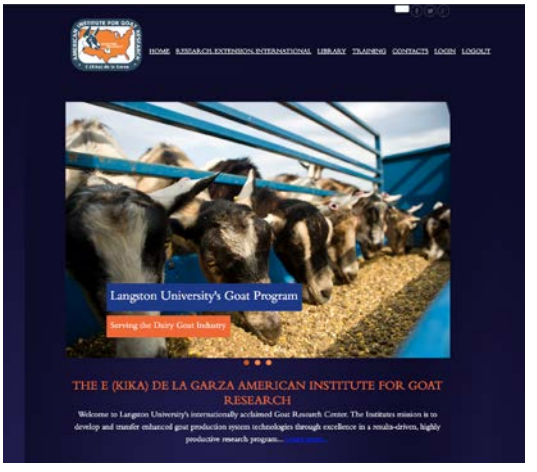
Dr. Roger Merkel testing tensile strength of goat leather.

TANNING GOATSKIN

Since 2007, the Institute has held an annual tanning goatskin workshop. The objective of the workshop is to teach interested persons how to tan skins with the hair on for hobby or craft use. Attendees express interest in tanning skins for a variety of reasons. Some are livestock producers who own an exceptionally pretty goat and wish to tan skins of animals they raise. Other people are hunters who wish to tan deerskins or pelts of other game animals. Other persons wish to use as much of the animal as possible, dislike the waste of an animal's skin, or wish to learn and practice "old-time" skills. Some workshop attendees already tan skins but want to expand their knowledge. The workshop consists of discussion of the theory and methods of tanning and the steps involved. Then participants have the opportunity to work with skins in many of the tanning process steps and actually tan skins using two different methods. The workshop uses readily available chemicals and all processes are done by hand. Thus, it is a low-cost process that producers can try at home. The hands-on nature of the workshop, with participants working with actual skins in most of the tanning steps, ensures skill transfer. This format allows students to work with and learn from each other and receive practical knowledge of the tanning process that will help them when trying tanning skins at home.

> The Institute website continues to be an effective and increasingly important means of disseminating information.

Interest in tanning goatskins goes beyond local producers. In 2013, Fort Valley State University in Georgia invited Dr. Roger Merkel of the Institute to present the tanning workshop at their university to enhance the use of their processing facility. Other groups requesting special workshops have been the U.S. National Guard, a youth group, a veterinary science club, and other producer groups.



Much of the extension and research materials are available on the Institute website.

INTERNET WEBSITE

In order to deliver program to an international audience, an Internet presence was established many years ago. In an effort to deliver that information in a timely, efficient manner, and in a more appealing format, the Internet presence has been updated. However, the process is very time consuming and therefore two Internet sites have been established on a temporary basis. The older web server (*http://www.luresext.edu*) is built upon HTML code, javascript, and PERL scripts, which have become difficult to administer as the site has expanded over the years. The new web server (*http://goats.langston.edu*) is built upon Drupal, which is a content management system (CMS) that is much easier to maintain. This transition will last until all the information has been successfully ported over from the old server to the new server. This is a time-consuming process because the two servers basically do no speak the same language and do not understand each other's content packages.

Capabilities of both websites include a document library with the complete proceedings of the annual Goat Field Day and the quarterly newsletter

The Institute has Angora goats for mohair production research.

since 1998. Both the proceedings and newsletters are also available in portable document format (pdf), which allows for the viewing and printing of documents across platform and printer without loss of formatting.

Information, recent abstracts, and scientific articles of completed and current research activities in dairy, fiber, and meat production are available for online viewing and reading. Visitors can take a Virtual Tour of the research farm and laboratories, complete with digital photos and narrative. Visitors are also be able to browse a digital Photo Album. Visitors can subscribe to our free quarterly newsletter online. Visitors will be able to read about research interests of faculty and will be able to contact faculty and staff via email.

Mortality composting bays.

MORTALITY COMPOSTING

In 2009, Langston University and Oklahoma State University received an extension grant for a mortality composting demonstration project. All livestock producers encounter mortality. Goat and sheep operations may experience annual mortality losses of approximately 10% of young before weaning and 5% of adult breeding animals. Finding appropriate disposal methods can be challenging. The State of Oklahoma Department of Agriculture, Food and Forestry lists five acceptable options for animal carcass disposal: 1) rendering, 2) burial, 3) incineration, 4) landfills, and 5) composting. Composting is an inexpensive, environmentally friendly method of disposing of animal mortality that is commonly used in the poultry and swine industries. Several different styles of composting bins were constructed and a workshop was conducted for participants desiring mortality composting information. A fact sheet was also developed. Further, Oklahoma State University's television agricultural program, SUNUP, filmed a segment on small stock mortality composting that aired on Oklahoma's public television station and is archived on their YouTube channel. A link to the segment is on the Institute website.

> Activities of the mortality composting projects exemplify how the Institute identifies and gives attention to areas not addressed previously or elsewhere.

Subsequent to the demonstration grant, the Institute was awarded a USDA/NIFA Grant #2010-38821-21582 (OKLXMERKEL10; Accessing #223167) to form a collaborative project with Virginia State University and Florida A&M University to train farmer educators on goat mortality composting. Through that grant each collaborating institution established a demonstration site and held training workshop for producers and extension personnel on mortality composting. In April 2014, the Institute held a conference entitled "What Farmer Educators Need to Know about Mortality Composting — Beyond the Basics" that included basic information on mortality composting and more in-depth information on particular aspects given by national leaders in the topic of mortality composting. Attendees were representatives of producer organizations, universities, USDA/NRCS, extension organizations as well as individual goat producers. Conference papers were included in the proceedings of the annual goat field day and are posted, along with conference presentations, on the Institute website.

An additional output from the final conference was interest by the Livestock and Poultry Environmental Learning Center, hosted on *eXtension.org*, that included an announcement of the final

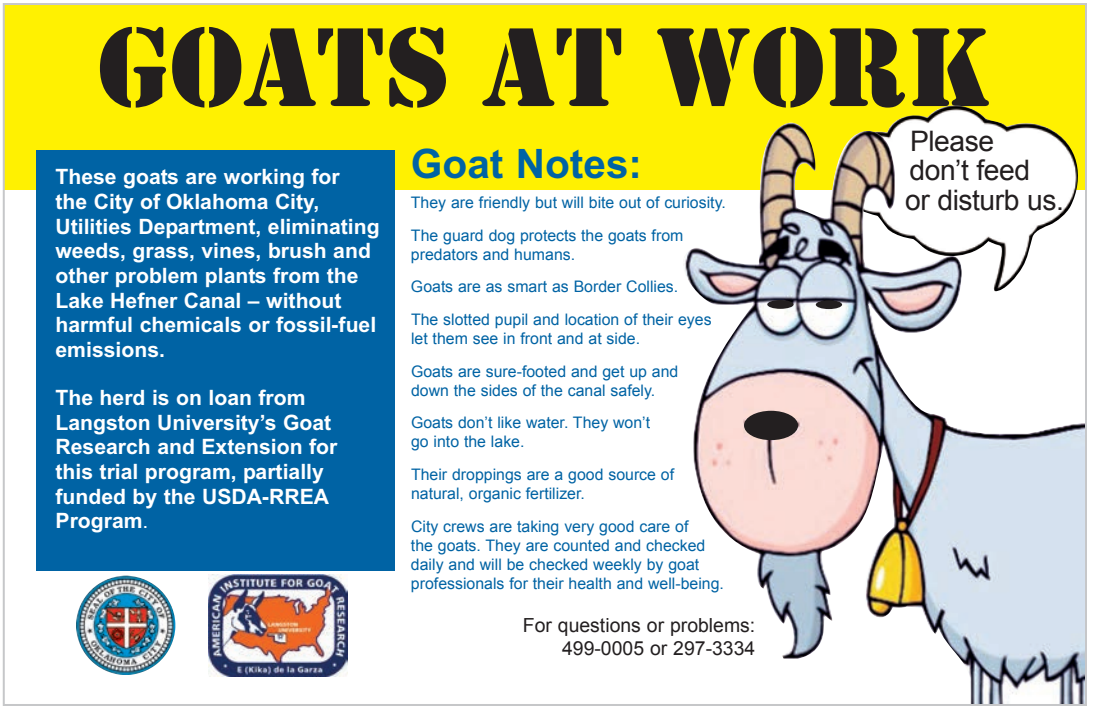
workshop in its newsletter and subsequently a two-part webinar series in which the presenters from the final workshop presented their papers live on-line as webinars. These webinars are archived and available for anyone to view. Other grant outputs included a training module on mortality composting for the Institute's web-based training and certification course for meat goat producers and a chapter on mortality composing that was printed in both the Institute's meat and dairy goat production handbooks.

MEAT GOAT BUCK PERFORMANCE TEST

To further genetic progress of meat goats through the identification of superior sires in the industry, Langston University and the Oklahoma Meat Goat Association established a meat goat performance test in 1997. From its inception until 2008, the test was open to purebred and crossbred bucks born between December 1 of the previous year and March 31 of the current year. In 2009 and at the request of breeders, the start date was moved one month later in the year and the test was open to purebred and crossbred bucks born between January 1 and April 30 of the current year. Prior to 2004, the capacity of the meat buck performance test was 53 because that was the number of Calan gate feeders that were installed in the testing facility. In 2004, a new automated feeding system, Feed Intake Recording Equipment (FIRE), was installed in the testing facility. With the combined FIRE system and Calan gate feeders, the Oklahoma Buck Performance Test Buck had a capacity of 100 bucks.

The FIRE system is a completely automated electronic feeding system originally developed for swine but modified for goats by the Institute. Animals wear an electronic eartag, which is read by an antenna in the feeder. Feed intake is automatically recorded every time a buck visits a FIRE feeder. For the Calan feeders, each buck wears a collar with an electronic "key" encased in hard plastic. The key unlocks the

> The Institute has conducted a wide array of vegetation management projects and partnered with numerous entities.



Dr. Steve Hart at a "Nose to Tail" extension event in Oklahoma.

door to only one Calan feeder, thus enabling the buck to eat out of his individual feeder. Each morning, any feed that remains in the Calan feeder is removed and fresh feed is weighed and placed into the Calan feeder. The difference in weight between the fresh feed placed in the Calan feeder one morning and the remaining feed the next morning is the amount consumed. Because only one goat is capable of opening an individual Calan door, it is possible to calculate feed intake of individual bucks.

The Institute responded to changing needs of the small ruminant industry by transitioning the Meat Goat Buck Performance Test into one for both sheep and goats and including an assessment of internal parasite resistance.

Because the FIRE system has not previously been used with goats, Langston University determined the appropriate stocking density per FIRE feeder. As many as 10 young goats can share a FIRE feeder without any adverse effects. Langston University also compared the FIRE system with the Calan feeders. We found no differences in average daily gain or feed intake of growing goats on the FIRE system and the well-established Calan feeders.

In early 2000, the American Boer Goat Association Board of Directors designated the Oklahoma meat goat buck performance test as an ABGA Approved Performance Test. In 2003, the International Boer Goat Association, Inc. sanctioned the Oklahoma meat goat buck performance test.

In 2011, the annual meat buck performance test was temporarily discontinued because a research project needed the performance testing facility. The annual meat buck performance test will be re-inaugurated in 2017 as a Second Generation Performance Test to include hair sheep rams and to include resistance to internal parasites via an artificial challenge.

RENEWABLE RESOURCES EXTENSION ACT

Goats are a proven biological method for controlling unwanted vegetation and invasive plant species. Many tribal and municipal governments are interested in utilizing goats for biological control because rugged and steep terrain can create issues for both traditional machinery and

city employees; however, tribal and municipal managers feel that they lack the necessary livestock management skill. This Renewable Resources Extension Act (RREA) project established partnerships between Langston University and tribal and municipal governments, and established demonstration sites using goats for biological control with Langston University providing technical assistance.

In 2011, Langston University and the City of Stillwater cooperated to establish a pilot project that relied upon goats, and not city workers, to control unwanted vegetation in controlled areas, especially in drainage easements. Stillwater's Stormwater Manager Cody Whittenburg said in a press release "I like this idea because it's eco-friendly and may prove beneficial for managing especially difficult areas. Many other cities have successfully used goats to manage vegetation in urban and residential areas. Goats are natural mowers and may be more efficient in certain areas than machines." The pilot program was launched in October and Langston University provided a herd of goats and equipment. The goats were sequentially released in a fenced area in three places where steep or rugged terrain made it difficult to mow using traditional machinery. Stillwater's External Services Director John McClenny reported to the Stillwater City Council that "All of staff feels like this program was a success by every measure that we have." Those measures include providing good public relations, a partnership with Langston University, and an environmentally friendly solution. McClenny told councilors that he had received a number of positive comments from the public, and councilors echoed that sentiment. "I did not receive one negative comment about it," Councilor John Bartley said. Stillwater is looking to make the pilot program long term, McClenny said, and goats could be used to maintain steep rights-of-way or areas in parkland such as around the dam in Boomer Lake. "(These are) places that machinery can't get to, and this is the only thing that works," he said. Rugged terrain can create issues for both traditional machinery and city employees, which could increase the city's tort liability. This pilot project was continued in 2012. The pilot project was so successful that an employee of Stillwater's Parks and Recreation department purchased a herd of goats and then leased them to the city of Stillwater.

In 2014, Langston University and the city of Oklahoma City entered into a partnership to clear unwanted vegetation along the Hefner Canal, which connects two lakes in Oklahoma City (Lake Overholser to Lake Hefner). The canal had become overgrown with vegetation and the city was concerned about the safety of city employees in the clearing of the canal banks. So the city

Drs. Terry Gipson, Tilahun Sahlu, and Roger Merkel look over production handbooks produced by the Institute.

approached Langston University in the hopes that goats could be employed for the vegetation-clearing task. Langston University was pleased to partner with the city and deployed goats for the task. The goats have become instant celebrities and have become the subject of numerous television and newspaper articles. One such newspaper article can be found at *http://newsok.com/we-got-the-bleat-okc-goats-become-social-media-celebs/article/5338899*. In addition, you can follow the goats at *@hefner_goats* on Twitter.

OKLAHOMA AND TULSA STATE FAIRS

Most children are not raised on a farm and do not get to see the miracle of birth. Langston University has collaborated with the Oklahoma Veterinary Medical Association to bring the miracle of birth to the public. The Institute has provided pregnant females for the birthing center at Tulsa State Fair for last 14 years and for last 7 years at the State Fair of Oklahoma. The births are videoed and replayed on a monitor so that they can be seen at any time. The does are the highlight of the centers every year as the children laugh at the kids jumping on their mothers and playing. In addition and since 2002, Langston University has provided personnel to be the superintendent of the meat goat show at the Oklahoma State Fair.

WEB-BASED TRAINING FOR MEAT GOAT PRODUCERS

New meat goat producers, as well as some established ones, have an expressed need for current, correct information on how to raise goats and produce safe, wholesome products in demand by the public. As the meat goat industry grows and evolves, a quality assurance program is essential. Such a Quality Assurance program ensures the production of a wholesome product that satisfies consumers and increases profit for the meat goat industry.

Langston University was awarded funding by the Food Safety and Inspection Service of USDA to develop training and certification for meat goat producers. Langston University organized and led a consortium of 1890 universities and producer associations in this project. The consortium identified the subject topics most pertinent and pressing for the instructional modules. The consortium then identified experts on the selected subject topics and pursued these experts as module authors. These authors represent the most qualified persons in their field in academia as well as in the industry.

Langston University translated the instructional modules into web pages with accompanying images, and pre- and post tests for those producers wishing to pursue certification The on-line training program currently has 23 modules representing the original modules plus a module on mortality composting produced through the grant on mortality composting discussed in a previous section. For certification producers must pass 16 required modules and three of the seven elective modules. All modules are also available in pdf for easy printing and the introductory module is available as a podchapter for downloading and listening on your favorite mp3 player. The website (*http://goats.langston.edu/Training*) was unveiled in late 2005.

Since the certification program's inception in 2007, more than 1,500 producers have enrolled for certification and 369 have completed the certification process. These instructional materials will best serve meat goat producers in assisting them to produce a safe, wholesome, healthy product for the American consumer. Funding source for this project was USDA/FSIS/OPHS project #FSIS-C-10-2004 entitled “Development of a web-based training and certification program for meat goat producers.”

In 2015 the Institute published the second edition of the *Meat Goat Production Handbook*. The Institute is currently working on updating the web-based training program as well as establishing additional modules for the new chapters included in the second edition.

STATE/ COUNTRY	NUMBER CERTIFIED
UNITED STATES	
AL	5
AR	11
AZ	2
CA	6
CO	3
CT	1
FL	25
GA	18
IA	5
ID	1
IL	5
IN	8
KS	11
KY	9
LA	3
MA	2
MD	4
MI	9
MN	4
MO	14
MS	3
MT	2
NC	17
NE	4
NH	1
NJ	2
NV	3
NY	7
OH	11
OK	33
OR	7
PA	10
SC	6
SD	2
TN	13
TX	40
UT	2
VA	11
VT	1
WA	5
WI	5
WV	6
WY	3
CANADA	
AB	2
BC	4
MB	3
NS	1
ON	3
Botswana	1
England	2
India	1
Malaysia	4
Mexico	2
Pakistan	1
Saudi Arabia	1
South Africa	1
Suriname	1
Zimbabwe	2
Total	**369**

WEB-BASED TRAINING FOR DAIRY GOAT PRODUCERS

As a companion to the web-based training and certification program for meat goat producers, the American Institute for Goat Research is developing an on-line training and certification program for dairy goat producers. The program utilizes the information found in the Dairy Goat Production Handbook using the same paradigm as the meat goat certification course. Producers wishing to become certified must pass the required modules plus a number of the elective modules. The course will be unveiled in 2017.

RISK MANAGEMENT EDUCATION FOR SMALL PRODUCERS IN OKLAHOMA

In 2014 and 2015, a series of informational and instructional meeting were held in four locations in Oklahoma for small farmers. Three meetings were held in Idabel, three meetings in Tatums,

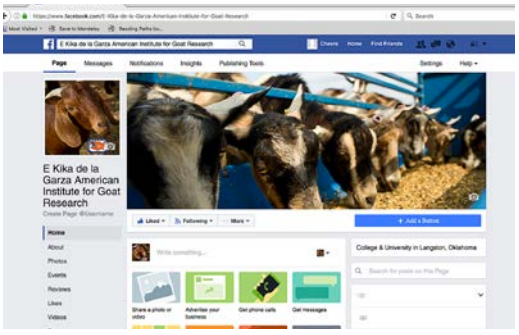
three meetings in Anadarko, one meeting in Haskell, one meeting in Boley, and one meeting in Tulsa. Primary presentations concentrated upon record keeping and reasons to keep records, which are: 1) to assist farmers in planning and making decisions, 2) for accessing loans and calculating taxes, and 3) for evaluations and analysis.

Other presentations were on USDA services such as Food Nutrition Services, Farm Service Agency, Natural Resource Conservation Services, Rural Development, and Risk Management Agency.

A series of goat production and management seminars were also provided. Participants were very active in the meetings and stated they missed these type of meetings due to the Center of Outreach Programs being terminated from Langston University in 2012. Participants interviewed said they needed more information to produce better marketable products. The participants' response had nothing to do with money, but knowledge. They needed to know how they could maximize their income. One farmer responded that because of meetings like this one, he would begin keeping records, as it would assist him in completing income tax forms.

FACEBOOK

Facebook is the ultimate social media app and the Institute has established a Facebook presence. You can find us at E Kika de la Garza American Institute for Goat Research. Like us on Facebook and get the most up-to-date information from the Institute.



Alpine dairy goats in the Institute milking parlor.

EXTENSION GRANTS

Training Farmer Educators on Goat Mortality and Butcher Waste Composting, A Regional Approach

- USDA 1890 Institution Capacity Building Grants Program
- Project number OKLXMERKEL10
- 2010–2014
- R.C. Merkel, T.A. Gipson, A. McKenzie-Jakes, and A. Yousuf
- Langston University; Florida A&M University; Virginia State University
- Funding amount: $279,614

Objectives:

1) Host project collaborators and 1890 extension leaders to discuss mortality and offal composting
2) Establish mortality composting teaching demonstration sites
3) Train CES, NRCS and other outreach personnel and farmer group leaders in composting animal mortality and butcher waste
4) Publish a manual on small-stock mortality composting
5) Develop a training module on mortality composting write a chapter on mortality and butcher waste composting

Enhancing Capabilities of Socially Disadvantaged and Underserved Farmers via Low Literacy Materials in English and Spanish

- USDA 1890 Institution Capacity Building Grant Program
- Project number OKLXGIPSON10
- 2010–2015
- T.A. Gipson, R.C. Merkel, M. Simon, and J. Fernandez Van Cleve
- Langston University; Kentucky State University; University of Puerto Rico – Mayagüez
- Funding amount: $282,000

Objectives:

1) Utilize existing core chapters from the Meat Goat Production Handbook to develop a low-literacy training manual for meat goat production
2) Translate the low-literacy meat goat production training manuals into Spanish
3) Develop supplemental explanatory and "how to" demonstration materials to the English and Spanish manuals in video format (DVD and web-based) for use by extension agents, outreach specialists and individual farmers

Extension Education Delivery Tools for Dairy Goat Producers: A Web — Based Certification Program and E-Book

- USDA 1890 Institution Capacity Building Grant Program
- Project number OKLXMERKEL11
- 2011–2016
- R.C. Merkel, T.A. Gipson, S. Hart, Y. Park, and C.M. Mikolayunas
- Langston University; Fort Valley State University; University of Wisconsin
- Funding amount: $350,000

Objectives:

1) Develop scientific-based content for a dairy goat web-based certification program and e-book
2) Design and construct a web-based certification program based upon the developed content
3) Develop a printed handbook based on the web-based program
4) Develop an e-book version of the handbook

Sustainable Small Ruminant Production Through Selection for Resistance to Internal Parasites

- USDA 1890 Institution Capacity Building Grant Program
- Integrated-research and extension
- Project number OKLXSAHLU12
- 2012–2016
- T. Sahlu, A. L. Goetsch, T. A. Gipson, S. P. Hart, Z. Wang, R. Mateescu, and E. DeVuyst
- Langston University; Oklahoma State University
- Funding amount: $600,000

Objectives:

1) Determine early progress in selection of small ruminants for resistance to internal parasitism 'on-station' and 'on-farm'
2) Characterize changes performance due to selection; develop and implement a new second generation central sire performance test for small ruminants at Langston University
3) Develop early-life genetic indicators of resistance and assess changes in physiological conditions affected by selection
4) Evaluate economic and management considerations of whole herd/flock selection; disseminate potential benefits of selection and associated economic and management considerations for adoption by small ruminant producers

Rehabilitation of Urban and Suburban Landscapes: An Eco-Friendly Partnership Between Langston University and Tribal and Municipal Governments

- USDA Renewable Resources Extension Act Program
- Project number OKLUOKLXRREAGIPSON14
- 2014–2016
- T.A. Gipson, and S. Hart
- Langston University
- Funding amount: $40,500

Objectives:

1) Establish partnerships between Langston University and tribal and municipal governments
2) Establish demonstration sites using goats for biological control, with Langston University providing technical assistance

Comparison of Biological Control of Redcedar with Goats to Conventional Methods of Control

- USDA 1890 Institution Capacity Building Grant Program
- Project number OKLUSHART2014
- Integrated-research and extension
- 2014–2017
- S.P. Hart, T.A. Gipson, R.C. Merkel, C. Clifford-Rathert, J. Pennington, and C. Williams
- Langston University; Lincoln University; Crowder College
- Funding amount: $565,784

Objectives:

1) Compare various methods for redcedar control, specifically for efficacy, environmental impact and costs to property managers and policy makers with information to enable them to make informed decisions on redcedar control
2) Evaluate factors affecting redcedar consumption by goats so that goats can be managed more effectively to control redcedar
3) Utilize near-infrared spectroscopy (NIR) to predict volatile oil content of redcedar and to predict the digested redcedar content of feces (enables prediction of quantity of redcedar consumed by the goat)

Young girl and goat in India at a "Health and Vaccination Camp" of West Bengal University of Animal and Fishery Sciences near Kolkata.

INTERNATIONAL OVERVIEW

OBJECTIVES

Goats and goat products are part of the livelihood of a majority of the world's population and are an important resource for poor farmers in many countries of the world. Part of the mission of the E (Kika) de la Garza American Institute for Goat Research is to effect positive change in goat production throughout the world. To fulfill this aspect, the Institute has developed and maintains many strong ties with research and academic institutions around the world. In addition to collaborative work with foreign institutions, the Institute has hosted visiting scientists from over 30 foreign countries to conduct research activities. Training for foreign livestock workers and scientists as well as for U.S.-based persons who will travel and work overseas are other ways in which the Institute is active in the international arena.

Dairy goat center sign at Egerton University near Nakuru, Kenya for Trilateral Partnership Project.

International research and training, hosting foreign scientists, and training those who will teach others are internationally-focused activities that give the Institute unique opportunities to not only increase knowledge of foreign production systems and constraints, but also to positively impact agricultural development in foreign countries and help alleviate poverty and hunger. General objectives of the Institute's international program are to: 1) increase our knowledge of goat production systems worldwide and current constraints to increased production; 2) build human capacity

through training foreign scientists and agricultural workers in goat production, thereby allowing them to more effectively carry out their missions of teaching, research, and extension; 3) increase Langston University and the Institute's involvement in agricultural development and impact on human welfare; and 4) enhance the Institute's knowledge of development and development issues.

INTERNATIONAL RESEARCH AND DEVELOPMENT

Applied Livestock Research Methods Handbook

In 2012 the Institute was awarded a grant by the USDA Foreign Agricultural Service to develop a manual for junior researchers in developing countries entitled *Methods of Livestock Research on Smallholder Farms*. Conducting research on-farm has many benefits including allowing research scientists to study the most limiting production constraints in the environment in which they occur, interacting with farmers to learn of other production problems, and often greater adoption of resulting technologies since farmers play a significant role in the research developing those technologies. However, most researchers do not conduct on-farm research due at least partially to inadequate training and knowledge of the design and conduct of on-farm experiments, statistical analyses and interpretation of resultant data, and preparation of reports suitable for peer-reviewed journals.

To assist researchers in conducting on-farm research, Dr. Arthur Goetsch led a team of Institute scientists and collaborators from the U.S., Ethiopia, India, Jordan, Mexico, Israel, and China in developing the manual. The manual focuses on methods of applied livestock research, with special attention to treatments, design, implementation, analysis, interpretation, and peer-reviewed articles. The target audience is junior to mid-level professionals (e.g., M.S.) and graduate students in developing countries.

Upon completion of the manual, Dr. Goetsch led workshops during 2013 and 2014 in Kenya, Ethiopia, China, Jordan, Malawi, Mexico, and India to create awareness of the resource, train junior researchers, and receive feedback for publication enhancement. Hardcopies of the publication are being distributed, and it is available free on the Institute's website at *http://goats.langston.edu/methods-livestock-research-smallholder-farms*. The publication has proven to be a popular download with the webpage garnering 329 page views since its inception with viewers literally scattered around the globe.

> The USDA FAS-supported on-farm research handbook project was a 'dovetailing' with two related and complementary international projects.

India-Africa-U.S. Trilateral Partnership for Food Security

In 2012, the Institute began a project funded by the U.S. Agency for International Development and managed by the USDA Foreign Agricultural Service to enhance capacity for research, teaching, technology transfer, and community development programs with Bunda College of Agriculture in Malawi and Egerton University in Kenya.

BUNDA COLLEGE OF AGRICULTURE

Animal Science Nutrition Laboratory

Bunda College of Agriculture (BCA) did not have a well-equipped laboratory for evaluating the quality of feedstuffs consumed by livestock, which constrained animal science research, student training, extension activities, and optimal animal management practices. Therefore, an Animal Science Nutrition Laboratory (ASNL) with most essential instruments and supplies was established. The ASNL now has capacity for key analyses noted below.

- Dry matter or moisture
- Ash
- Kjeldahl nitrogen or crude protein
- Gross energy via bomb calorimetry
- Neutral detergent fiber
- Acid detergent fiber
- Acid detergent lignin
- Fat or ether extract
- In vitro dry matter and neutral detergent fiber digestibility
- In situ dry matter, nitrogen, and neutral detergent fiber digestibility

These capabilities arose from equipment and supplies provided and set up/installed by personnel of the Institute through the project as well as associated training in laboratory analyses and preparation of animals with rumen cannula used for in in vitro and in situ digestibility measures. The Laboratory Coordinator of the Institute, Mr. Kesete Tesfai, was primarily responsible for most of these activities, encompassing a number of trips to BCA. Apart from items used in the actual assays noted above, there were other pieces of equipment required such as for high-quality water filtration and cooling systems. Drs. Lionel Dawson and Arthur Goetsch providing the training in rumen cannulation.

The ASNL is now an important component of the BCA teaching program as well as integral in animal science research being conducted, which encompasses graduate programs of numerous M.S. and Ph.D. students. Because there is not a laboratory in Malawi as well equipped for analyses of diets and feedstuffs used for livestock, BCA receives numerous requests from outside entities such as feed companies and non-governmental organizations with livestock projects. In response to this demand, a service-providing program is being developed. Fees received will be

Other Trilateral Partnership activities at BCA were designed to improve performance of animals on-campus and assist in a community breed enhancement program.

Drs. Arthur Goetsch and Tilahun Sahlu visiting a sheep production site in India near Tamil Nadu Veterinary and Animal Sciences University at Chennai.

Dr. Terry Gipson during artificial insemination training at Bunda College of Agriculture in Lilongwe, Malawi.

The most important area for improving research, teaching, and extension capacity of BCA was an Animal Science Nutrition Laboratory, which the Institute was well-suited to lead.

used to ensure sustainability of the laboratory for this function as well as internal BCA missions relating to teaching and research.

Improved Animal Management

The ASNL is playing an important role in improving management of livestock of BCA and local smallholders being assisted through gaining a better understanding of the quality of feedstuffs and diets available and consumed. Moreover, there were a number of other interventions of the project contributing to enhancements of animal management at BCA, including repair of an irrigation system and purchase and planning of use of improved forages and tree legumes for enhanced nutritional planes and elevated animal performance. Relatedly, there was technical assistance and training provided in feeding and health management. Through these activities, the condition of livestock at the BCA campus markedly improved in the latter part of the project period.

Artificial Insemination and Improved Breed Semen

Training in artificial insemination included attention to collection and use of fresh semen as well as the frozen form. In this regard, 400 straws of Boer and Saanen goat semen were imported from the U.S., which are now being used in a community development project at local villages for cross-breeding with indigenous goats to increase milk and(or) meat production. Other related technical assistance for improved management practices in local villages is being provided by BCA personnel. Moreover, now that the condition of animals at BCA has improved through enhanced feeding management practices, these animals also will be subjected to artificial insemination with semen of the improved genotypes. Dr. Terry Gipson had a

major role in these activities. Training in surgical preparation of teaser bucks for heat detection, provided by Dr. Dawson, will aid in the campus artificial insemination program. Furthermore, BCA has interest in developing a composite goat breed for both meat and milk production attributes. This semen and the artificial insemination technology may allow background work to determine merit of such an intervention and possibly initial activities if so warranted. Training in methods of livestock research on smallholder farms may be of special utility in design of future research to evaluate potential impact of this or other similar interventions.

Goat Cheese

Goat milk production and its use in value-added processing were not project emphasis areas for BCA. However, the exposure to cheesemaking from the milk of goats during a workshop at Egerton University also attended by BCA personnel may create an impetus for future attention to this consideration.

EGERTON UNIVERSITY

Dairy Goats Improvement Centre

Egerton University (EGU) has had an ongoing dairy goat community development project. However, a scarcity of purebred animals has limited potential program scope. Hence, genetic diversity was broadened by importing live Toggenburg, Alpine, and Saanen goats from South Africa and frozen semen of Toggenburg and Saanen goats from the U.S., which were activities mainly of Dr. Gipson. At the end of the project the Dairy Goats Improvement Centre (DGIC) had 34 purebred Toggenburg, Alpine, and Saanen goats. Initially, 30 animals were imported from South Africa, ten of each breed with one-half males and one-half females. Although some losses were incurred in the early period after arrival for various reasons, with a few females initially pregnant, subsequent breeding proceeding well, improvements in management noted later, and addition of semen imported from the U.S., the number of purebreds is expected to increase markedly in the near future.

The primary need at EGU targeted in the Trilateral Partnership was importation of purebred dairy goats to create the Dairy Goats Improvement Centre.

Rumen cannulation training at BCA.

Training in artificial insemination was similar to that at BCA, addressing fresh and frozen semen. Instruction in surgical preparation of teaser bucks for heat detection, presently being performed at EGU without assistance, will facilitate insemination at the proper times with animals on campus. In addition to live animals, 292 straws of semen of Toggenburg and Saanen goats were imported from the U.S. Goats of the existing herd at EGU, with some background breeding of Toggenburg, Alpine, and Saanen goats, are being inseminated with fresh and frozen semen for improved milk production and later distribution in the community. Moreover, a community fee-based artificial insemination program has been established to ensure program sustainability. Inseminations occurred during the project at three locations noted below.

- Shalom Primary School in Rongai, Principal of Mr. John Kamau Ngaruiya
- Commercial farm of Mr. Solomon Miyumo
- Local orphanage directed by Dr. Troy Sammons and Mrs. Rebekah Sammons of Christian Veterinary Mission

There were no fees at this time, but this will be initiated soon as interest and demand increase. Milk from animals of the Shalom Primary School provides nutrition for students at a reduced cost, and male goats are castrated and later slaughtered for meat to supplement student meals. The orphanage is for children of parents that work or make a living recycling trash from the Nakuru dump site; school services and animal care training are offered for the poor and underserved children. Mr. Ngaruiya, Mr. Miyumo, and Dr. Sammons each attended all or most of the 2-week workshop held at EGU in the fall of 2014, covering topics of feeding management, artificial insemination, health care, and value-added goat milk processing. Technical assistance was provided to the farms in addition to artificial insemination, such as means of animal identification for appropriate record keeping and

Mr. Jerry Hayes providing training on the use of CIDRs for estrus synchronization at Egerton University near Nakuru, Kenya.

Arrival at EGU of dairy goats from South Africa.

Through the Trilateral Partnership, EGU now has a village dairy goat development program based on artificial insemination.

castration of young males to achieve desired breeding for maximum improvements in genetic merit. The motorcycles equipped with coolers provided by the project will be critical for work in villages hard to reach by other means. As the program expands in the future, training provided in on-farm livestock research in developing countries should be of value in tracking improvements in economic and food securities from this and other related interventions.

Dairy Goat Management

Concomitant with importation of animals of improved dairy breeds, there is need for greater attention to appropriate management practices compared with local breeds with less production potential. The relevant training provided in health and veterinary care, feeding management, record keeping, and day-to-day management practices, provided by Drs. Goetsch and Dawson and Assistant Research Farm Manager Mr. Jerry Hayes, has resulted in improved livestock production skills not only at the EGU campus but also on collaborating farms through training provided by EGU implementers. In this regard, the EGU DGIC is being developed into a model farm for dissemination of a preferred overall management program package for highly productive dairy goats in Kenya and the East Africa region.

Dairy Goat Milk Products

For realization of maximal economic impact from an intervention such as that represented by the DGIC, the value chain must be considered and value-added processing integrated as a critical component. In this regard, there was training in the making of various types of cheeses from goat milk, conducted by Dr. Steve Zeng. Through these sessions, the EGU dairy product program just recently started a dairy goat milk product program of a M.S. student focusing on differences in cheesemaking processes compared with cow milk, and it is anticipated that this area will be increasingly emphasized and expanded upon in the future.

Dr. Zaisen Wang delivering an invited presentation at the 2015 Sheep and Goat Production and Academic Conference at Dengfeng, China.

COLLABORATION WITH NORTHWEST AGRICULTURE AND FORESTRY UNIVERSITY, CHINA

In October, 2015, Dr. Goetsch traveled to the Northwest Agriculture and Forestry University (NWAFU) in Yangling, China. The primary purpose of the visit was collaborative research in accordance with a Memorandum of Understanding between the two institutions established many years ago. Dr. Goetsch provided assistance in initiating experiments dealing with emission of the greenhouse gas methane by dairy goats. One of studies was with a portable box system that an individual animal is situated in for 30 minutes, with gas concentrations measured at the beginning and end of the period. The difference in concentration of methane multiplied by volume of the unit is used to determine emission, which is then expressed on a daily basis. The other trial was conducted in environmental chambers allowing quantification of not only consumption and emission of different gases by animals, in this case groups rather than individuals, but also emission of gases such as ammonia from feces and urine. In addition to this collaborative research, Dr. Goetsch gave a presentation on current areas of emphasis of small ruminant research to faculty, staff, and students of the University and on practical feeding considerations for dairy goats to farmers of a local dairy goat association.

In May, 2016, Dr. Goetsch again traveled to the NWAFU. The primary purpose of the visit was to attend and make a plenary presentation at the 3rd Asian-Australasian Dairy Goat Conference and to provide a presentation at an associated workshop on use of the Langston University interactive nutrient calculation system for goats.

Education and Training

USDA BORLAUG FELLOWS

As part of the 2014 Norman E. Borlaug International Agricultural Science and Technology Fellowship Program initiative, the Institute was selected by the U.S. Department of Agriculture to be the mentoring institution for training two Kenyan scientists. Dr. Bridgit Muasa of the Central Veterinary Laboratories, Ministry of Agriculture, Nairobi, Kenya was selected to receive training in the area of assisted goat reproductive management under the mentorship of Dr. Erick Loetz. Dr. Chrilukovian (Chris) Wasike of Maseno University in Kenya was selected to undergo training in genomic selection in dairy goats, specifically on the trait of residual feed intake, with Dr. Terry Gipson serving as his

mentor. The Borlaug Fellow Program allows foreign researchers the opportunity to travel to the U.S. for specific training programs. The U.S.-based mentors also make follow-up visits to the Fellows' home institutions for further work and collaboration.

During her training, Dr. Muasa gained expertise in the following areas: Estrus and ovulation hormonal synchronization; estrus detection; early pregnancy diagnosis by ultrasound; artificial insemination (transcervical, intrauterine, and laparoscopically-aided); multiple ovulation induction, retrieval, evaluation, and transfer of embryos; gamete management (flushing, grading, and cryogenic storage); and laparoscopic oocyte aspiration. Dr. Muasa's expanded her expertise by taking part in goat semen collection, evaluation, and freezing through Reproductive Enterprises Incorporated, Stillwater, OK, and by completing a course on in vitro fertilization at Texas A&M University, College Station, TX.

Dr. Wasike's training entailed a mixture of mastering various statistical analyses and learning how to acquire and utilize genomic data via collection of DNA samples from dairy goats. Dr. Wasike, along with his mentor, Dr. Terry Gipson, and Drs. Muasa and Loetz toured the laboratory of the GeneSeek® Division of Neogen Corporation in Lincoln, NE. Drs. Wasike and Gipson submitted samples from dairy goats to Neogen for analysis of single nucleotide polymorphisms (SNP) as part of Dr. Wasike's research and training program. To further learn about the analysis and use of genomic information, Drs. Wasike, Gipson, and co-mentor Dr. Megan Rolf of Oklahoma State University traveled to Washington, DC to visit the USDA Animal Genomics and Improvement Laboratory, located in the Beltsville Agricultural Research Center, Beltsville, MD. There they met with Dr. George Wiggans of the USDA AIPL who explained how the USDA acquires, authenticates, and analyzes data for genomic evaluations.

The USDA Borlaug Fellow program provided an opportunity to train Kenyan scientists in expertise areas of the Institute of mutual interest.

To complete Dr. Wasike's training, Dr. Terry Gipson made arrangements for a follow-up visit to Maseno University that occurred in mid-2015. During the follow-up visit, Drs. Wasike and Gipson analyzed the resulting SNP data, used an online database to insert needed information, and conducted a genome wide association study. An abstract of the research was prepared and findings were

Drs. Bridgit Muasa and Chris Wasike were USDA Borlaug Fellows in 2014.

presented at the annual meeting of the American Society of Animal Science in 2016.

In addition to training and research activities, Drs. Muasa, Wasike, Loetz, and Gipson had the opportunity to attend the Borlaug Dialogue session of the World Food Prize Symposium in Des Moines, Iowa and interact with scientists from around the world.

SUPPORTING THE PHILIPPINE GOAT INDUSTRY

During the past several years, the Institute has collaborated with Philippine institutions to support the growth of their goat industry. The collaboration has taken the form of supporting a Philippine nationwide dairy goat project through providing training in specific topics to Philippine scientists, participating as a presenter and resource person in train the trainer programs located in the Philippines, and receiving agricultural extension training personnel at the Institute for short-term training program.

The Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development is implementing a Dairy Goat Science and Technology Program. Central Luzon State University in the Science City of Muñoz, Neuva Ecija is working with the Council on this project. In particular, Central Luzon State is working in two areas of this program and the Institute hosted and provided training to several Philippine scientists in 2015.

> Collaboration with the Philippine goat industry entailed short-term training of two scientists at the Institute in 2015.

Training a Philippine Scientist in Mastitis Detection and Management

In August, 2015, the Institute hosted Dr. Virginia Venturina from the College of Veterinary Medicine at Central Luzon State for a training program on mastitis detection, prevention, and treatment in dairy goats. Dr. Venturina serves as the Project Leader for the Development of Diagnostic and Management Protocols for Intrammamary Infection in Goats. As such, it was her responsibility to develop and lead research and extension activities in the areas of mastitis and udder health. Dr. Venturina's visit was designed for her to receive training on different detection methods of udder infection ranging from direct microscopic count to machine cell counters to animal-side indicator tests.

Another aspect of Dr. Venturina's training was comparison of various on-farm methods of subclinical mastitis detection. To accomplish that, Dr. Venturina conducted a small research trial comparing results of four different somatic cell tests with a machine count done in the Institute's DHI lab. Other tests done by Dr. Venturina were a test for an enzyme that is an indicator of udder infection and bacterial culture of milk. All tests were done on milk from individual udder halves. Dr. Venturina also took rectal temperature of the dairy does, infrared temperature of the udder, and evaluated udder health by palpation and use of a strip cup to look for abnormal milk.

Finally, Dr. Venturina had the opportunity to visit dairy goat farms in Oklahoma and speak with producers about management and animal health. Dr. Venturina gained valuable experience from her visit that will greatly benefit her as she continues to work on mastitis detection and management protocols for the Philippine National Dairy Goat Science and Technology Program.

Training Philippine Scientists on the Dairy Herd Improvement Program and Data Use for Genetic Evaluation

In October, 2015, the Institute hosted three additional scientists from Central Luzon State University, Dr. Emilio Cruz, Director of the university's Small Ruminant Center, and two of his staff, Drs. Neal del Rosario and Alvin Soriano. These scientists were working to devise a system to collect data on Philippine dairy goat production and to subsequently use those data for genetic evaluation.

Dr. Virginia Venturina from the Philippines during training in mastitis detection and management.

The visit of Drs. Cruz, del Rosario, and Soriano was structured to provide them with information on Dairy Herd Improvement (DHI) from on-farm sample collection to genetic evaluation. The scientists began their training by learning about the workings of the Institute's DHI laboratory from sample analysis to record interpretation. From Langston the Philippine team traveled with Dr. Roger Merkel to Spindale, NC to visit the office of the American Dairy Goat Association. One morning was spent in a very fruitful discussion of ADGA's linear appraisal system and some of the important aspects of it as it relates to goat milk production. Following that discussion, the group visited Spinning Spider Creamery in Marshall, NC.

From western North Carolina, the team traveled east to Raleigh, NC to visit the Dairy Records Management System office and learn how they process DHI records. The final aspect of their training was a discussion with Dr. George Wiggans of the USDA Animal Genomics and Improvement Laboratory in Beltsville, MD to discuss dairy goat genetic improvement programs and practical aspects of a data recording system.

The group learned a great deal throughout its visit and received many suggestions and ideas to take back to the Philippines. The state of record

keeping for dairy goats is in its infancy in the Philippines. Drs. Cruz, del Rosario, and Soriano will work to begin structuring a data collection system for dairy goats that, ultimately, could lead to genetic evaluations for use by Philippine goat producers.

A Resource for Philippine Training

In September, 2014, Dr. Roger Merkel traveled to the Philippines to be a resource person and lecturer for the training entitled "International Training of Trainers on Meat and Dairy Goat Production Technologies and Infrastructure for Smallhold Farms." This training was conducted by the International Training Center on Pig Husbandry, Agricultural Training Institute, Department of Agriculture, Republic of the Philippines as part of the agreement regarding the Association of Southeast Asian Nations (ASEAN) Working Group on Agriculture and Training Extension. Twenty participants representing the countries of Indonesia, Viet Nam, Laos, and the Philippines attended the training.

In February, 2016, Dr. Merkel returned to the Philippines to be a trainer and resource person for the Training of Trainers on Meat and Dairy Goat Production Technologies and Infrastructure for Smallhold Farmers. This training was held at the International Training Center on Pig Husbandry (ITCPH), Agricultural Training Institute, Department of Agriculture of the Philippines. Dr. Merkel provided a day of lectures on various aspects of goat husbandry and management. He also served as a resource person during other presentations at the training.

Training Philippine Extension Personnel

In November, 2013, the Institute hosted 11 people from the Department of Agriculture of the Republic of the Philippines for a one-week training and introduction to the American Institute for Goat Research. The Philippines Department of Agriculture is placing increasing importance on goat production because of the goat's high adaptability to a wide array of climatic conditions and feed resources. Goat production is also being highlighted due to the effects of global warming that have put increasing pressure on natural resources and livestock production. The Philippines Agricultural Training Institute is the arm of the Department

Collaboration involved training a veterinarian in aspects of goat mastitis and scientists from Central Luzon State University in dairy goat data collection and genetic evaluation.

Artificial insemination training of a group of Philippine veterinarians.

Dr. Roger Merkel providing artificial insemination training in the Philippines.

Assistance to the Philippine goat industry included trips of Dr. Roger Merkel in 2014 and 2016 for training in a variety of topics.

of Agriculture that conducts livestock extension and training activities. Their goal is to expand such activities in the area of goat production.

The group held discussions on aspects of U.S. goat production and viewed demonstrations of various management and production techniques in the areas of milking and milk handling, internal parasite, nutrition, diseases, and climate change and its effects on production. The group also had the opportunity to tour the Oklahoma State University College of Veterinary Medicine, the Oklahoma Animal Disease Diagnostic Laboratory, and Reproduction Enterprises, Inc. of Stillwater, Oklahoma.

In April, 2016, the Institute hosted four extension training personnel from the Agriculture Training Institute of the International Training Center on Pig Husbandry for a one-week training on goat production. The group received training in many aspects of goat production including reproduction, nutrition, health, and management.

Certificates of training in goat reproduction and management for extension training personnel from the Philippines.

EVALUATION OF GOAT PRODUCTION PRACTICES IN SOMOTILLO, NICARAGUA

In October 2015, Drs. Roger Merkel and Erick Loetz travelled to Somotillo, Nicaragua to evaluate goat production practices at a Baptist mission-run farm. The scientists visited the farm to observe the animals and management practices, look at the pastures and barns, and speak to farm personnel. The pair of scientists also visited the Somotillo branch of the Universidad Nacional Autonoma de Nicaragua. This university utilizes the mission farmland area and animals for student on-farm practice in crops, horticulture, and animal science. Drs. Merkel and Loetz discussed current activities at the farm with university scientists and future plans.

Drs. Merkel and Loetz also visited some local farms to see village practices and learn more about agriculture in the area. Upon their return to Langston University, the scientists provided their sponsors with a report evaluating the current condition of the farm and recommendations for improvements.

CONTINUING ETHIOPIA COLLABORATION

As addressed in previous reports of the Institute, there has been considerable collaboration with Ethiopian institutions since the mid-/late 1990s, and this has continued in the last five years. First, the on-farm research handbook project overviewed earlier entailed not only a workshop at Hawassa University in 2013 but also development of a forage evaluation research strategy for the Southern Agricultural Research

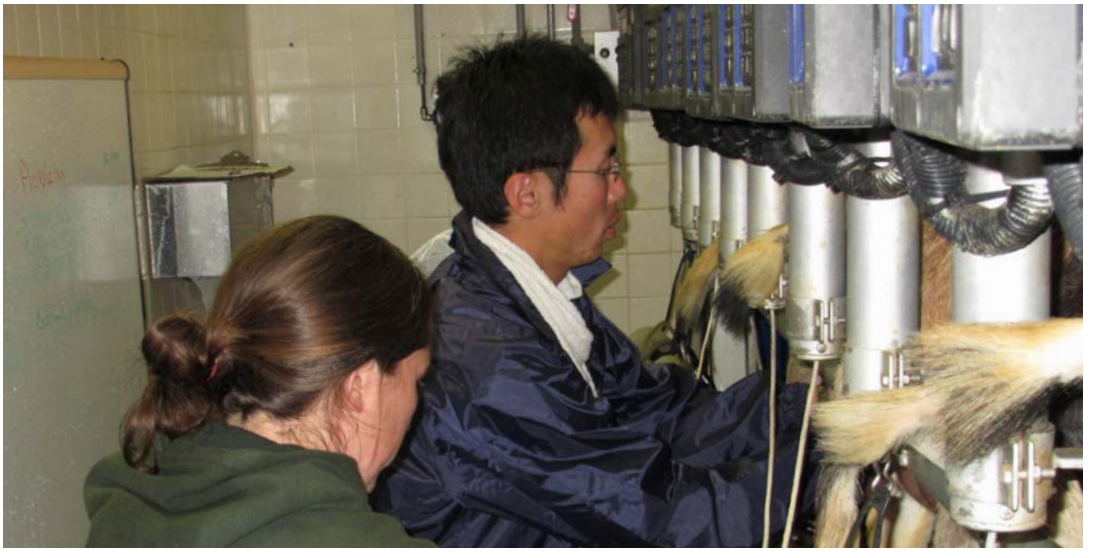
Initial interaction with the Philippine goat sector was in 2013 when 11 people from the country's Department of Agriculture spent one week at the Institute.

Facility tour during visit of Prof. Che Devendra.

Sheep and goats grazing at the Agricultural center of Sunnyside Mission, Somotillo, Nicaragua.

Institute (SARI) by Mr. Asrat Tera Dolebo of SARI and Dr. Goetsch. The two also designed an experiment addressing feedstuff associative effects in meat goats that was conducted at the Institute during Mr. Asrat's 6-month period as a Visiting Scholar in 2013–2014. Moreover, in conjunction with the on-farm research handbook workshop, Dr. Goetsch spent a few days at Addis Ababa University preparing a Concept Note entitled "Increased Sustainable Production of Small Ruminants of Smallholder Farmers in Ethiopia through Improved Mineral Nutrition" for the Bill & Melinda Gates Foundation (BMGF) PEARLs (Program for Emerging Agricultural Research Leaders) with faculty member Mr. Mesfin Mamo Gobena. Mr. Mesfin and Dr. Goetsch had met and discussed the potential collaboration during a week-long "Agricultural Connections Workshop" in Nairobi and Navaishi, Kenya, held in 2013. The workshop was supported by the Bioscience for east and central Africa program (BecA) and the Bill & Melinda Gates Foundation. Dr. Goetsch also met and interacted with Prof. A. K. Thiruvenkadan of Tamil Nadu Veterinary and Animal Sciences University in Chennai, India during the conference, which led to one of the on-farm research workshops in India. Dr. Goetsch attended the Agricultural Connections Workshop after the on-farm research handbook workshop at Egerton University as a part of that project and the Trilateral Partnership. The PEARLs Concept Note for the mineral nutrition project in Ethiopia did not result in funding; however, the activity contributed to Mr. Mesfin's M.S. program at the University of Florida working on both the Institute's CBG collaborative, interdisciplinary, and integrated projects concerning genomic aspects of selection of small ruminants for resistance to internal parasitism and hair sheep resilience to climatic stressors.

There has been training of Ethiopian researchers through studies conducted at the Institute as Visiting Scholars in the last five years in addition to Mr. Asrat and his feedstuff associative effect



Mr. Fumitaka Yoshimura, Farm Manager of Nagoya University, Japan, learning proper milking procedures during a short-term visit.

study. Dr. Mengistu Urge Letta of Haramaya University, who was a Visiting Scholar for six months in 2000–2001 and collaborated in the Ethiopia Sheep and Goat Productivity Improvement Program in 2005–2011, spent one year on sabbatical developing procedures to be used with sheep and goats on the CBG project addressing resilience to climatic stress factors. In this regard, Dr. Dereje Tadesse, most recently a faculty member of Debre Berhan University and previously Haramaya University, is currently a Visiting Scholar using these procedures with hair sheep on this project. Finally, Ms. Hirut Yirga, also a faculty member with Haramaya University and working on her Ph.D. degree, was a Visiting Scholar for six months in 2015–2016 continuing the Institute's research on use of brackish and saline drinking water by sheep and goats, which is the topic of her doctoral research in Ethiopia as well.

Institute personnel periodically make foreign assessment visits and host many short-term visitors from around the world.

In 2011 the six-year USAID Mission-funded Ethiopian Sheep and Goat Productivity Improvement Program (ESGPIP) was officially closed. Since that time the Institute committed itself to continuing to provide technical support for individual partners of the project. One of the secondary partners, and a beneficiary of the second importation of Dorper sheep and Boer goats, was the Southern Agricultural Research Institute (SARI). In 2013, technical assistance was given to SARI on the subject of inbreeding in the imported Boer goats due to the small original population size at the SARI station in Jinka. Inbreeding is a lesser concern in the Dorper breed because SARI established one of the first Dorper crossbreeding sites of the ESGPIP and Dorper rams were available from the first importation; thus, the genetic base was broader for Dorper sheep than for Boer goats at SARI. However, training was given to SARI staff working with Dorper sheep to minimize inbreeding in the imported Dorper flock. In 2014, technical assistance was given to SARI staff working with Boer goats on the subject of artificial insemination. During the ESGPIP, frozen semen was imported from South Africa and that semen was available to the research community. Training concentrated upon artificial insemination using fresh semen. The SARI research station housing the Boer goats has a small cadre of Boer males that were easily

trained for semen collection. The fresh semen was extended and utilized to hone inseminator skills.

In August of 2016, Drs. Roger Merkel and Terry Gipson participated in a Workshop on Promoting Higher Education Linkages Between American and Ethiopian Universities on Agriculture and Food Security co-organized by the Ministry of Foreign Affairs and Ministry of Education of Ethiopia and the U.S. Embassy of Ethiopia. Dr. Merkel was a panel member for a session on Challenges to Linkages between U.S. and African Universities. Many U.S. and Ethiopian institutes of higher education attended the workshop.

Prior to and after the 'Linkage' workshop mentioned immediately above, Drs. Merkel and Gipson traveled to several Ethiopian livestock research centers to meet with officials and discuss continuing or potential collaboration. The Institute scientists first visited the Oromia Agricultural Research Institute, Addis Ababa to discuss their breeding program concentrating on Horro sheep. They then traveled north to the Debre Berhan Agricultural Research Center and its Sheep Breeding and Multiplication Center to discuss a breeding program on Menz sheep and see their herds of Awassi and Dorper sheep. The Dorper sheep are being distributed to villagers through a community based breeding program. While in Debre Berhan, Drs. Merkel and Gipson visited Debre Berhan Agricultural Research Center and Debre Berhan University and its Ataye Research Station to see their Boer goats and discuss potential collaboration. The duo then went south to visit the SARI and renew ties with researchers there and learn about their village community based breeding program. Finally, the pair visited Haramaya University in eastern Ethiopia to meet with Dr. Mengistu Urge, M.S., Hirut Yirga, and other scientists.

In addition to the aforementioned activities, Dr. Tilahun Sahlu, Institute Director, has met with scientists at universities, regional agricultural research institutes, and attended conferences to strengthen and further the Institute's Ethiopian ties. Examples of his activities are attending the International Conference on Enset organized by Addis Ababa University, meeting scientists at the Ethiopian Biotechnology Institute, and conversing with various university administrators to discuss mutual research and training cooperation.

VISITORS AND SHORT-TERM TRAINING

During the past five years, the Institute has welcomed many people for visits or short-term training. On particular note was a visit by world-renown small ruminant scientist Prof. Che Devendra. Prof. Devendra spent a day at the Institute speaking with scientists and touring the facilities.

The Institute has also hosted several visitors for training sessions lasting up to one week. Two Philippine persons interested in establishing a commercial meat goat farm spent several days at the Institute learning our production and management practices.

The Institute was also pleased to welcome Mr. Yoshimura Fumitaka, University Farm Manager from Nagoya University, Japan for several days of training.

Other visitors included representatives of the Farmer to Farmer Program in Myanmar as well as numerous other university and other personnel.

THE END RESULT

The E (Kika) de la Garza American Institute for Goat Research is proud of its international activities and the impact they have on strengthening human and institutional capacity of foreign institutions, providing important and relevant research results on local issues of importance, and in the assistance provided to small farmers, and particularly women, in enhancing family nutrition and income generation. These are unique activities that support the mission and goals of the Institute.

A homemade soda bottle salt lick in the Philippines.

INTERNATIONAL GRANTS

2012-2014

Handbook for Livestock Research on Smallholder Farms in Developing Countries

- Langston University; Hawassa University, Hawassa, Ethiopia; West Bengal University and Animal and Fishery Sciences, Kolkata, India; Northeast Institute of Geography and Agroecology, Changchun, China; Jordan University of Science and Technology, Irbid, Jordan; Universidad Autónoma Chapingo, Texcoco, Mexico; Ben-Gurion University of the Negev, Beer Sheva, Israel; Fort Valley State University, Fort Valley, Georgia; Kyoto University, Kyoto, Japan
- USDA Foreign Agricultural Service Scientific Cooperation Research Program
- $40,000

2012-2014

Enhancing Capacity for Research, Extension, and Teaching Activities with Small Ruminants of Bunda College of Agriculture in Malawi and Egerton University in Kenya

- Langston University; Bunda College of Agriculture, Lilongwe, Malawi; Egerton University, Nakuru, Kenya
- USAID, administered by USDA Foreign Agricultural Service
- $358,847

2014-2016

Applied Reproductive Technologies for Caprine Embryo and Gamete Management

- Langston University; Institution Central Veterinary Laboratories at the Ministry of Agriculture, Nairobi, Kenya
- Borlaug Fellow, USDA Foreign Agricultural Service
- $31,467

2014-2016

Genomic Selection in Dairy Goats

- Langston University; Maseno University, Kisumu, Kenya
- Borlaug Fellow, USDA Foreign Agricultural Service
- $34,297

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PEER-REVIEWED JOURNAL ARTICLES

2017

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Goetsch, A. L. 2016. Invited Review: Current areas of research of feeding practices for lactating dairy goats. Professional Animal Scientist 32:725–735.

Mengistu, U. L., R. Puchala, T. Sahlu, T. A. Gipson, L. J. Dawson, and A. L. Goetsch. 2016. Conditions to evaluate differences among individual sheep and goats in resilience to restricted drinking water availability. Small Ruminant Research 144:320–333.

Tsukahara, T., R. Puchala, J. Hayes, T. A. Gipson, T. Sahlu, and A. L. Goetsch. 2016. Behavior effects of mixing different breeds to evaluate electric fence stand additions to barbed wire fence to contain mature and growing meat goats. Professional Animal Scientist 32:854–860.

Tsukahara, T., R. Puchala, J. Hayes, T. A. Gipson, T. Sahlu, and A. L. Goetsch. 2016. Effects of breed, method of adaptation, and interval treatment on behavior of Boer and Spanish goats in pens with barbed wire fence designed for cattle containment and electric fence strands added for goats. Small Ruminant Research 137:130–137.

Tsukahara, Y., R. Puchala, T. Sahlu, and A. L. Goetsch. 2016. Effects of level of brackish water on feed intake, digestion, heat energy, and blood constituents with growing Boer and Spanish goat wethers. Journal of Animal Science 94:3864–3874.

2015

Askar, A. R., T. A. Gipson, R. Puchala, K. Tesfai, G. D. Detweiler, A. Asmare, A. Keli, T. Sahlu, and A. L. Goetsch. 2015. Effects of supplementation and body condition on intake, digestion, performance, and behavior of yearling Boer and Spanish goat wethers grazing grass/forb pastures. Small Ruminant Research 125:43–55.

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Goetsch, A. L., G. D. Detweiler, Z. Wang, J. Hayes, and T. A. Gipson. 2014. Supplements of lactating meat goat does grazing grass/forb pastures. Journal of Applied Animal Research 42:16–26.

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Asmare, A., R. Puchala, K. Tesfai, G. Detweiler, L. Dawson, A. Askar, Z. Wang, and A. Goetsch. 2012. Effects of small ruminant type and level of intake on metabolism. Small Ruminant Research 102:186–190.

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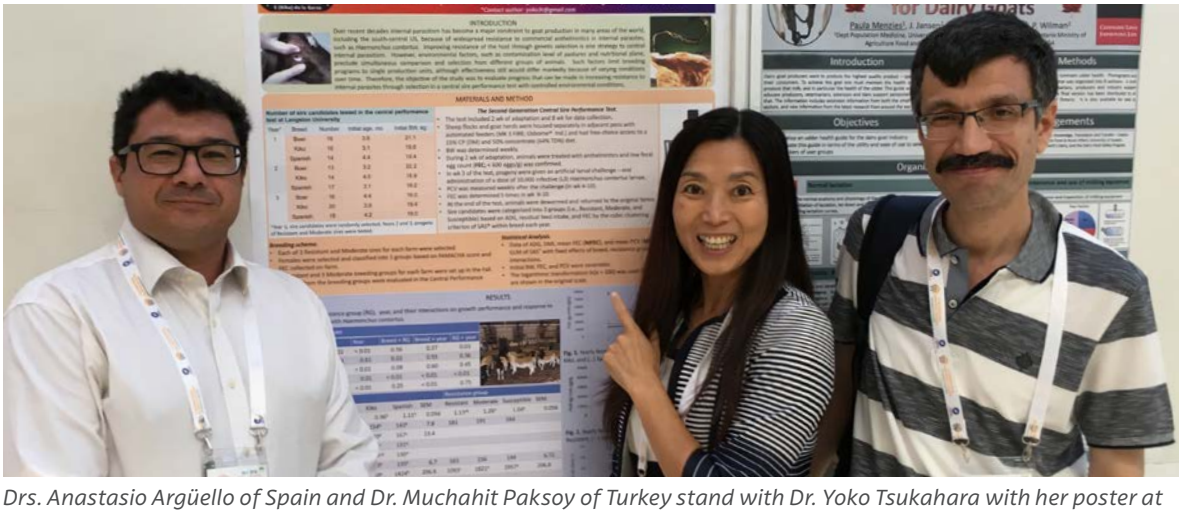

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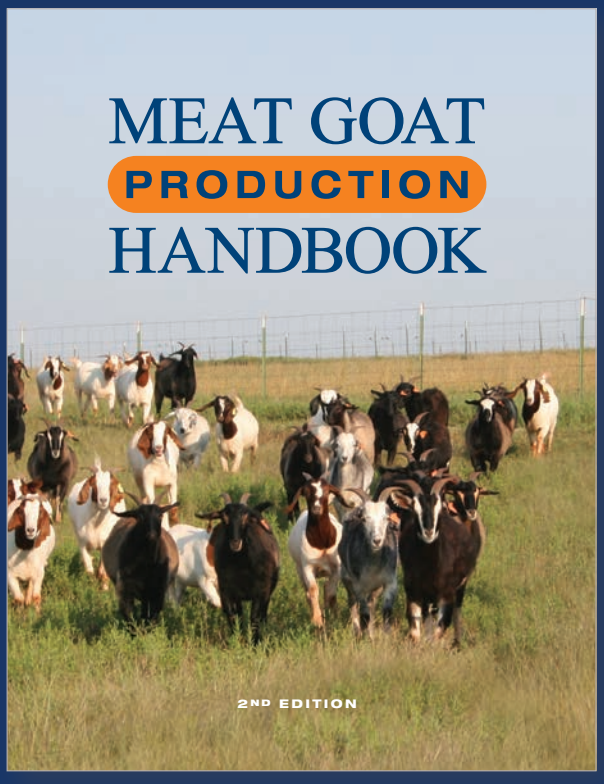

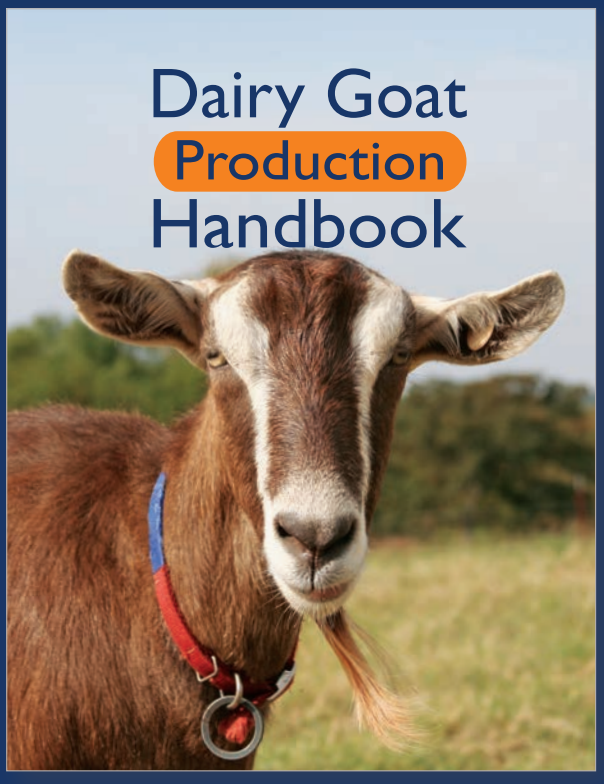

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