Sustainable Small Ruminant Production in the Southeastern U.S.

Proceedings of the

2023 SCC-81 Coordinating Committee Meeting

Raleigh, NC

January 22, 2023

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SCC081: Sustainable Small Ruminant Production in the Southeastern U.S.

Project Administration

Duration: 10/01/2022 to 09/30/2027

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Statement of Issues and Justification

Small ruminants remain a vital component of many small farms in the Southeastern U.S., providing milk, meat, and fiber, as well as a means to control brush. In addition to conventional and ethnic markets, there is a growing demand for grass-finished, organic, and local meat products (USDA, NASS, 2012, 2015). Small ruminants are challenged by gastrointestinal nematodes (GIN) due to loss of effective dewormers and warmer temperature much of the year. Minimizing the use of anthelmintics and focusing on other means of control (Whitley et al., 2014) such as fungus feeding addresses both conventional and organic production. The most promising means of GIN control is genetic resistance, or an animal's ability to resist infection with GIN. The National Sheep Improvement Program (NSIP) includes estimated breeding values (EBVs) for parasite resistance as worm egg count (Aaron, 2014) in sheep and goats. Research is needed on combining genomics with EBVs, consideration of additional EBVs of economic importance as well as wider use of EBVs by goats that are plagued by GIN to a greater degree than sheep. It is important to understand how the immune system functions in susceptible and resistant animals to fine tune selection for resistance. And, while the group has made great strides on forage management and condensed tannin-rich forages such as sericea lespedeza (Coffey et al., 2007) for GIN control, further research is needed to examine the importance of native plants with secondary plant compounds and meeting both production goals and GIN control with existing GIN-important forages and grazing systems. Similarly, little is known on integrating small ruminants and silvopasture. Trees provide shade to increase animal welfare particularly during summer months, opportunities for better forages to graze, and another revenue source.

In general, ruminant livestock production systems are most efficient if there is maximal reliance on fresh plant material consumed by the animals, with minimal use of harvested forage or other supplemental feedstuffs. However, this can be difficult to achieve because of considerations such as seasonal growth patterns of forage and browse plant species, varying environmental conditions, and changes in nutrient and energy requirements of animals in accordance with stage of production. And, this is becoming even more complex because of climate change, with more variable and extreme conditions expected in addition to shifting averages. There are numerous means by which these challenges are addressed, but which have not been adequately studied for goats, sheep, as well as co-grazing species. Examples include use of monocultures of annual or perennial cool and warm season grasses and legumes in different areas, mixtures of grasses, forbs, leguminous forages and trees, and browse plants, silvopasture, strategic supplementation, use of inexpensive byproduct or alternative supplemental feedstuffs, modified birthing time, careful selection of species, breed within species, and individual animals within breed for specific production conditions, etc. Moreover, for goats and sheep, how such decisions affect the degree of infection with GIN and resultant impact on animal health and productivity are of paramount importance. Lastly, in order to most appropriately study these and other factors and manage animal and farm conditions, smart, real-time technologies should be developed, namely to characterize and monitor animal physiological conditions and behaviors indicative of well-being, nutritional status, and level of productivity.

Profitability of small ruminant production is closely tied to optimum reproductive function. Production efficiency is closely tied to the number of offspring available for marketing, and hence a direct function of number of lambs/kids born and surviving. Reproductive performance is affected by a variety of processes, this project explores the constraints and opportunities (1) resulting from seasonal reproduction in sheep/goats, and by (2) increasing the use of assisted reproduction on small farms. Sheep and goats are short-day breeders and traditional production systems use fall breeding/spring lambing. Such systems create seasonal peaks in lamb and goat supplies and does not meet the market demands for goat/sheep meat throughout the year. Research will explore the increased use of aseasonal germplasm and management tools, such as the male effect, to breed out-of-season and achieve a more continuous kid/lamb supply. Availability of extended or year-round breeding can be used to develop accelerated mating systems to increase efficiency of kid/lamb production. Use of assisted reproduction in small ruminants lags behind its use in other livestock species, and is compounded by the lack of approved products to control the reproductive cycle. Research here address cost effective assisted reproduction, ranging from estrus synchronization protocols, timing of artificial insemination, processing and storage of semen, and insemination techniques.

Because of dwindling resources for extension programs, it is imperative that we find a means to disseminate our research and transfer technologies developed from it. This will be achieved through online programs, websites, and train-the-trainer programs. These research and outreach priorities on GIN control, forage feeding programs, and improvements in reproduction require coordinated efforts of multiple research institutions, each contributing their specific expertise towards the design of integrated systems.

The U.S. relies heavily on imports of lamb and goat meat to satisfy domestic demand. However, this reality does not ensure greater market opportunity and thus profitability for small ruminant producers. Factors affecting the markets are scarcely understood. Small ruminant producers possess potential for greater profit if they can enter more lucrative markets than the local sale barn. Some small ruminant producers are using various strategies to increase the sale price of their animals or produce value-added items. Identifying these strategies and devising new methods of increasing product value will help increase farm profit and sustainability.

The number of institutions conducting sheep and goat research, as well as large ruminant research, has been declining, along with animal numbers and researchers/extension specialists. Hence, it has become more important to coordinate research/extension between institutions and cooperate on projects across stations to maximize available resources. Currently only one other multi-state regional project addresses small ruminants (NC-214: Increased efficiency of sheep production). There is limited duplication between the two projects, with NC-214 more national in scope, restricted to sheep research only, and with objectives that also address wool and dairy. This project here has a more regional focus on the southeastern U.S., covers both sheep and goats, a strong extension/outreach component, and extensive representation by 1890 institutions.

Objectives

1. Utilization of gastrointestinal nematode (GIN) control methods including feeding *Duddingtonia flagrans*, forage/grazing management, and animal selection for GIN resistance.
2. Emphasis of forage feeding systems for year-round grazing to meet nutritional requirements that mitigate drought and other plant and animal stressors.
3. Strategies for the improvement of small ruminant reproduction.
4. Disseminate research results and information to stakeholders.
5. Identify producers' challenges and opportunities in marketing goats and goat products

Procedures and Activities

Objective 1: Methods of GIN control will include genetic and genomic selection, forage/grazing management, and selective deworming or the strategic use of anthelmintics and alternatives. Other control methods may include condensed tannin-containing forages, grazing systems, and nematode-trapping fungi (*D. flagrans*). Participating agencies include Fort Valley State University (**GA**), USDA ARS Booneville, West Virginia University (**WV**), University of Maryland Eastern Shore (**MD**), Tuskegee University (**AL**), Delaware State University (**DE**), Virginia State University (**VA**), Louisiana State University (**LA**), North Carolina State University (**NC**), Langston University (**OK**), Florida A&M University (**FL**), Prairie View A&M University (**TX**), and Tennessee State University (**TN**). Collaborating institutions to examine GIN resistant genetics and genotypes and relationships among the EBVs generated by NSIP are AR, WV, NC, DE, GA. The development of genomic enhanced EBVs and resistant genetic phenotypes will be explored by AR, WV, and collaborators. Trials at WV will measure specific immune responses of resistant breeds during a primary and challenge infection with *Haemonchus contortus* to elucidate mechanisms of immunity. Institutions to examine the best use of *D. flagrans* (BioWorma), which recently became available in the U.S., and integration of nonchemical control of GIN in conventional and organic production systems include GA, AR, LA, OK, FL, TX, TN, AL, and VA . One aspect of Bioworma use to be addressed is the necessity of daily feeding, such as if dietary inclusion every other day might suffice. Dose used will be based on manufacturer recommendations. Important measures in these Bioworma studies include Famacha score, fecal egg count, larval recovery from cultured feces, body weight change, examining feeding periods during lambing to dams, and to offspring at weaning (approximately 60 to 120 days of age occurring in winter, spring, or summer). Studies involving condensed tannin containing forages including birdsfoot trefoil, sericea lespedeza, and native legumes will occur at all participating agencies to evaluate potential both as a forage (grazing schemes and fed fresh) and processed (hay, haylage, silage, pellets). That is, forages containing condensed tannins can be used in a variety of ways, such as grazing, feeding of hay, and use of commercially available sericea lespedeza pellets. The results of these trials will lead to an integrated strategy for controlling worms on commercial and breeding operations that manage conventionally or organically.

Objective 2: Cool-season and warm-season annual and perennial forages, including native grasses and legumes, will be established in conventional and organic pasture, evaluated and compared to determine forage availability and quality, stocking rate, and animal performance during different stages of production by AR and GA for sheep or goat production systems. At AL, silvopasture

systems (mixed pines and hardwoods) with and without annual forages will be examined for goat production, and GA will consider benefits of silvopasture for sheep and cattle. GA will examine use of natives in a pasture system for pollinator benefits as well as improving diversity of the pasture system, providing additional quality summer grazing and possible control of GIN at the pasture life cycle stage. Native and other varieties of sericea lespedeza will be examined in a pasture system as a summer grazing/hay crop for small ruminants of mixed sexes and ages depending on time of year implemented by GA and AR. Supplementation with low cost feeds (soy hull and corn gluten feed) will occur at DE and VA.
Supplements of concentrate and leguminous trees browsed or consumed in a cut-and-carry manner will be compared with growing meat goats grazing grass/forb pastures in the summer at OK, with characterization of grazing behaviors in addition to feed intake, digestion, and performance. Also, in OK, low-cost accelerometers constructed from off-the-shelf components will be evaluated in relation to commercial units to characterize behaviors of goats and hair sheep such as grazing, ruminating, and idle, standing versus lying, distance traveled, and spatial-temporal movement. Tall fescue toxicosis continues to cause production, health, and welfare issues for small ruminants as it is an important southern cool season forage, but the endophyte-infected tall fescue variety persists more so than endophyte-free varieties. AR will examine markers (prolactin) for tolerance of fescue toxicosis in Katahdin ewes and potential genetic selection. Pregnancy and conception rate (ewes), body weight and condition (ewes and lambs), and incidence of foot and other health issues will be examined.

Objective 3: Work on assisted reproduction techniques in small ruminants will be carried out at a number of stations. Liquid semen AI with either fresh , cool-stored, or cryopreserved semen in goats will be conducted at TX, and DE. The research will evaluate insemination dose and volume, extender composition (animal vs nonanimal protein source), synchronization of estrus/ovulation, timing of AI, and AI technique (laparoscopic, transcervical and intracervical). In sheep, semen collection, processing, storage, and AI protocols will be evaluated in VA. Techniques evaluated will be simple intracervical and transcervical AI with the use of a speculum to locate the cervix, the addition of antioxidants to a simple skim milk, egg yolk and defined nonanimal protein extenders, the use of fixed timed AI following CIDR synchronization or the addition of estrus detection in the protocol, and reductions in semen dose currently in use for (300 million sperm/ml) in liquid AI protocols. Stations will be cooperating in a number of these project VA, TX and DE.
In AR out-of-season breeding using multiple sires (Oct/Nov vs. Jan/Feb lambing), as well as impact of tall fescue toxicosis on reproduction in sheep will occur. This will include characterization of tolerant vs. susceptible ewes, determined by concentration of prolactin, relative prolificacy and maintenance of body condition, and management strategies to optimize reproduction in tall fescue grazed ewes. In VA work will continue on a transition from accelerated mating to semi-continuous lamb production system. This project will also continue to evaluate the forage-base needed to develop this to be a totally pasture-based system.

Objective 4: Producer workshops, which teach the use of integrated parasite control methods, will be taught throughout the region, with at least 5 conducted each year. Parasite control will continue to be an important educational focus. Efforts are strongly supported by the work in the other objectives. Local, county, and regional meetings will be held in each of the states. Efforts will continue to update extension field faculty on small ruminant production and management. Information for agricultural professionals including Extension staff and producers among others will be posted to various websites in each of the states, as well as the website of the including those managed by KY, GA, and MD2 (Maryland Small Ruminant Page at www.sheepandgoat.com; American Consortium for Small Ruminant Parasite Control at www.wormx.info). Efforts will be made to continue to support the eXtension Goat Industry as an online information source to producers.

Objective 5: Survey questionnaires will be developed with open and close-ended questions to survey goat and sheep producers as part of a regional project entitled 'Developing a sustainable small ruminant meat production and marketing systems for the Southeastern United States through an 1890 universities consortium.'. The questionnaire will include questions relevant to farm size and facilities, producers' demographic information (name, gender, education, etc.), local, regional, and national market outlets that producers are using, costs and inputs involved in production, challenges they are facing in marketing their product, their suggestions to overcome such challenges, advertising avenues, and more. Producers participating in all educational and outreach events to be conducted by the collaborating SCC-81 institutions will be informed about the survey and encouraged to participate in the survey. Survey booths will be installed at the relevant conferences, such as the National Goat Conference, Professional Agricultural Workers Conference, Small Farm Conference, annual conference of Southern Sustainable Agriculture Working Group, and Annual Farmers Conferences to be hosted by the collaborating SCC-81 institutions, and the conference participants will be informed and encouraged to take the survey. Extension educators and other agricultural professionals attending these conferences will be encouraged to disseminate the survey to their clientele. In addition, surveys will either be mailed to willing producers, conducted in face-to-face interviews, or as feasible based on participant producers. Moreover, social media, email, and other similar outlets will be used to reach out to a wider producer community for the survey. Based on the survey results, challenges faced by producers and the opportunities that they have realized within their locality will be documented. Strategies will be developed to guide producers to tap into available opportunities effectively. Some strategies will be matching their production/breeding cycle with the high-demand time, such as different celebrations and festivities. Additional strategies will include keeping records of animal performance, expenses, and incomes, and use these pieces of information to calculate the sale price. Another strategy will be to create a local producers' coalition and work together for marketing their animals and products for the best possible price. Adding value to the product and selling value-added products may be a feasible strategy for some producers. Resulting from the tabulation of the survey results, a strategic document will be prepared and published. The document will serve as a valuable educational material for training and educating producers and professionals, who work with goat producers.

Expected Outcomes and Impacts

- Improved selection for sheep and goats resistant to GIN to reduce the need for deworming.
- Increased participation in NSIP.
- Increased use of artificial insemination and other reproductive management techniques.
- Increased use of alternative (parasite?) control methods involving forages and forage management by producers.
- Improved forage-based systems for conventional and organic small ruminant production.
- Enhanced knowledge of small ruminant grazing practices that support diverse forage systems.
- Improved summer gains for growing lambs and kids on forage-based systems.
- Increased use of leguminous trees to provide supplemental nutrients of meat goats for increased economic returns.
- Enhanced knowledge of the development and use of inexpensive equipment to characterize grazing behavior of small ruminants
- Exchange of ideas and information.
- Coordination of specific research and extension programs to accelerate goals.

- Identification of critical research objectives.
- Improved outreach to scientific community and producers.
- Increased market awareness and marketing opportunities for producers.

Educational Plan

Technical committee members of this project have been involved in organizing producer workshops and field days at their respective institutions. These events will be the basis of the educational and outreach activities of this project. The project will facilitate the coordination of these activities and provide a range of subject matter expertise in the selection of the presenters at workshops and field days. Members will prepare articles for publication in industry magazines. There are several participants from 1890 Land Grant institutions that have a special mandate to serve under-represented groups and small-scale, limited resource farmers. These groups have shown a particular interest in small ruminant production that will benefit from activities from this project.

Land Grant Participating States/Institutions:

FL, GA, MD, NC, TX, VA

Non-Land Grant Participating States/Institutions:

ARS

Objective I: Utilization of gastrointestinal nematode (GIN) control methods including feeding *Duddingtonia flagrans*, forage/grazing management, and animal selection for GIN resistance.

Fort Valley State University

Impact of sericea lespedeza (*Lespedeza cuneata*) complete feed pellet on internal parasites in goats.

T. H. Terrill, N.C. Whitley, A. Pech-Cervantes B. Carter, N. Mendez, Y. Smith, L. Wartley, G. Dykes

Objective: Sericea lespedeza (SL; Lespedeza cuneata) is considered a low input forage but cannot be grown in all areas. A leaf meal pellet is available, but supply is limited due to the high level of leaf meal in the pellet and farmers using the pellet often mix it with other feed components. If a complete feed pellet could be developed with less SL plant material used but with similar bioactivity against parasites, the pellet may be more readily available, less expensive and could reduce the need for farmer feed mixing. Therefore, the effect of a complete feed pellet with SL on gastrointestinal parasites was investigated.

Procedure: Eighteen naturally parasite-infected intact male Spanish goats (6-7 months old and 25.3 ± 0.3 kg BW) were used in a 5-week trial to investigate effects of sericea lespedeza (SL; Lespedeza cuneata) used in a complete feed pellet on indicators of gastrointestinal parasitism.
Goats were individually housed in 1.5 x 1.5 m pens with ad libitum access to clean water. Treatments were the complete feed pellet (COMP, n=9; 50% sericea lespedeza leaf meal by weight) or a commercially available meat goat pellet (14% CP goat feed, Mid-GA Farm Services, Montezuma, GA; CON; n=9), with a corn-soybean meal-soyhulls-based supplement to ensure isonitrogenous and isocaloric diets. Diets were fed to 10% orts (both measured daily). Treatments were assigned for similar initial fecal egg count (FEC) and BW, with BW measured at the start and end of the study. At the start of the study (Day 0) and weekly thereafter, FEC and coccidia oocyst count (FOC were conducted via a modified McMaster's technique with a sensitivity of 50 eggs per gram (epg) or oocysts per gram (opg), and percentage packed red blood cell volume (PCV) was measured via microhematocrit centrifugation. Data was analyzed with SAS software using a mixed model for repeated measures.

Results:
Larval cultures indicated 88% *Haemonchus contortus* and 12% *Trichostrongylus* spp. There was a treatment effect on both FEC ($P < 0.02$) and FOC ($P < 0.03$) of the goats, with reduced counts in the COMP groups compared with CON animals (Figure 1 and 2). Fecal egg counts averaged 2148 ± 294 and 1023 ± 331 epg for CON and COMP groups, respectively, with FOC values of 1316 ± 223 and 339c 249 opg, respectively. Percentage packed cell volume (PCV) was also impacted by treatment ($P < 0.02$), with higher PCV values for COMP goats than CON animals (24.2 ± 0.6 and 22.5 ± 0.5, respectively; Figure 3). There was no differences in the goats' BW (35.5 ± 0.9 kg week

0, 39.4 ± 0.9 kg on Week 5) but there was a treatment effect ($P < 0.04$) on ADG, with greater ADG values in the animals on the COWP pellet ration (Figure 4).

Impact: Results of this and a previous study indicate equivocal effects of the complete pellet containing 50% sericea lespedeza leaf meal by weight; higher levels of sericea might prove to be beneficial.

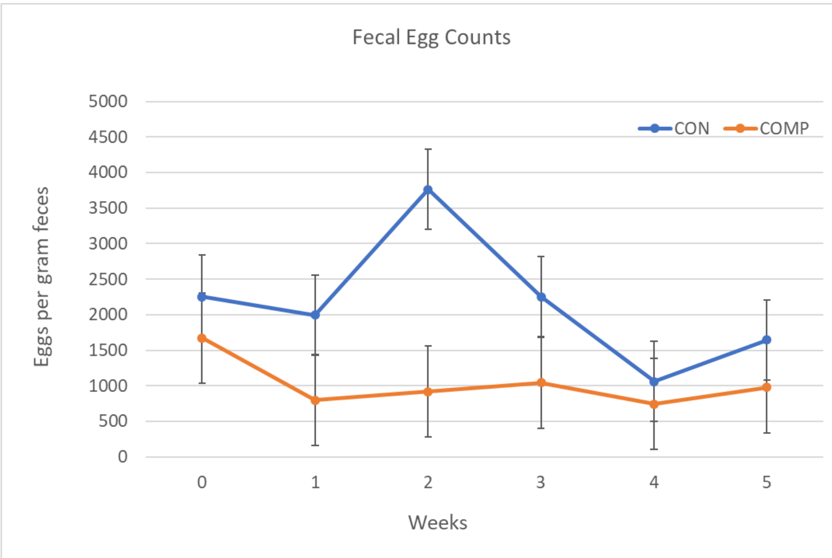

Figure 1. Gastrointestinal nematode eggs per gram of feces of naturally gastrointestinal parasite-infected goats fed control (CON) and sericea lespedeza leaf meal complete pellets (COMP) treatments for 5 weeks. Effect of treatment (log transformed data used for analysis), $P < 0.02$.

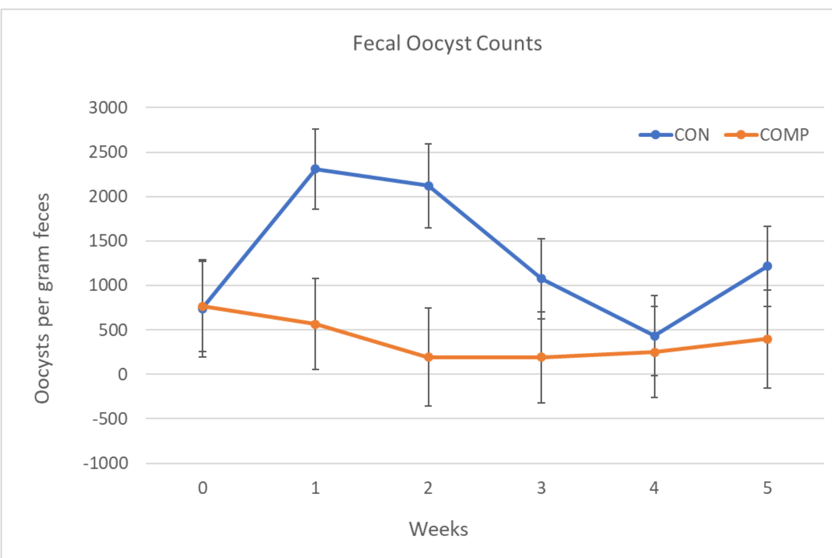

Figure 2. Coccidia oocysts per gram of feces of naturally gastrointestinal parasite-infected goats on control (CON) and sericea lespedeza leaf meal complete pellets (COMP) fed for 5 weeks. Effect of treatment when log transformed data used for analysis, $P < 0.03$.

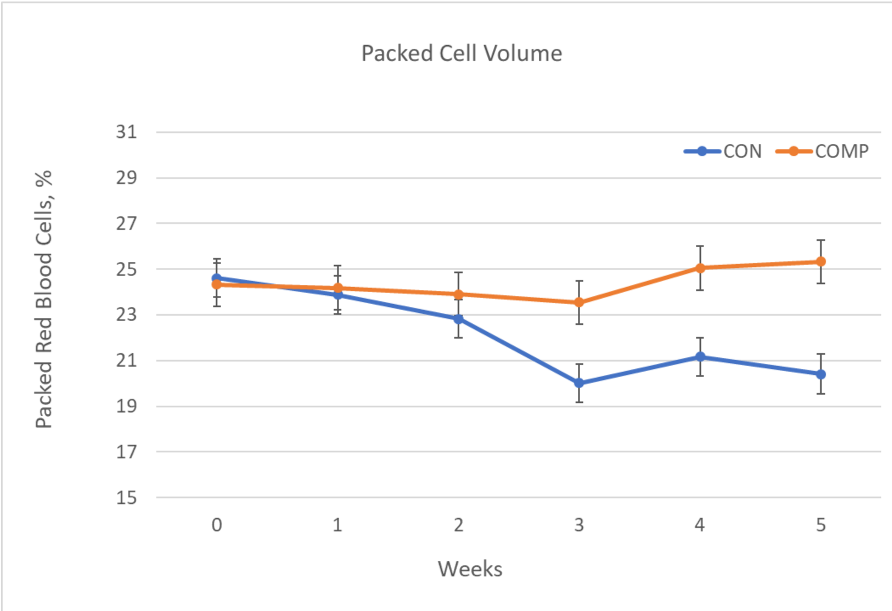

Figure 3. Blood packed cell volume of naturally gastrointestinal parasite-infected goats on control (CON) and sericea lespedeza leaf meal complete pellet (COMP) treatments, at each week of a 5-week feeding trial. Effect of treatment when log transformed data used for analysis, $P < 0.02$.

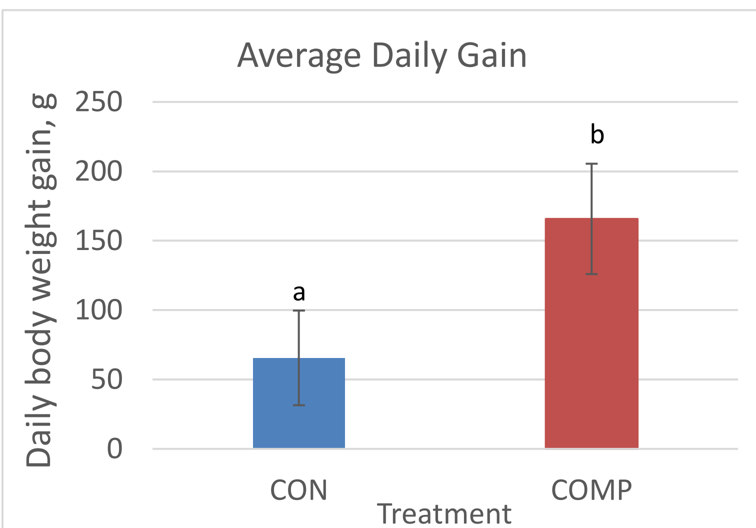

Figure 4. Average daily gain of naturally gastrointestinal parasite-infected goats on control (CON) and sericea lespedeza complete pellet (COMP) treatments in a 5-week feeding trial. Bars with different letters differ ($P < 0.04$).

Investigating potential bioactivity of black seed (*Nigella sativa*) and sericea lespedeza (*Lespedeza cuneata*) combination pellets against gastrointestinal parasites in goats.

A. Neha, A. Shaik, S. Chandan Chelkapally, N. Mendez, Y. Smith, N. C. Whitley, G. Dykes, A. Pech Cervantes, V. Owen, T. H. Terrill

<u>Objective</u>: Black seed (*Nigella sativa*) and sericea lespedeza (SL; *Lespedeza cuneata*) are plants that have been shown to have nutraceutical properties. Previous studies in small ruminants, have shown that SL forage negatively impacts gastrointestinal parasites, especially against infection with gastrointestinal nematodes (*Haemonchus contortus*) and protozoan parasites (*Eimeria* spp.). It has been shown to decrease fecal egg counts and improve packed cell volume in parasitized chickens. It has reported to have positive effects on productive and reproductive performance including milk yield and composition, digestibility, blood chemistry parameters, mortality rate, egg composition and carcass traits. However, there have been no clear studies on use of black seed meal on parasites in goats. Therefore, the objective of this study was to determine effects of pelleted black seed meal in combination with sericea lespedeza or sericea lespedeza only compared to an alfalfa pellet (fed to parasitized or anthelmintic-treated goats) as a control.

<u>Procedure:</u> Sixty-one naturally parasite-infected intact male Spanish goats 5-6 months old and 28.9 ± 0.2 kg BW were used in a 4-week trial. Goats were individually housed in 1.5 x 1.5 m pens. Treatments were a feed pellet with both black seed meal and SL leaf meal (BSSL, n=15), SL only pellet (SL; n=15) or a commercially available alfalfa pellet in parasitized (CONP; n=16) or anthelmintic treated (CONT; n=15) goats. A corn-soybean meal-soyhulls-based supplement was used to ensure isonitrogenous (17% crude protein) and isocaloric diets. Diets were fed to 10% orts (both measured daily). Treatments were assigned for similar initial gastrointestinal nematode fecal egg count (FEC). At the start of the study (Week 0) and weekly thereafter, FEC and coccidia oocyst count (FOC) were conducted via a modified McMaster's technique with a sensitivity of 50 eggs per gram (epg) or oocysts per gram (opg), and percentage packed red blood cell volume (PCV) was measured via microhematocrit centrifugation, and goats were weighed. Data was analyzed using a mixed model for repeated measures using SAS (analysis on transformed data, LSMEANS on untransformed data reported).

<u>Results:</u> Fecal egg counts were influenced by a treatment by week interaction, $P < 0.0001$ (Figure 1) with BSSL and SL different from parasitized controls (CONP) after Week 2 except for Week 4 for BSSL and Week 6 for SL. The FEC for treated controls (CONT) were lower than CONP on Week 1 and lower than all treatments thereafter. Goat FOC were also influenced by a treatment by week interaction, $P < 0.0001$ (Figure 2) with SL different from CONP starting at Week 1 and continuing through Week and BSSL only lower than CONP at Weeks 6 and 7. As would be expected, there was no effect of anthelmintic treatment on FOC (different from all treatments on Week 4 only). Goat PCV was lower for CONT than all others ($P < 0.04$; Figure 3). Goat body weight was higher for SL and CONT (similar to each other) than BSSL and CONP (similar to each other), treatment by week, $P < 0.002$ (Figure 4).

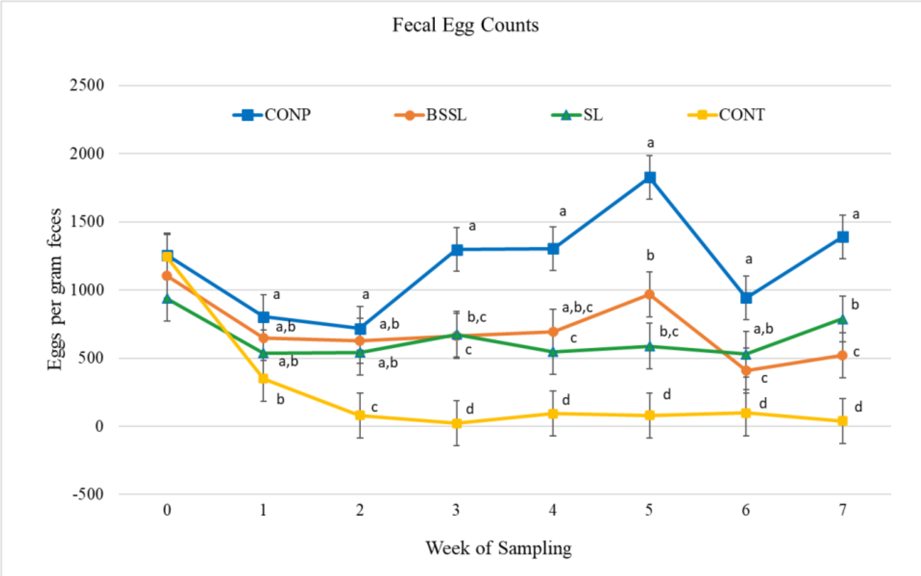

Figure 1. Fecal egg counts in naturally parasitized goat kids were influenced by a treatment by week interaction, P < 0.0001 for goats fed a black seed meal, sericea lespedeza combination pellet, (BSSL), sericea lespedeza pellet (SL) or alfalfa pellets (anthelmintic treated, CONT or not CONP) for 7 weeks. Points with different letters differ within time period, P < 0.05 except Week 3, CONP vs BSSL, P=0.0560 and CONP vs SL P=0.0903.

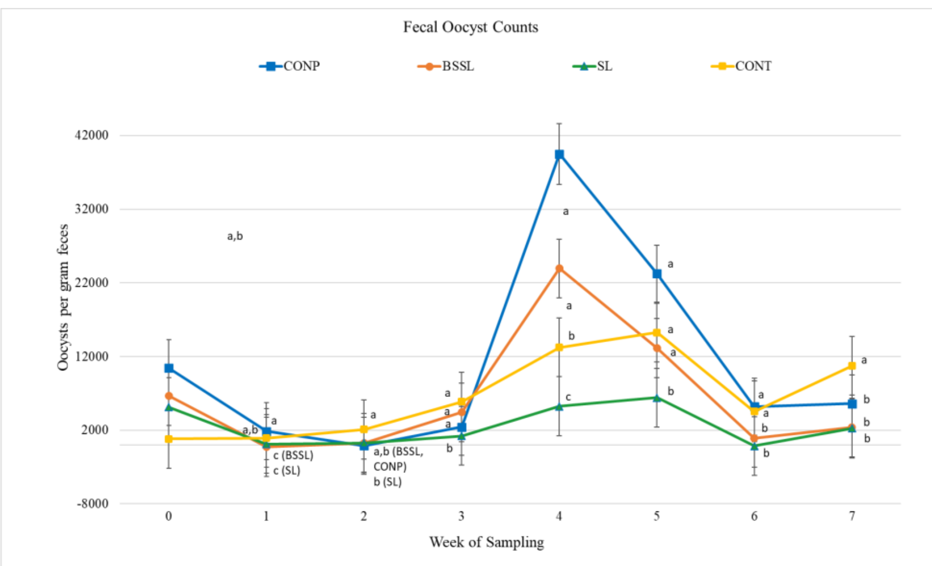

Figure 2. Fecal coccidia oocyst counts in naturally parasitized goat kids were influenced by a treatment by week interaction, P < 0.0001 for goats fed a black seed meal, sericea lespedeza combination pellet, (BSSL), sericea lespedeza pellet (SL) or alfalfa pellets (anthelmintic treated, CONT or not CONP) for 7 weeks. Points with different letters differ within time period P < 0.05 except Week 1 CONP vs SL, P=0.5023 and CONT vs SL, P=0.0608, Week 2 CONT vs SL, P=0.0565 and Week 7 CONP vs CONT, P=0.0692.

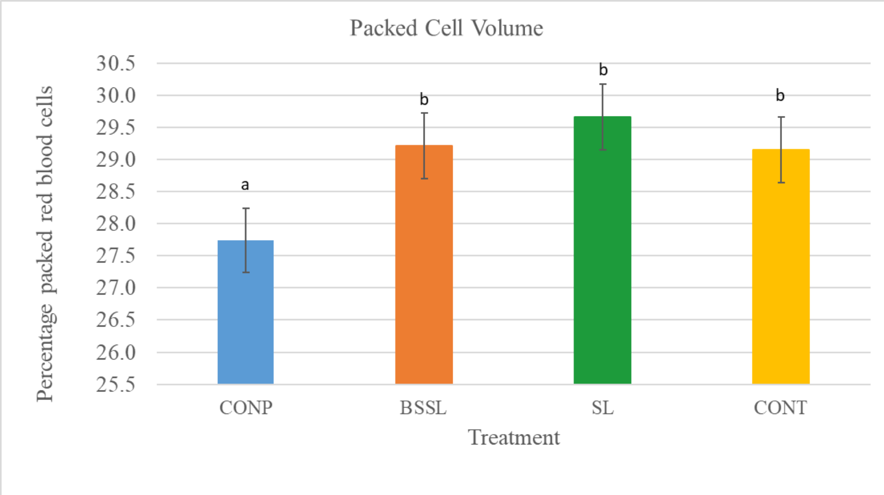

Figure 3. Packed red blood cell volume in goats kids fed a black seed meal, sericea lespedeza combination pellet, (BSSL), sericea lespedeza pellet (SL) or alfalfa pellets (anthelmintic treated, CONT or not CONP) for 7 weeks. Bars with different letters differ, P < 0.04.

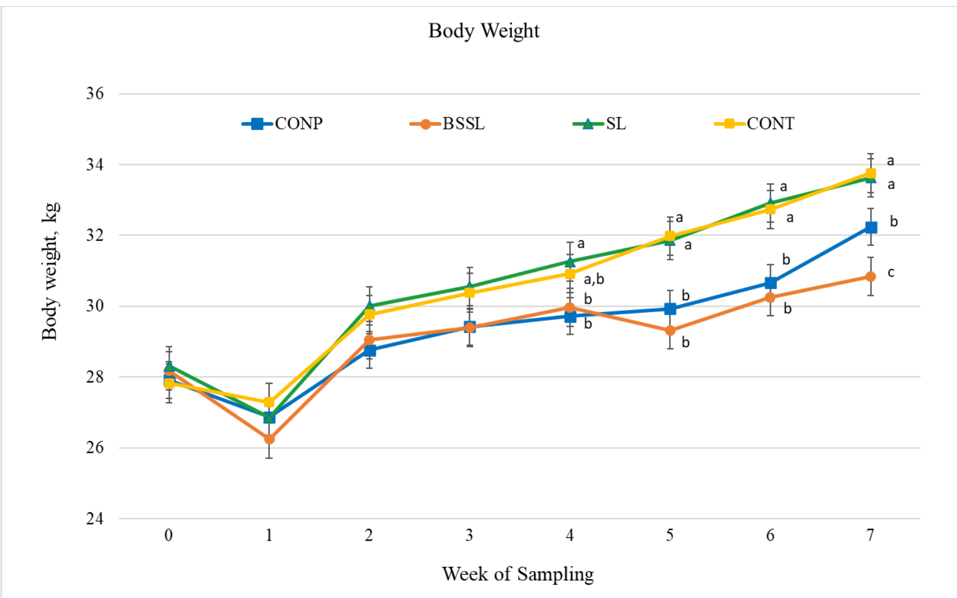

Figure 4. Body weight (kg) for naturally parasitized goat kids fed a black seed meal, sericea lespedeza combination pellet, (BSSL), sericea lespedeza pellet (SL) or alfalfa pellets (anthelmintic treated, CONT or not CONP) for 7 weeks. Treatment x week, P < 0.002; points with different letters differ within time period P < 0.05 except Week 4, SL vs BSSL, P=0.0860 and Week 7, CONP vs SL P=0.0676.

Impact: Although there were some impacts of black seed mixed with SL on indicators of gastrointestinal indicators, the possible reduction in body weight supports the need for additional research.

Copy number variant-based genome wide association study reveals immune-related genes associated with parasite resistance in a heritage sheep breed from the United States.

Z. Estrada-Reyes, I. Ogunade, A.A. Pech-Cervantes, T.H. Terrill.

Objective: Florida Native is a heritage sheep breed in the United States and expresses superior ability to regulate gastrointestinal nematodes. The objective of the present study was to investigate the importance of copy number variants (CNVs) on resistance to natural *Haemonchus contortus* infections.

Procedures: A total of 300 Florida Native sheep were evaluated. Phenotypic records included fecal egg count (FEC, eggs/gram), FAMACHA© score, percentage cell volume (PCV, %), body condition score (BCS) and average daily gain (ADG, kg). Sheep were genotyped using the GGP Ovine 50K single nucleotide polymorphism (SNP) chip. Log ratios from 45.2 k SNP markers spanning the entire genome were utilized for CNV detection. After quality control, 261 animals with CNVs and phenotypic records were used for the association testing. Association tests were carried out using correlation-trend test and principal component analysis correction to identify CNVs associated with FEC, FAMACHA©, PCV, BCS and ADG.

Results: Significant CNVs were detected when their adjusted p-value was <.05 after FDR correction. A total of 8124 CNVs were identified, which gave 246 non-overlapping CNVs. Fourteen CNVs were significantly associated with FEC and PCV. CNVs associated with FEC overlapped 14 Quantitative Trait Locus previously associated with H. contortus resistance.

Impact: Our study demonstrated for the first time that CNVs could be potentially involved with parasite resistance in Florida Native sheep. Immune related genes such as CCL1, CCL2, CCL8, CCL11, NOS2, TNF, CSF3 and STAT3 genes could play an important role for controlling H. contortus resistance. These genes could be potentially utilized as candidate markers for selection of parasite resistance in this breed.

Langston University

Evaluate on farm use of Duddingtonia flagrans (Livamol® with BioWorma®) and COWP in controlling Haemonchus contortus in grazing meat and dairy goats

R. C. Merkel, Z. Wang, A. O. Sonibare, T. A. Gipson, D. Guy, and C. Anderson

Objective: A control method recently introduced into the US is feeding grazing animals the nematode-trapping fungi, *Duddingtonia flagrans*, in a product called Livamol® with BioWorma® (LB). *Duddingtonia flagrans* is a naturally occurring, nematode-trapping fungi that passes through the animal intact and is deposited in the feces where it entraps and consumes the larval stages of roundworms thereby reducing the number of infective larvae on pasture. It has been shown to have no effect on other non-target species such as insects, earthworms, or soil micro-fauna. In preliminary studies in Australia in goats, there was an 81-99% reduction in worm burden across several research sites within the same season due to *Duddingtonia flagrans* yielding an average of 86% reduction across all studies and seasons. This is a greater reduction than exists for several chemical anthelmintics. The goal of the trial was to evaluate LB and COWP and any potential synergistic effects that may occur on the farms of two Oklahoma goat producers, a meat goat operation and a dairy goat operation. The objective of the trial was to evaluate potential synergistic effects of *Duddingtonia flagrans* (Livamol® with BioWorma®) and COWP in controlling *Haemonchus contortus* and to compare costs of the different treatment methods.

Procedure: Guy Farm - Mr. Guy raises Spanish and Boer meat goats with crossbred goats between the two breeds. He grazes goats and provides supplementation. Mr. Guy has never used either COWP or LB. Twenty Spanish and Boer cross goats were used for the trial. Ten goats received LB with the remaining ten acted as a control group. LB goats grazed a 2.5-acre pasture that had been lightly grazed in 2022 and housed in a small pen with barn access at night. The remaining goats grazed a similar size pasture and were housed similarly but separately from the LB goats. Goats were supplemented with a small amount sweet feed to which the LB was mixed. A guardian dog was with both pens of goats. The dog was fed daily and had access to water. The experimental period was 12 weeks. To evaluate the effect on LB and(or) COWP on goats having *Haemonchus contortus* infection used as it might on farm, there was no adaptation period. LB is a granular product that must be fed daily at a rate of 1 g per kg BW. LB was measured using the cup provided in the LB pail. LB was mixed with a small amount of water to aid the product in sticking to the supplement. This method worked well in an initial trial done at AIGR in 2021. Control goats received the same amount of supplement without LB. Anderson Farm - Ms. Anderson raises LaMancha and Alpine dairy goats. This trial used 24 goats of which 14 yearling LaMancha or LaMancha Alpine crossbred goats that received LB and 10 adult dairy goats that did not receive LB. Ms. Anderson routinely uses COWP but has never used LB. All of her goats have been dosed with COWP in 2022. The 10 goats receiving LB were housed in a separate pasture having access to shelter and water. The 10 adult dairy goats were selected from Ms. Anderson's dairy herd and grazed their normal pastures. Both groups received similar supplements with the LB goats receiving LB mixed with water and added to their supplement. A guardian dog was with both pens of goats. The dog was fed daily and had access to water. The experimental period was 12 weeks. To evaluate the effect of LB or COWP on goats having *Haemonchus contortus* infection used as it might on farm, there was no adaptation period. LB is a granular product that must be fed daily at a rate of 1 g per kg BW. LB was measured using the cup provided in the LB pail. LB was mixed with a small amount of water to aid the product in sticking to the supplement. This method worked well in an initial trial done at AIGR in 2021. Control goats received the same amount of supplement without LB. Animal measures were taken at the beginning of the trial and every 28 days thereafter. Measurements included FEC, FAMACHA©, PCV, BCS, and BW. Pathophysiological parameters - In order to estimate host resilience, individual blood samples were collected every 2 weeks by jugular venipuncture into K2 EDTA tubes to measure the packed cell volume (PCV) as an indicator of anemia according to the microhematocrit method. Additionally, PCV were used as a welfare indicator value. Therefore, if any doeling's PCV value is lower than 16%, an anthelmintic treatment will be given according to AIGR protocol. A combination of anthelmintics was dosed as follows: Cydectin® 0.4 mg/kg BW (Moxidectin, Bayer Health Care, LLC), Valbazen® 10 mg/kg BW (Albendazole, Zoetis, INC), and Prohibit® at a dose of 12 mg/kg BW (Levamisol hydrochloride, Agri laboratories, LTD). Parasitological parameters Individual measurements were performed to characterize the effects of the different treatments on worm biology by evaluating parasitological data *in vivo* [i.e., fecal egg excretion and infective larvae (L_3) culture]. Individual fecal samples were collected once every two weeks directly from the rectum to determine fecal egg counts (FEC) using a modified McMaster technique. Fecal egg counts data will be expressed as eggs per gram of feces (EPG). Along with the FEC, larval cultures were prepared per treatment group to determine the treatment effects on infective larvae (L_3) number. Moreover, composition of GINs genera was assessed, with L_3 identification by applying morphological. A fecal pool per treatment replicate group was cultured in triplicate. The fecal culture procedure was carried out at room temperature (23-25 °C) for 12 days. Hatchability was calculated and Baermann technique allowed L_3 recovery. For genus identification, third stage larvae were transferred to a microscope slide, and 100 larvae per larval culture and date of sample was differentiated based on key of morphological identification. Statistical Analysis - Data will be analyzed using repeated measures method in R. The statistical model was

$$y = X\beta + Zu + e$$

where, y is the vector of dependent variables (FEC, FAMACHA, PCV, or BW); X is the incidence matrix of fixed effects, β is the vector of fixed effects e.g. covariates (initial BW, initial PCV, etc.), replicate, date, and treatments (BioWorma or Control), Z is the incidence matrix of random effects, u is the vector of animal IDs on which repeated measure are taken, and e is the vector of random errors.

Results: Due to the disparate management styles of the two on-farm collaborators, farms were analyzed separately. Results are displayed graphically below. In the graphs, the black point is the least-squares mean estimate for each treatment (BioWorma and Control) and the red bar is the 95% confidence interval for each point estimate. The two farms are displayed side-by-side and using the same scale so that comparisons can be visually appraised.

As mentioned in the Materials and Methods section, existing management practices in place on the two on-farm collaborators dictated the grouping of animals into treatment groups. On the Anderson Farm, 14 yearling received LB and 10 adult goats served as the control groups. This age difference is evident in the BW graphs below (Fig. 1a and 1b) for Anderson farm and to a lesser extent for Guy Farm (Fig. 1a and 1b). Younger animals are more susceptible to haemonchosis than older animals and the two on-farm collaborators were keen in protecting this more vulnerable group.

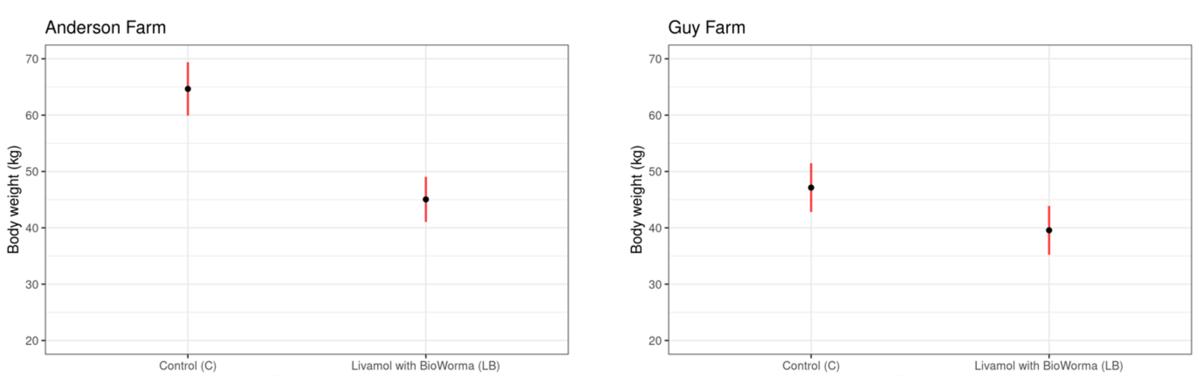

Fig. 1a and 1b. Effect of treatment on body weight for Anderson Farm (1a) and Guy Farm (1b).

Another age-confounding effect can be seen in the BCS graphs below (Fig. 2a and 2b), although BCS were not different (P>.10) between treatment groups for Guy Farm. Generally, younger animals tend to have higher BCS than older animals.

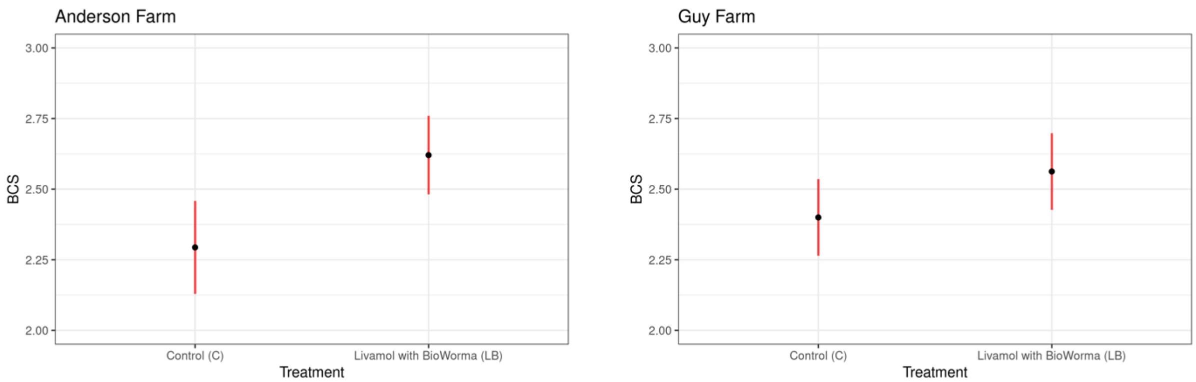

Fig. 2a and 2b. Effect of treatment on body condition score (BCS) for Anderson Farm (2a) and Guy Farm (2b).

FAMACHA is an indirect measure of anemia and PCV is a direct measure. Other studies have demonstrated the relationship between these two measures (Burke et al., 200). This study also noted that relationship in the graphs below (Fig. 3a and 3b); however, the relationships between treatments and FAMACHA and between treatments and PCV did not exhibit that underlying relationship. For Anderson Farm, FAMACHA scores (Fig. 4a)were similar (P>.10); however, LB had significantly (P<.01) higher PCV (Fig. 5a) than did C. For Guy Farm, FAMACHA scores (Fig 4b)were significantly (P<.01) lower for LB than C; however, PCV (Fig. 5b) were similar (P>.10).

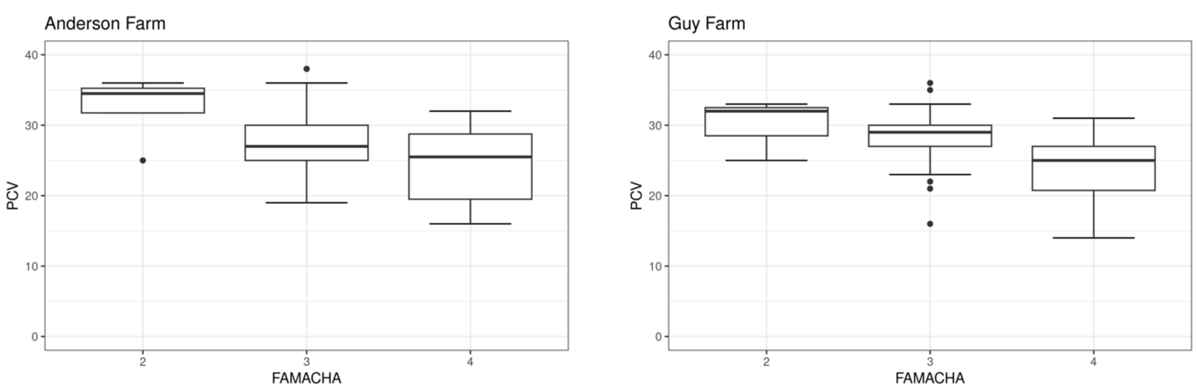

Fig. 3a and 3b. Boxplot of packed cell volumen (PCV) and FAMACHA scores for Anderson Farm (3a) and Guy Farm (3b).

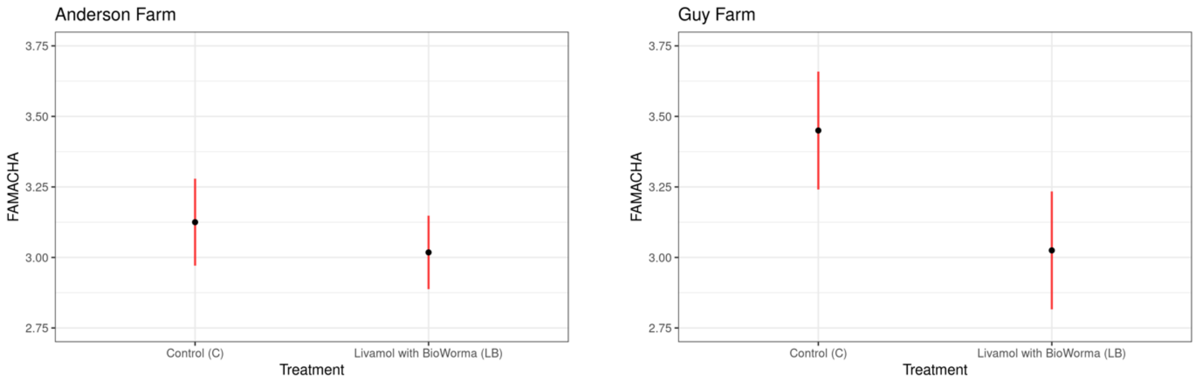

Fig. 4a and 4b. Effect of treatment FAMACHA for Anderson Farm (4a) and Guy Farm (4b).

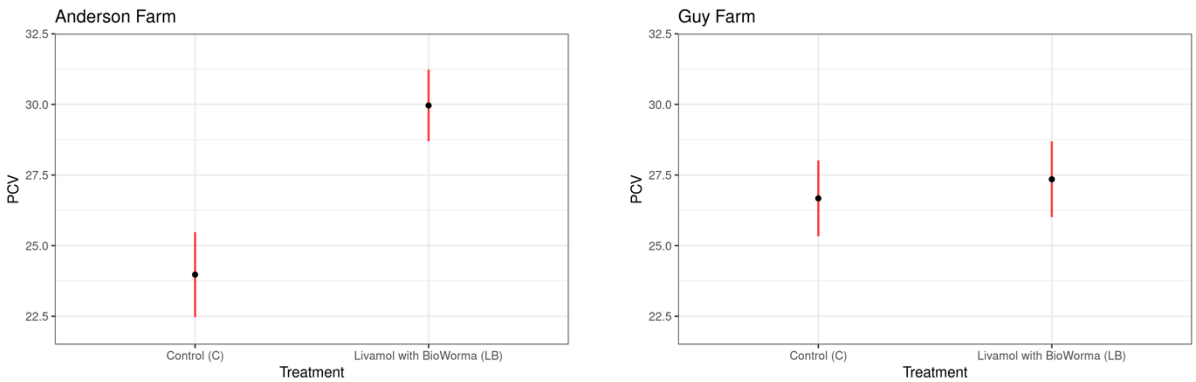

Fig. 5a and 5b. Effect of treatment on body weight for Anderson Farm (5a) and Guy Farm (5b).

For Anderson Farm, LB had significantly (P<.01) higher FEC (Strongyle type) (Fig. 6a) than did C; however, for Guy Farm treatments had similar (P>.10) FEC (Fig. 6b).

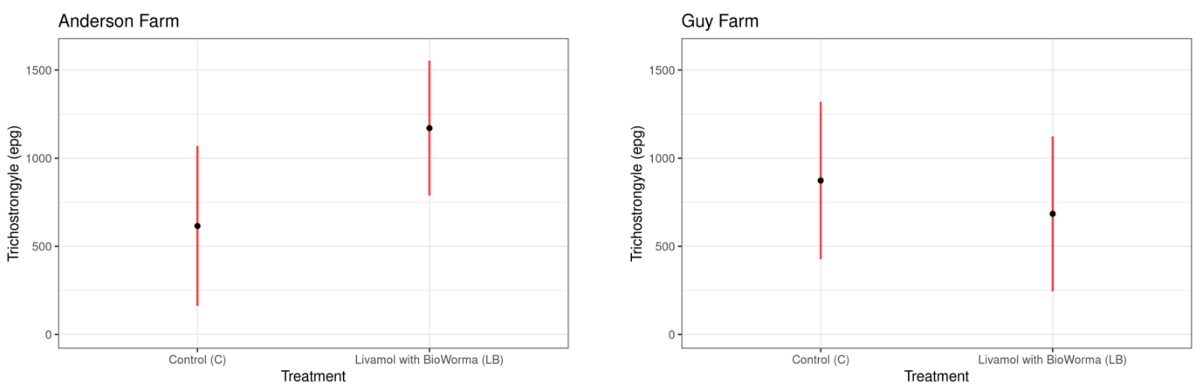

Fig. 6a and 6b. Effect of treatment on fecal egg count (Strongyle type) for Anderson Farm (6a) and Guy Farm (6b).

For Anderson Farm and for Guy Farm (Fig. 7a and 7b), treatments had similar (P>.10) coccidia oocyst counts.

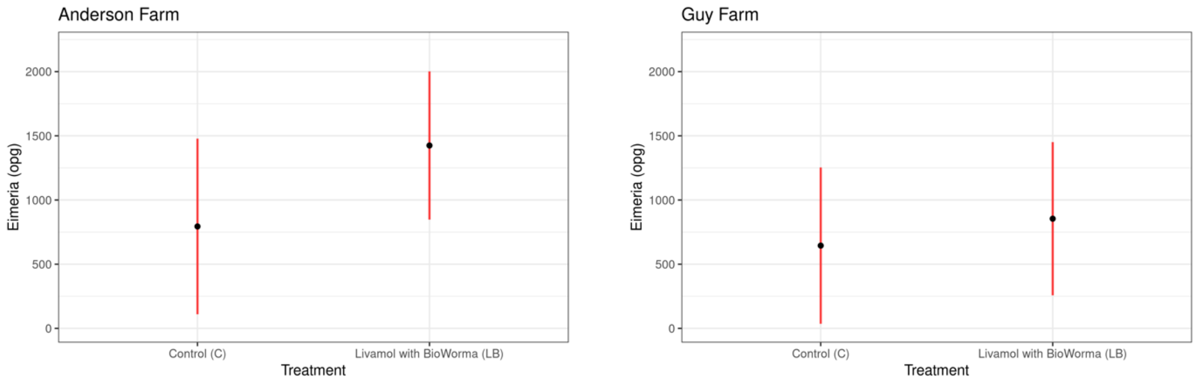

Fig. 7a and 7b. Effect of treatment on coccidia oocyst count for Anderson Farm (7a) and Guy Farm (7b).

For Anderson Farm and for Guy Farm (Fig. 8a and 8b), treatments had similar (P>.10) tapeworm egg counts.

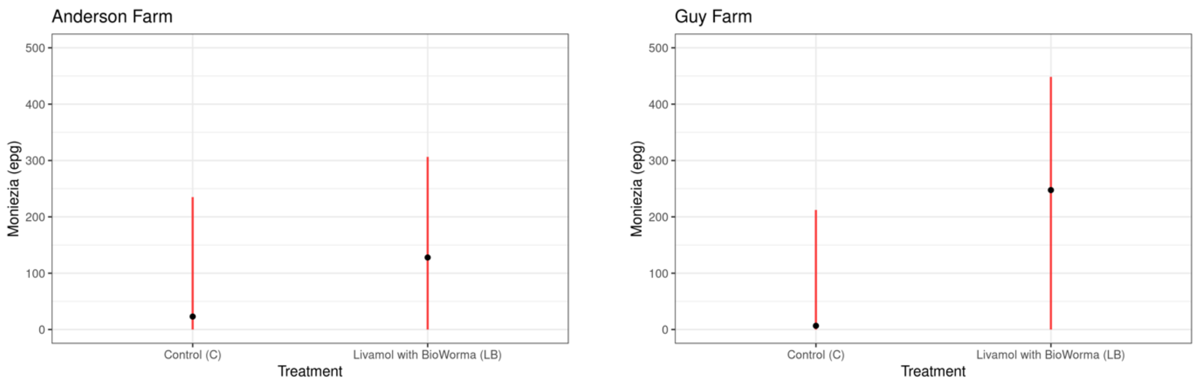

Fig. 8a and 8b. Effect of treatment on tapeworm egg count for Anderson Farm (8a) and Guy Farm (8b).

Larval counts followed the same trend as seen in FEC (Strongyle type; Fig. 6a and 6b). For Anderson Farm, LB had significantly (P<.01) higher larval counts for *Haemonchus contortus* (Fig. 9a) than did C and *Haemonchus contortus* was significantly (P<.01) higher than other species; however, larval counts for species other than *Haemonchus contortus* were similar for the two treatments (Fig. 9a). For Guy Farm, *Haemonchus contortus* was significantly (P<.01) higher than other species; however, larval counts for *Haemonchus contortus* were similar (P>.10) between treatments (Fig. 9b) and larval counts for species other than *Haemonchus contortus* were similar for the two treatments (Fig. 9b).

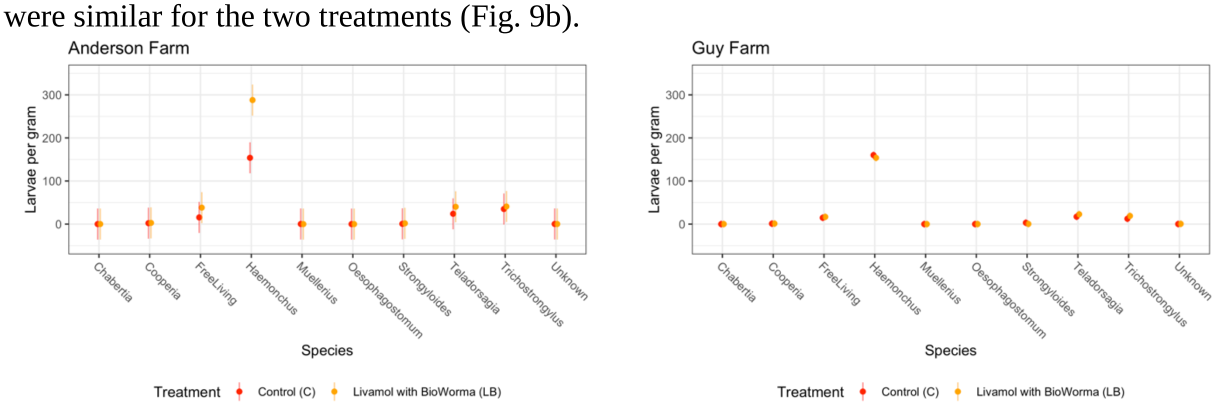

Fig. 9a and 9b. Effect of treatment on larval count for Anderson Farm (9a) and Guy Farm (9b).

For Anderson Farm and for Guy Farm (Fig. 10a and 10b), treatments had similar (P>.10) hatchability rates.

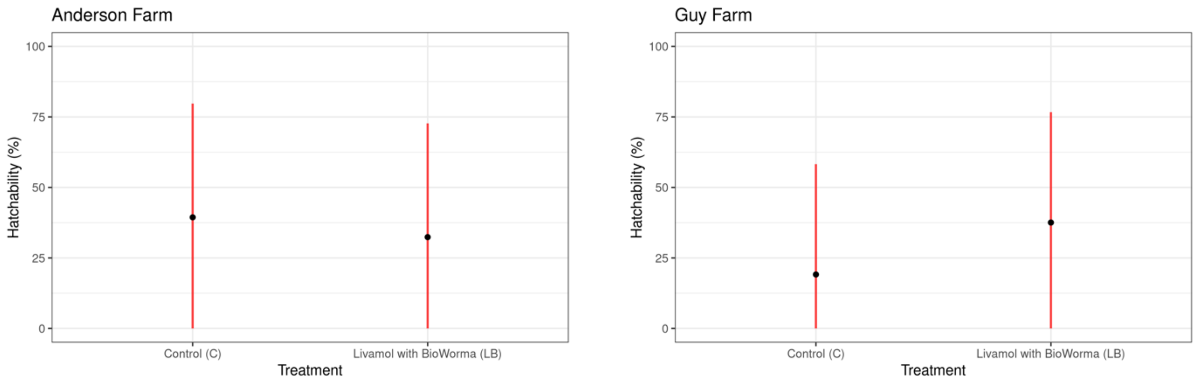

Fig. 10a and 10b. Effect of treatment on hatchability for Anderson Farm (10a) and Guy Farm (10b).

Impact: Theoretically, the nematode-trapping fungi, *Duddingtonia flagrans*, in Livamol® with BioWorma® preys upon the L_3 larvae in the fecal pellet and therefore, should decrease the number of infective larvae. However, this study did corroborate that hypothesis. In fact, Livamol® with BioWorma® had equal or greater number of L_3 larvae per gram of feces as did the control group. Therefore, based upon this study, the added expense and labor cost associated with Livamol® with BioWorma® is not warranted.

Prevalence and abundance of gastrointestinal parasites in Kiko kid goats from 16 states of the USA

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Objective: Gastrointestinal (GI) parasitism is a multi-etiological (i.e., helminth, protozoa) infection being a major constraint in small ruminant production. Younger animals are especially susceptible as their immune system is not competent to cope with these infections. This study was conducted to determine the prevalence, composition and abundance of gastrointestinal parasites in Kiko kid goat.

Procedure: A total of 170 male Kiko kids (4-6 month-old) were evaluated. Origin farms (n= 27) were located in 16 states of the USA. Individual coprology and fecal egg counts (FEC, Mc Master method) and pooled coprocultures (by state) were performed to identify the Strongylida genus applying morphological keys.

Results: A complex parasite community with the most prevalent parasites being helminth Strongyles (Nematoda:Strongylida) 89.6% and protozoa Coccidia (*Eimeria* spp) 78.9%. The mean FEC values for main parasites: strongyle and coccidia were high (2349±4553.3 EPG, 4460± 9136.9 OPG, respectively) and their FEC values showed an over dispersed distribution within the population (coefficient k < 8). From coprocultures, six genus of Strongylida order parasites were identified with *Trichostrongylus* spp, *Oesophagostumum* spp and *Teladorsagia* spp being the most frequent. Overall, few animals harbored the highest burdens a indicated by the dispersed distribution seen in FEC. Infected animals with the higher parasite burden for strongyles (EPG>1000) and coccidia (OPG>3000) accounted for 45.6% and 38.5%, respectively. The helminth macrobiota showed variations by state, with higher diversity in southern states.

Impact: Multi-etiological GI parasitism and high prevalence and mean FEC values highlighted the relevance of these infections regarding goat welfare and production, especially in younger animals. Animals harboring the highest burden might be identified in each farm in order to focus the control measures on them. These epidemiological facts might be considered when control programs are planned.

Multi-anthelmintic resistance in Alpine kids artificially or naturally infected with gastrointestinal nematodes

J. Quijada

Objective: The objective was to determine the anthelmintic efficacy of pharmaceutical drugs normally used on the research farm of the American Institute for Goat Research of Langston University.

Procedure: Sixteen 5-mo old Alpine kids were split into two equal groups. Group 1 was artificially infected with 10,000 infective larvae (L3, 85% *Haemonchus contortus*) whereas Group 2 was naturally infected. Both groups were orally dosed with Cydectin and Prohibit at 0.4 mg/kg BW and 12 mg/kg BW, respectively. Anthelmintic effect was assessed by a fecal egg count reduction test (FECR) with fecal samples taken at day 0 pre-treatment and at day 14 post-treatment.

Results: The artificially infected kids in Group 1 recorded an 80% reduction in FEC while the naturally infected kids in Group 2 recorded a 39% increase in FEC between the two sampling dates. The World Association for the Advancement of Veterinary Parasitology has established a FECR value of >95% to establish an anthelmintic is effective. Results show anthelmintic resistance to both drugs used.

Impact: Other anthelmintic drugs need to be tested combined with management strategies to combat internal parasites, increase the refugia population, and minimize the negative effects of internal parasites in this herd.

Comparing pooled fecal samples collected from pen floors versus pooled and individual fecal samples from penned goats as a method to estimate parasite burden

K. Saywon, J. Quijada, R. Merkel, W. Wang, T. Gipson, and A. Goetsch

Objective: A common method to assess gastrointestinal parasitism is through conducting fecal egg counts (FEC) of all animals. FEC is rarely carried out on farms because of the time-consuming fecal sampling, stress that can occur during handling of animals, lack of expertise in FEC, and cost of individual fecal analyses. The objective of this study was to determine if a pooled pen FEC from feces collected from pen floors (*FloorFEC*) is representative of pooled animal FEC from samples collected directly from the rectum of all goats in the pen (*Pen6FEC*) or half of them (*Pen3FEC)*. These FEC were compared to the individual FEC (*IndivFEC*) of all goats in the pens.

Procedure: Three *FloorFEC* samples, done by collecting 10 to 12 fecal pellets from a minimum of six different floor areas, were taken for 8 wks from six pens each housing six 6-mo old Spanish goats. Rectal grab fecal samples were taken from all goats in wks 1, 3, 5, and 7 for *IndivFEC* and the animal pooled samples. The modified McMaster technique was used to assess FEC and the number of coccidian oocysts. Data was analyzed using Lin's concordance correlation coefficients.

Results: Subsampling three goats in a pen (50% of the pen) and doing a pooled FEC (Avg PEN3FEC A and B) correlated well with Avg IndivFEC, 0.77 and 0.79. Pooled samples well-represented average FEC from the sampled animals in that group (Pen6FEC and Pen3FEC) and resulted in fewer FEC done. FloorFEC had only moderate relationship with average IndivFEC and pooled Pen 6FEC and Pen3FEC A and B.

Impact: Greater accuracy in estimating pen FEC was achieved by subsampling goats in a pen and conducting a pooled FEC when compared to floor fecal sampling. Floor sampling of feces may be beneficial in pen confinement trials as a first tool in monitoring barberpole worm infestation, with individual or pooled samples as the next step if a high FEC was found. This may be useful when minimal handling of animals was desired or in production situations. Using floor or pooled samples for FEC can decrease the number of FEC done, saving time and cost.

North Carolina A&T State University

Modulation of systemic immunity and gut health using a garlic drench in goats

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(North Carolina A&T State University)

Objective: To determine the effect of a garlic drench on fecal egg count and protein secretion in goat blood

Procedure: Two trials (adult and weaned) were conducted. Twenty-four (24) Boer x Spanish goats were selected from North Carolina Agricultural and Technical State University's Small Ruminant Research Unit. The animals were randomly placed into two groups of six each in the experimental group and control group. Weekly sampling was performed. Ten (10) ml of the undiluted garlic extract (Garlic Barrier) was given to treatment group and same amount of distilled water to control animals on daily basis for 30 days. Body weight, body condition score, FAMACHA, fecal and blood samples were collected. Fecal samples were evaluated for egg per gram and microbial DNA. Blood samples were evaluated for packed cell volume, total cell count, protein concentration, ELISA, and RNA isolation.

Results: Fresh and aged garlic did not have adverse effects and stimulated protein secretion in vitro. Garlic drenches significantly decreased the Eggs Per Gram during first ($p<0.004$) and third ($p<0.027$) weeks of treatment. It was also found to have a significant increase on the total protein concentration ($p<0.004$). Administration of fresh garlic as a drench in goats impacted global gene transcription, protein secretion, and gut health indicators in meat goats. Both systemic and local effects were observed. Garlic is a potential immuno-modulator. Garlic differentially modulated GIN parasite fecal egg levels, had no effect on probiotic gut microbes, changed the Neutrophil: Lymphocyte ratio (N: L), stimulated Galectin gene expression and secretion in blood from goats on pasture who are naturally infected with GIN.

Table 1: Effect of garlic in adult and weaned goats.

Parameters	Control	Garlic (adult goats)	Garlic (weaned goats)
Plasma protein	720 ng/ul	1523 ng/ul	850 ng/ul
FEPG	1050	400	19500
N:L	1.85	2.32	1.64
Microbial DNA	0.205 ng/ul	ND	0.165 ng/ul
RNA concentration	39.25 ng/ul	32.75 ng/ul	35.65 ng/ul

ND=not determined

Impact: This study provides evidence in support of the use of garlic to improve animal health and production in ecofriendly, organic parasite control for sustainable agriculture.

North Carolina State University

Rams enrolled in the National Sheep Improvement Program have improved performance and value in ram test program

A.R. Weaver, D.L. Wright, S.P. Greiner

Objectives: The objective here was to evaluate the performance and value of rams enrolled in the National Sheep Improvement Program (NSIP) compared to those not enrolled during a ram test program.

Procedure: Rams (Katahdin = 116, Texel = 3) were delivered to the Southwest Virginia Agricultural Research and Extension Center Ram Test on May 31. Rams were dewormed and rested for two weeks. On June 21, rams were given *Haemonchus contortus* L3 larvae adjusted for body weight (average = 5000 L3). FAMACHA scores and fecal egg counts (FEC) were monitored every two weeks until August 30. Rams were dewormed based on FAMACHA ≥ 3. The top 50% of rams, excluding any dewormed rams, based on the sale index [Sale Index = 0.50*(0.33*average daily gain ratio + 0.67*weight per day of age ratio) + 0.50*logFEC ratio] were sold at auction as breeding stock. Rams were classified as NSIP if enrolled.

Results: Of the 119 rams on test, 52% were enrolled in NSIP. Thirteen rams required deworming during the test (38% of these were NSIP rams). Average sale index of NSIP rams tended to be greater than that of non-NSIP rams (101.4 vs. 98.3, $P = 0.06$). Of rams with sale index ≥ 100 (top 50%), a greater percentage of these rams were NSIP vs. non-NSIP (61% vs. 39%, respectively; $P < 0.05$). When NSIP status was evaluated for the top 20% of rams (sale index ≥ 107), a greater percentage of these rams were also NSIP vs. non-NSIP (78% vs. 22%, respectively; $P < 0.01$). Rams (n = 57) were sold on September 23 with an average sale price of $1482. Rams enrolled in NSIP commanded greater prices than those not enrolled ($1659 vs. $1222, $P < 0.05$). When sale price was regressed on sale index for NSIP and non-NSIP rams, R^2 for NSIP rams was 0.19 compared to the R^2 for non-NSIP rams of 0.76. Given the weaker relationship between price and sale index for NSIP rams, estimated breeding values (EBVs) were evaluated. NSIP rams with EBVs reported for post-weaning weight, post-weaning FEC, and Maternal Hair Index sold for greater prices than those rams missing one or all of these EBVs ($1837 vs. $971, respectively; $P < 0.05$).

Impact: In summary, NSIP rams had greater performance (as indicated by sale index) and value compared to non-NSIP rams. For rams enrolled in NSIP, sale index was a poor predictor of value indicating buyers may be considering other factors besides sale index, such as EBVs, when purchasing NSIP rams. For rams not enrolled in NSIP, sale index did a reasonable job predicting sale price indicating buyers placed value placed on average daily gain, weight per day of age, and FEC when selecting rams without EBVs.

Evaluation of supplemental feeding behavior and growth performance in Katahdin lambs divergently selected for fecal egg count estimated breeding value

N.K. Valliere, D.L. Wright, S.P. Greiner, S.A. Bowdridge, A.R. Weaver

Objectives: The objective of this study was to evaluate the effect of fecal egg count (FEC) estimated breeding value (EBV) selection on daily supplemental intake, average daily gain (ADG), supplemental feed:gain (S:G), frequency of feeder visits, and FEC.

Procedure: Over two years (Y1, Y2), Katahdin lambs were divergently selected for FEC EBV generating low FEC EBV lambs (LowFEC) and high FEC EBV lambs (HighFEC) (Y1: LowFEC, n = 27; HighFEC, n = 24. Y2: LowFEC, n = 37; HighFEC, n = 40). Lambs were fed post-weaning for eight weeks in Y1 and five weeks in Y2 at the Southwest Virginia Agricultural Research and Extension Center (Glade Spring, VA). Pasture-raised lambs were supplemented with a concentrate pellet (16% CP) ad-libitum using a C-lock, Inc Super SmartFeed system with free choice hay in a dry lot. Body weights and FEC were measured every two weeks. Feed intake and feeding behavior data were collected daily.

Results: In Y1, LowFEC lambs had lower average FEC compared to HighFEC lambs (405.25 vs. 771.23 epg; $P < 0.05$). LowFEC lambs in Y2 tended to have lower average FEC compared to

HighFEC lambs (1191.75 vs. 2028.30 epg; $P = 0.1$). In Y1, LowFEC lambs had greater intake compared to HighFEC lambs (1.45 vs. 1.27 kg; $P < 0.05$). LowFEC lambs tended to have greater intake in Y2 (1.64 vs. 1.16 kg; $P = 0.1$). While ADG was not affected by FEC EBV type in Y1 ($P > 0.70$), LowFEC lambs in Y2 had increased ADG compared to HighFEC lambs (0.27 kg vs. 0.21 kg; $P = 0.05$). In both years, LowFEC lambs had numerically greater S:G compared to HighFEC lambs, but these differences were not significant ($P > 0.1$) due to high levels of variation around these means. Over both years, the number of feeder visits did not differ between LowFEC and HighFEC lambs ($P > 0.1$).

Impact: Selection of sires for LowFEC EBV resulted in progeny with lower FEC that had increased supplemental intake, but no difference in S:G compared to HighFEC progeny. In addition to improvements in parasite resistance, selection for FEC EBV may impact lamb feeding behavior in the post-weaning period. Additional work is needed to understand the reasoning for increased feed intake in lowFEC lambs and the impact of parasitism on feed efficiency.

Tuskegee University

Prevalence of Gastrointestinal Parasites in Lactating Kiko Does and their Kids in Woodlands with Supplements

B. Shrestha, U. Karki, A. Tiwari, and S. Chaudhary

Objectives: To evaluate the prevalence of GI parasites in lactating Kiko does and their kids stocked in woodlands with supplemental grazing or feedstuffs

Procedure: Seventeen lactating Kiko does with their kids (33) were divided into two groups. Each group was assigned to separate sets of woodland plots and rotated among those plots throughout the study period (July-Oct 2021). Group 1 was allowed for supplemental grazing in adjacent silvopasture plots for 3-4 hours daily, and Group 2 was supplemented with *ad libitum* hay and corn (0.5% of metabolic weight). Animals were checked for FAMACHA score at the beginning after a 5-day-adjustment period, fortnightly during the study, and at the end. Fecal samples were collected from animals having FAMACHA score 3 and higher and analyzed for the type and quantity of GI parasites. Data were analyzed in SAS 9.4.

Results: No difference was detected between groups of does and kids for any GI-worm parasites; however, Group 1 kids had lower coccidia count vs. Group 2 kids ($p<0.05$).

Impact: Results show no effect of supplement type used in this study on GI-worm parasites in Kiko does and kids, but a significant effect on coccidia prevalence in kids.

Influence of Supplement Type on the Prevalence of Gastrointestinal Parasites in Nursing Ewes and Lambs Raised in Woodlands

S. Chaudhary, U. Karki, B. Shrestha, and S. Lamsal

Objectives: To evaluate the impact of supplement type on the prevalence of GI parasites in nursing ewes and lambs stocked in woodlands

Procedure: Eighteen Katahdin-St. Croix cross ewes with their lambs (23) were divided into two groups. Each group was assigned to separate sets of woodland plots (3 plots/group) and rotated in the respective plots throughout the study period (May-August 2022). Group-1 sheep were supplemented with whole corn and Group-2 sheep with whole soybean (0.5% of live weight) and *ad libitum* hay. Fecal samples were collected on Days 1, 45, and 70 and analyzed for the type and quantity of GI parasites using the MacMaster technique. Data were analyzed in SAS 9.4 (NPAR1WAY procedure).

Results: No difference was detected between groups of ewes and lambs for *Haemonchus contortus* (HC). However, Group-1 lambs had higher coccidia count and lower *Moniezia* spp. count vs. Group 2 lambs ($p<0.05$).

Impact: Results showed no effect of supplement type on HC prevalence in ewes and lambs but a significant effect on the prevalence of coccidia and *Moniezia* spp. in lambs.

Use of Legume Forages to Promote Health Status of Small Ruminants

U. Karki, A. Tiwari, B. Shrestha, and S. Lamsal

Objectives: To evaluate the effect of leguminous forages on the health status of small ruminants

Procedure: Kiko does (19; age:15-16 months) and Katahdin ewes (19; age: 23-24 months) were divided into two groups. Group 1 was rotationally stocked in legume-grass pastures (Southern peas (*Vigna unguiculata* (L.) Walp.) + browntop millet (*Urochloa ramosa* L. Nguyen) 50:50 mix) and Group 2 in sole-grass (browntop millet) pastures for 87 days beginning in early August 2020. Live weight, body condition score (BCS), FAMACHA score, and fecal samples for parasite egg counts were collected on Day 1, fortnightly during the study, and at the end. Blood and fecal samples were collected on Days 1, 47, and 87. Blood samples were analyzed for 34 parameters and fecal samples for fecal nutrients and predicting animal performance.

Results: Group 1 animals (one or both species) showed better live weight, BCS, FAMACHA score, and few blood parameters vs. Group 2 animals. Parasite egg count was lower in Group 1 ewes vs. Group 2 ewes.

Impact: These results show that legume addition to grass pastures promotes the heath condition of small ruminants.

University of Florida

Investigating orange oil and lespedeza hay as an alternative anthelminthic for goats.

E. Duvalsaint, L. Carmona, D. Vyas, M. Wallau

Objective: The study aimed to evaluate the in vivo effects of orange oil (OR) and sericea lespedeza hay (*Lespedeza cuneata*; LH) supplementation on fecal egg counts, FAMACHA and body condition score, hematological parameters, nutrient digestibility, and growth performance in goats.

Procedure: Twenty-four bucks (4-6 months; 16 ± 9 kg) were used in this study and distributed in 12 experimental pens (2 animals per pen). Experimental pens (N=12; 2 bucks/pen) were blocked by low, medium, and high fecal egg counts. Treatments were arranged in a 2 × 2 factorial model with 2 levels each for SH and OR. Treatments were: 1) Control: Pen receiving coastal bermudagrass based basal diet; 2) OR: Pens receiving basal diet with orange oil; 3) LH: Pens receiving basal diet replacing 20% coastal bermudagrass hay with LH; 4) LHOR: Pens receiving LH with OR. Experimental duration was 5 weeks including one week for adaptation and 4 weeks for data collection. Orange oil was orally dosed (600 mg/kg BW) once during week 1 of data collection. Data were analyzed using PROC GLIMIMIX of SAS with LH, OR, and blocks as fixed factors while pen was used as random factor in the model. Fecal and blood samples, body weight, BCS, and FAMACHA scores were collected once weekly.

Results: Orange oil was effective at lowering 41% of *H. contortus* eggs in fecal samples while no effects were observed with LH. No treatment difference was observed on dry matter intake, and body weight. These results should be considered preliminary as data analysis is still under progress.

Impact: Orange oil has deworming potential against *H. contortus* and it may be an effective alternative to deworming agents. However, LH may not have any effects on fecal egg counts. Future studies should explore the mechanism and economic benefit of using OR for small ruminant producers.

USDA, Agricultural Research Service, Booneville, AR

Duddingtonia flagrans **included in trace mineral mix or feed for control of gastrointestinal nematodes in sheep**

J.M. Burke, K. Petersson, E. Kass, J.E. Miller, A. Vatta, M. Acharya, S. Rohila

Objective: Objective was to determine efficacy of *Duddingtonia flagrans* (Df) included in a mineral mix compared with a feed supplement in Katahdin ewe lambs weaned Jan 2022 (76 ± 2.0 d of age; 21.2 ± 1.1 kg). A second study was to determine efficacy of Df included in feed supplement as recommended with or without coccidiostat as decoquinate.

Procedure: Lambs were supplemented in pairs with a 12% CP sweet feed (226 g and 6 d later 450 g/lamb) that was thoroughly mixed daily with trace mineral mix [7.1 g salt (87.7%), Sheep Trace Mineral Premix (8.8%), and Vitamin ADE mix (3.5%), Premier 1] and coccidiostat (0.2 g of Decoquinate Type A as Deccox®, Premier 1). Lambs were randomly assigned to one of three treatments (n = 8/treatment; 2/pen): 1) control (CON) or no Df, 2) Df (BioWorma® Int. Anim.

Health Prod.) mixed in supplement as recommended (DfC; weighed daily at 1.7 g/lamb), or 3) Df added in mineral (DfM; trace mineral was mixed with 13.6 g Df for 8 lambs then stored for 7 d in a Ziploc bag) which was then added to the supplement. The Df dose used was for the heaviest lamb. Pair feeding lasted 1 h, then lambs had access to free choice bermudagrass hay and water. Fecal samples were collected for fecal egg counts (FEC) and coproculture in pairs twice weekly, and blood collected to determine packed cell volume (PCV) weekly between d -2 and 27. Larval recovery was calculated per pair: (L3/g feces/average FEC) × 100. A second study was conducted similarly to first, but with the following treatments: 1) control (no coccidiostat/no Df), 2) no coccidiostat/ Df, 3) coccidiostat/no Df, or 4) coccidiostat/ Df (n = 4 ewe and n = 4 ram lambs/treatment).

<u>Results</u>: In the first study, GIN were 51.3% *Trichostrongylus* spp./*Teladorsagia* spp., 44.9% *Haemonchus contortus* and < 2% each of *Cooperia* spp., *Oesophagostomum* spp. Most samples contained some Strongyloides. FEC were log transformed; FEC, PCV, larval recovery were analyzed using repeated measures over time. There was a treatment × date interaction for FEC (*P* = 0.02) but DfM was similar to CON throughout. PCV were similar among treatment groups (*P* > 0.10). Surprisingly, larval recovery was similar among treatments (*P* > 0.10). Results were similar in the second study in that there were no differences in larval recovery among treatment groups. It was determined through cooperation with the manufacturer that the spore count was approximately 10-fold less than optimal dose through possible mixing error.

<u>Impact</u>: Df spore counts were lower than expected. Newly manufactured product is now available and viability and repeat of these studies will occur. Because this is a relatively new technology for control of GIN in the U.S. and the only method of pasture control, it is desired to have a viable product that consumers can rely on.

Virginia State University

The Efficacy of a Natural Fungus (*Duddingtonia flagrans*) in Controlling Gastrointestinal Nematodes in Lactating Meat Goat Does

D. O'Brien, K. Matthews (Delaware State University, S. Wildeus, N. Whitley (Fort Valley State University) and S. Schoenian (University of Maryland)

<u>Objectives:</u> Small ruminant production in the US is significantly impacted by infections with gastrointestinal nematodes (GIN), especially the blood sucking GIN, Haemonchus contortus. Unfortunately, the indiscriminate use of available drug classes has led to multi-drug resistant GIN that pose significant challenges to parasite control on many farms. The objective of this study was to evaluate the effectiveness of a natural fungus, Duddingtonia flagrans (Bioworma®, International Animal Health) in reducing GIN loads in lactating meat does.

<u>Procedure:</u> Thirty-eight late gestating Spanish and Myotonic does were dewormed (d 0) approximately 2 weeks prior to kidding with a combination of levamisol (Prohibit®; 12 mg/kg BW) and moxidectin (Cydectin®; 0.4 mg/kg BW) prior to the start of feeding BioWorma® according to the manufacturer's recommendations. At this time, does were also allocated into

two treatment groups (n=19/group), split into 3 replications per treatment and placed on six pasture paddocks (n=6/7 per paddock). Does were then fed either a corn and soybean meal supplement at 1.5% of their BW with (BIO) or without (CON) Bioworma® daily until weaning and hay was offered throughout the study. Bioworma® was added to the ration based on the manufacturer's recommended dose of 0.066 g/kg BW and on the weight of the heaviest doe. To evaluate the effect of Bioworma® treatment, BW, body condition score (BCS), and FAMACHA© scores were recorded every 2 weeks for 98 days. Blood and fecal samples were also collected for determination of packed cell volume (PCV) and fecal egg counts (FEC). Pooled (d 28) or pooled treatment group feces (d 42, 56, 70, 84 and 98) were also collected and cultured to determine GIN genera. If blood PCV fell below 19%, does were dewormed and removed from the study (n=2 BIO; n=2 CON). Data were analyzed using repeated measures in a mixed model, and FEC were log transformed prior to analysis.

Results: Following deworming (d 0), FEC were reduced by 97% by d 14. There was a mixed population of GIN throughout the study (averaging 70.3%, 17.7%, and 12.0% for H. contortus, Tricostrongylus spp., and Oesphagostomum spp., respectively). Bioworma® supplementation had no impact on BW, BCS, FAMACHA© scores, nor PCV averaging 38.8±0.5 kg, 2.3±0.03, 2.2±0.02, and 29.3±0.3%, respectively. There was also no effect of treatment on FEC (averaging 1067±254 and 1107±144 and 987±282 and 847±163 eggs per gram for BIO and CON does on days 0 and 98, respectively.

Impact: Bioworma® supplementation in a highly susceptible group of lactating does, had no influence on GIN indicators. Additional research is needed to confirm the efficacy of Duddingtoni flagrans in controlling GIN and how best to incorporate in current on-farm parasite control strategies.

The efficacy of copper oxide wire particles alone or in combination with moxidection to reduce parasite loads in meat goat kids.

D. O'Brien, K. Matthews (Delaware State University, S. Wildeus, N. Whitley (Fort Valley State University) and S. Schoenian (University of Maryland)

Objectives: Infections with the blood sucking parasite, Haemonchus contortus, are of primary concern for small ruminant producers, especially due to the prevalence of anthelmintic resistance. The objective of this study was to determine the effectiveness of copper oxide wire particles alone and in combination with Cydectin.

Procedure: At weaning (88.4 ± 0.7 d), 45 meat goat kids with FAMACHA© scores ≥ 3 and weighing 12.5 ± 0.4 kg were separated into the four treatment groups after accounting for initial FAMACHA© eyelid color score, breed (Spanish or Myotonic), and birth type (single or multiple): copper oxide wire particles (COWP; n = 12; 1 g bolus Copasure®; Animax Ltd), Cydectin® alone (CYD; n = 10; 0.4 mg/kg; Bayer), a combination of COWP + CYD (n = 12) and an untreated control group (CON; n = 11) Feces were collected on d 0 and 14 for determination of FEC. Pooled treatment group feces were also cultured on d 0 and 14 to determine gastrointestinal nematode (GIN) genera. Individual FEC were calculated and treatment efficacy was determined according to the guidelines established by the World Association for the Advancement of Veterinary Parasitology. FEC were log transformed and analyzed using repeated measures in a mixed model with d 0 FEC as a covariate. Individuals were removed from the study if d 0 FEC was less than 400 eggs/g (n = 3, n = 3, n = 2, and n = 2 for CON, COWP, CYD and COWP + CYD, respectively)..

Results: There was a mixed population of GIN cultured from pooled fecal samples (averaging 70.3%, 17.7%, and 12.0% for H. contortus, Tricostrongylus spp., and Oesphagostomum spp., respectively). Pre-treatment FEC averaged 1262 ± 241, 2794 ± 765, 2050 ± 378 and 1375 ± 221 eggs per gram (epg), for the CON, COWP, CYD and CYD+COWP, respectively. There was an effect of treatment on FEC with FEC on day 14 lower ($P < 0.05$) for COWP (497 ± 200 epg), CYD (746 ± 334 epg) and COWP + CYD (559 ± 246 epg) treated kids compared to the CON (1701 ± 895 epg). CON group FEC increased by 35% while treatment with COWP reduced FEC by 71% (84 - 92% Confidence Interval; CI), compared to 56% (60 - 89% CI) for CYD and 67% (88 – 90% CI) for COWP + CYD.

Impact: Even though all treatments were more effective than the CON, the effect of COWP + CYD was similar to COWP and CYD when used alone and no additive effect was observed. Under the conditions of this study, COWP, COWP + CYD and CYD were all effective in reducing FEC compared to leaving meat goat kids untreated.

Objective: II: Emphasis of forage feeding systems for year-round grazing to meet nutritional requirements that mitigate drought and other plant and animal stressors

Langston University

Effects of level and type of fiber sources on feed intake, average daily gain, digestion, and milk production by Alpine goats

W. Wang, R.V. Lourencon, R. Puchala, L.P. Ribeiro, and A.L. Goetsch

Objective: The objective is to determine effects of the level and quality of dietary forage and type of neutral detergent fiber (NDF) sources on feed intake, average daily gain (ADG), digestion, and milk production of Alpine goats. More specifically, effects on milk production and composition of diets high in high-quality forage and ruminally degradable fiber compared with diets with similar levels of total fiber but derived from lower levels of more fibrous feedstuffs and including alfalfa were evaluated.

Procedure: Thirty Alpine does and 32 Alpione doelings, averaging 45 ± 1.5 days-in-milk, were used a study with four 4-wk periods. 60C, 50C, 50W20S, and 40W30S diets were 60, 50, 30, and 30% concentrate and 40, 50, 50, and 40% forage, with 20 and 30% soybean hulls in 50W20S and 40W30S, respectively. Diet NDF concentration was 36, 39, 52, and 52% for 60C, 50C, 50W20S, and 40W30S, respectively.

Results: Overall dry matter intake (DMI) was highest ($P < 0.05$) for 60C and 50C, but differences were greater in periods 1 (2.96, 2.76, 2.06, and 2.27) and 2 (2.67, 2.76, 2.18, and 2.35) than in periods 3 (2.60, 2.55, 2.04, and 2.28) and 4 (2.38, 2.32, 2.07, and 2.13 kg/d for 60C, 50C, 50W20S, and 40W30S, respectively; SEM = 0.142). There was a three-way interaction in ADG, with values of 31, 32, -22, and -10 for doelings (SEM = 15.1) and 8, 0, -22, and -11 g for does consuming 60C, 50C, 50W20S, and 40W30S, respectively (SEM = 18.6). Digestion of organic matter after period 4 was 71.3, 71.3, 80.1, and 80.7% (SEM = 0.95) and of NDF was 44.7, 48.8, 73.7, and 75.8% for 60C, 50C, 50W20S, and 40W30S, respectively (SEM = 1.56). Milk fat concentration was highest ($P < 0.05$) for 40W30S (2.81, 2.92, 2.85, and 3.13%; SEM = 0.051), with raw milk yield similar among treatments (3.10, 2.87, 2.64, and 2.79 kg/day 60C, 50C, 50W20S, and 40W30S, respectively; SEM = 0.144). Average milk energy yield was 7.61, 7.20, 6.48, and 7.20 MJ/d (SEM = 0.354) and 2.85, 2.90, 3.11, and 3.18 MJ/kg DMI for 60C, 50C, 50W20S, and 40W30S, respectively (SEM = 0.130).

Impact: High-NDF diets may limit feed intake more in mid- than late lactation and restrict ADG of doelings; however, perhaps because of differences in digestibility, they did not significantly affect milk energy yield. For successful and advantageous use of diets very high in fiber for lactating dairy goats, forage sources should be very high in digestibility, and use of alternative feedstuffs such as soybean hulls may not be adequate.

Effects of dietary levels of alfalfa and Sericea lespedeza hay on feed intake, milk yield and composition, digestion, metabolism, body weight change, and behavior of Alpine dairy goats

F. Encinas, A.K. Patra, W. Wang, L. Ribeiro, H. Yirga, D. Tadesse, R. Puchala, I. Tovar Luna, and A.L. Goetsch

Objective: Objectives are to determine effects of dietary levels of alfalfa and Sericea lespedeza hay on feed intake, milk yield and composition, digestion, metabolism, body weight change, and behavior of Alpine goats.

Procedure: Sixty-four Alpine goats were used in a 16-week experiment beginning in early lactation. Diets were 50% forage and 50% concentrate. Each diet included 5% cottonseed hulls. The other 45% of the diet composed of forage was alfalfa hay (A45), Sericea lespedeza hay (L45), or mixtures of the two forages (30% alfalfa and 15% lespedeza, A30L15; 15% alfalfa and 30% lespedeza, A15L30). Diets were formulated to be 16% crude protein, 69-71% total digestible nutrients, 4.7, 5.2, 6.0, and 6.7% undegraded intake protein (dry matter basis; UIP), and 35.0, 32.6, 32.0, and 31.2% neutral detergent fiber for A45, A30L15, A15L30, and L45, respectively. Measures included feed intake, milk production and composition, body weight (BW), body condition score (BCS), body mass indexes (BMI), digestion, heat energy, and behavior.

Results: Feed intake (2.53, 2.82, 2.72, and 2.85 kg/d; SEM = 0.125), milk yield (2.82, 3.26, 2.93, and 3.17 kg/d; SEM = 0.21) and concentrations of protein (2.57, 2.57, 2.50, and 2.56%; SEM = 0.042) and urea (14.9, 13.3, 14.0, and 13.5 mg/dl; SEM = 0.55), BCS (2.81, 2.69, 2.68, and 2.71 for A45, A30L15, A15L30, and L45, respectively; SEM = 0.049) were similar among treatments. The fat content in milk was affected by diet and a diet × period interaction, with highest values among diets in period 4 for L45 (3.25, 2.94, 3.13, and 4.66%; SEM = 0.117). Change in BW and a BMI based on height at the withers and length (cm) from the point of the shoulder to the hook bone [BW/(height × length), g/cm^2] were not affected by diet.

Impact: Although analyses of other data are underway, these results suggest that dietary proportions of leguminous forages such as alfalfa and lespedeza, differing in composition including level of condensed tannins, can be varied in accordance with factors including availability and cost without marked effect on performance when appropriate consideration is given to levels of other dietary ingredients.

Effects of the concentration and nature of total dissolved salts in drinking water on feed intake, nutrient digestion, energy balance, methane emission, ruminal fermentation, and blood constituents in different breeds of goats and hair sheep varying in age

A. Patra, L. Ribeiro, H. Yirga, R. Puchala, and A.L. Goetsch

Objective: Objectives were to determine effects on feed intake, digestion, heat energy, methane emission, and ruminal fluid and blood constituent concentrations of drinking water higher in total dissolve solids (TDS) from the same natural source of brackish water and(or) NaCl addition with young Boer, Spanish, and Angora goats and Dorper, Katahdin, and St. Croix sheep in one study and with mature animals of the same breeds except for inclusion of Tennessee Stiff Leg rather than Angora goats.

Procedure: There were six simultaneous 6 × 6 Latin squares with 3-week periods. In the first study with young animals, water treatments were fresh (FR), a natural source of brackish water (BR) alone (100-BR), a similar TDS concentration as 100-BR via NaCl addition to FR (100-SL), BR with concentrations of all minerals increased by approximately 50% (150-BW), a similar TDS level as 150-BR by NaCl addition to FR (150-SL), and a similar 150 TDS level achieved by addition of a 1:1 mixture of BR minerals and NaCl to 100-BR (150-BR/SL). Concentrations (mg/kg) in BR were 4928 TDS, 85.9 bicarbonate, 225 calcium, 1175 chloride, 60.5 magnesium, 4.59 potassium, 1387 sodium, 1962 sulfate, and 8.3 boron, and TDS in other WT was 453, 5684, 7508, 8222, and 7319 for FR, 100-SL, 150-BR, 150-SL, and 150-BR/SL, respectively. With mature animals in the second experiment, water treatments were the same except for 100% increases in mineral levels above 100-BR rather than 50%. Animals in both studies consumed moderate quality grass hay ad libitum.

Results: There were very few significant effects of water treatments or interactions with animal type, although naturally animal type had numerous impacts.

Impact: All AT seemed resilient to these water treatments regardless of mineral source and concentrations, with TDS less than 10,000 mg/kg, which did not influence nutrient utilization, ruminal fermentation, energy balance, or blood constituent levels. Future research should address longer periods of consumption of brackish/saline water and natural or synthetic sources varying in levels of specific minerals.

Determining appropriate numbers and times of daily measurements to estimate ruminal methane emission and heat energy of meat goats using a GreenFeed system

D. Tadesse, R.Puchala, H. Yirga, L.P.S. Ribeiro, F. Encinas, T. Gipson, and A.L. Goetsch

Objective: The objective was to determine appropriate numbers and times of daily measurements to estimate methane and heat energy production by goats using the GreenFeed mobile animal group calorimetry system (GRP-CS). Estimates with GRP-CS were compared with those of a stationary individual animal calorimetry system (IND-CS).

Procedure: Sixteen growing Boer wethers were used in a study with a pen setting involving 4 2-wk periods of a Latin Square. Oat hay (9% CP and 58% TDN) was offered twice daily in individual feeders. The GRP-CS was programmed using C-Lock Inc. software to automatically dispense 120 g of pelletized feed per day during the gas sampling times to entice animals to visit the unit, with 5 g of pellets per drop during visits (CP = 20.3% and TDN = 74.1%). Pellets were dispensed in the hood after identification by RFID tag. There were 3, 4, or 6 equally spaced measurement periods per day (3 periods: 0600-0700, 1400-1500, and 2200-2300 h; 4: 0700-0800, 1300-1400, 1900-2000, and 0100-0200 h; 6: 0800-0900, 1200-1300, 1600-1700, 2000-2100, 0000-0100, and 0400-0500h) with GRP-CS (G-3T, G-4T, and G-6T, respectively) that occurred during 2 days in each of the 2 wk of periods. The same amount of pellets was provided individually when animals were moved to IND-CS, with measures occurring continuously for 2 wk.

Results: Methane emission using GRP-CS (25.4-27.3 g/day or 38.2-39.9 g/kg DMI) was more than twice of that with IND-CS (10.6 g/day or 15.7 g/kg DMI). However, differences between methane estimated using GRP-CS with 3, 4, and 6 times of sampling per day were nonsignificant (i.e., 25.4 g/day or 38.2 g/kg dry matter intake [DMI] for G-3T, 27.3 g/day or 39.7 g/kg DMI for G-4T, and 26.5 g/day or 38.9 kg/DMI for G-6T). When the effect of week was considered, there were no differences between methane estimates in wk 1 and 2 (i.e., 22.7 g/day and 34.4 g/kg DMI vs. 22.6 g/day and 33.3 g/kg DMI). Animal visits for G-3T, G-4T, and G-6T were 2.1, 2.8 and 3.8 times a day, which significantly differed from each other. Visit length for G-3T and G-4T was the same but higher than for G-6T (i.e., 4.5 min/visit for G-3T and G-4T, and 4.1 min/visit for G-6T). When expressed as a percentage of expected visits, the difference was not significant (i.e. 68.4, 69.4 and 62.4% for G-3T, G-4T and G-6T, respectively). On the other hand, the number daily visits in wk 1 and 2 was not different (i.e., 2.8 and 2.9 visits/day for week 1 and 2, respectively).

Impact: The results indicate that at least 3 daily measurements occurring between 0600-0700, 1400-1500, and 2200-2300 h will facilitate accurate estimation of methane emission using GRP-CS in a confinement setting.

Tuskegee University

Performance of Lactating Does and Kids in Woodlands when Supplemented with Feedstuffs (Hay and Concentrates) or Pasture Grazing.

B. Shrestha, U. Karki, A. Tiwari, S.Chaudhary, and L. Karki (University of Maryland Eastern Shore)

Objectives: To evaluate the performance of lactating does and their kids stocked in woodlands with supplemental grazing or feedstuffs

Procedure: The study was conducted in six woodland plots and adjacent silvopasture plots were used for supplemental grazing. Seventeen lactating Kiko does with their kids (33) were divided into two groups. Each group was assigned to separate sets of woodland plots and rotated among those plots throughout the study period. One group was allowed to supplemental grazing in adjacent silvopasture plots for 3-4 hours daily and another group was supplemented with ad libitum hay and corn (0.5% of metabolic weight). Animal performance data (live weight, FAMACHA score, and body condition score (BCS)) were collected at the beginning after a 5-day-adjustment period, fortnightly during the study, and at the end. Data were analyzed using the GLM procedure in SAS 9.4.

Results: Does on supplemental grazing showed better FAMACHA score than those on supplemental feedstuffs. Interaction effect between group and measurement date occurred for BCS. Supplement type did not show effect on kid performance. However, gender effect was significant with male kids grown heavier than females.

Impact: Results showed that supplemental grazing on planted forages can replace the need for supplemental feedstuffs when goats raised on a grazing system require supplementation.

Comparative Performance of Meat Goats and Hair Sheep Raised in the Pasture-Based Production System

U. Karki, B. Shrestha, S. Chaudhary, A. Tiwari, J. Johnson, K. Norwood, and L. Karki (University of Maryland Eastern Shore)

Objectives: To evaluate the performance of meat goats and hair sheep raised under similar grazing and management conditions.

Procedure: Studies were conducted in 2020 and 2021 involving Kiko does (17) and Katahdin-St. Croix ewes (18). Animals were rotationally stocked in grazing plots without any feed supplement during the lush-forage production seasons and supplemented during the lean period of forage growth. Performance data (live weight, body condition score (BCS – 1-5: 1- very thin, 5 - obese), and FAMACHA (a 5-color chart used to monitor anemic condition in small ruminants caused by barber pole worm; score - 1-5: 1-2- not anemic, 5 - extremely anemic) were collected at the beginning, fortnightly during, and at the end of each study. Blood profile (37 parameters), fecal nutrients (N, P), and the infestation of gastrointestinal parasites were also evaluated in one of the studies. Data from each study were analyzed separately in SAS 9.4, with alpha value set at 0.05. Kiko does showed poorer BCS and FAMACHA score compared to ewes.

Results: Species difference occurred in about 75% of the blood parameters and in both fecal nutrients. Gastrointestinal parasite infestation was greater in does versus ewes.

Impact: Results show that hair sheep (Katahdin-St. Croix ewes) is more resilient and performs better than meat goats (Kiko ewes) under the pasture-based production system in the southeast USA.

Virginia State University

Meat quality of Barbados Blackbelly and St. Croix hair sheep lambs rendered short scrotum or castrated at weaning

J. Lee (Fort Valley State University), S. Wildeus, and D. O'Brien

Objectives: This study evaluated meat quality parameters of short scrotum and castrated Barbados Blackbelly (BB; n=16) and St. Croix (STX; n=15) hair sheep ram lambs.

Procedure: Ram lambs born in April (n=21) and December (n=10) were rendered short scrotum (SS; n=17) or castrated (CA; n=14) using elastrator bands at weaning (63 d). Following a transition period of 2 mo in a dry lot, ram lambs co-grazed with ewe lambs in a rotational pasture system and were provided soy hull at 3% BW daily. At target weights of app. 40 kg lambs were slaughtered and loin cuts from individual carcasses were collected for meat quality analysis. Data from the two lambing groups were pooled and data analyzed as a completely randomized design with a 2 x 2 factorial treatment arrangement for: breed (BB or STX) and sex class (SS or CA).

Results: The CIE L* (lightness), a* (redness), and b* (yellowness) values of loin cuts were not significantly influenced by breed and sex. The longissimus muscle (LM) in loin cuts from CA had a higher ($P < 0.0001$) fat content (3.73 vs 2.55 ± 0.155%) and tended ($P = 0.06$) to have a lower moisture content (69.63 vs 70.75 ± 0.413%) than that from SS lambs. Neither breed nor sex did not significantly affect the myoglobin content, percent metmyoglobin and thiobarbituric acid reactive substances (TBARS) values of LM from lamb cuts. Cuts from SS lambs had a higher ($P < 0.0001$) shear value (3.22 vs 2.64 ± 0.093 kg) than those from CA lambs. However, the cooking loss of loin cuts was not significantly influenced by breed or sex class. The fatty acid profiles of LM from experimental lambs were significantly influenced by breed and sex class. Compared with BB, STX had higher ($P < 0.05$) concentrations of myristic (C14:0, 1.38 vs 1.23%), palmitic (C16:0, 20.15 vs 18.98%) and oleic (C18:1n9, 45.01 vs 42.81%), but lower ($P < 0.05$) concentrations of stearic C18:0 (17.29 vs 19.33%) and linoleic (C18:2n6, 6.14 vs 7.47%) acids in LM fat. Furthermore, the LM fat from SS lambs had higher ($P < 0.05$) concentrations of Linoleic acid (C18:2n6, 8.09 vs 5.51%) and arachidonic (C20:4n6, 2.04 vs 1.40%), but lower ($P < 0.05$) concentrations of palmitic acid (C16:0 , 19.07 vs 20.06%) and Elaidic acid (C18:1n9 , 41.57 vs 46.24%) acids than that from CA.

Impact: Data suggest that meat quality parameters were more greatly influenced by sex class than breed when landrace hair sheep lambs were slaughtered at a target weight. Loin cuts from SS were leaner, but less tender than those of CA, and also differed in their fatty acid profiles. Hence meat quality will be impacted by the choice rendering male lambs sterile.

Objective III: Strategies for the improvement of small ruminant reproduction

Fort Valley State University

Effects of Dietary Supplementation with Lespedeza on the Semen Quality and Fertility of Male Goats.

R. Heikal, J. Hicks, B. Holmes, J. Brown, G. Dykes, L. Wartley, N. Mendez, A. Neha, A. Shaik, S. Chandan Chelkapally, D. Brown, J. Crumpler, N.C. Whitley, A. Pech-Cervantes, T. Reese, M. Woldemeskel, T.H. Terrill, A.R. Moawad

Objective: Infertility is a major cause of economic losses in livestock production systems and parasitic infections are a significant cause of infertility in small ruminants. Sericea lespedeza (SL; *Lespedeza cuneata)* is a potent anthelmintic in sheep and goats. Positive impacts of lespedeza on male fertility have been reported in rats and rabbits; however, no studies have been conducted on goats. Here, we investigated the effects of feeding male goats with SL or annual lespedeza (AL; Kummerowia stiulacea) on their semen quality and fertility.

Procedure: Forty-nine mature intact Spanish bucks were randomly assigned into three groups and fed diets of 60% hay and 40% concentrate in an 8-week pen study. The treatment hays were SL (n=16), AL (n=17), and bermudagrass (*Cynodon dactylon*) as a control (n=16). At the end of the trial, scrotum circumferences (SC) were measured and the animals were transported to a processing facility for slaughtering. Testicles and epididymides were collected after slaughter for measuring their weights and lengths. Epididymal spermatozoa were retrieved and evaluated for their motility, concentration, viability, abnormalities, and membrane integrities. Sections from testicles and epididymides were also prepared for histopathological examination.

Results: Results showed that SC was higher ($P \leq 0.05$) in SL than AL groups. Testicular and epididymal weights were comparable ($P > 0.05$) among the three groups. Sperm motility, concentration, viability, and membrane integrities were higher ($P \leq 0.05$) in SL compared with the AL and control groups. Sperm abnormalities were higher ($P \leq 0.05$) in control and AL groups than in the SL group. Histopathological examination revealed mild focally extensive seminiferous tubular degeneration and necrosis in AL group.

Impact: These results suggest that feeding of male goats on SL enhances their sperm quality and fertility parameters, but more research is needed to determine possible negative effects of AL.

Effects of dietary supplementation of peanut skins on sperm quality and fertility parameters of growing male sheep.

A. R. Moawad A , M. Osbie A , M. Xiaoling A , M. Singh A , B. Kouakou A , T. H. Terrill A and A. A. Pech-Cervantes

Objective: The peanut is a pivotal plant cultivated in different parts of the world. It possesses various beneficial nutrients such as fibres, proteins, vitamins, minerals, polyphenols, antioxidants, Co-enzyme Q10, and all 20 amino acids with the highest level of arginine. Arginine helps to strengthen the body's immune system, regulates hormones and blood sugar, and promotes male fertility. Peanut skins (PS) contain high levels of tannin, giving the skins the richest part of antioxidant components. However, little is known about the effects of PS on semen quality and fertility of males in animals and humans. Our hypothesis is that dietary supplementation of untreated (intact) PS can improve sperm quality and reproductive parameters compared with a diet supplemented with treated PS. Here, we evaluated the effects of dietary supplementation of PS with and without polyphenols on reproductive parameters, and semen quality of Florida Native sheep lambs.

Procedures: Thirty-three Florida Native lambs (33.5 ± 0.1 kg) were placed in individual pens and distributed in three groups with 11 lambs per group and assigned to three dietary treatments; namely, (1) Control diet plus 0% PS (control), (2) Diet containing 20% of intact PS with polyphenols (untreated PS), and (3) Diet containing 20% of treated PS without polyphenols (treated PS). Treatments were incorporated into the concentrate and all animals were fed with Bermuda grass hay. Animals received the experimental diets for 7 days of adaptation and 42 days of the experimental period. At the end of the trial, scrotum circumferences (SC) were measured, and the animals were transported to a processing facility for slaughter. Testicles and epididymides were collected after slaughter for measuring their weights and lengths. Epididymal spermatozoa were recovered and evaluated for their motility, concentration, viability, abnormalities, membrane integrities, and acrosome status (Ghallab et al. 2017 Cryobiology 79, 14–20). Data were analysed by one-way ANOVA followed by Tukey's test.

Results: The SC, testicles, epididymal weights and lengths, and sperm concentration were comparable ($P > 0.05$) among the three groups. Sperm motility, viability, membrane integrities, and the percentage of spermatozoa with intact acrosome were lower ($P \leq 0.05$) in treated PS compared with the untreated PS and control groups. Sperm abnormalities were higher ($P \leq 0.05$) in the treated PS than in the untreated PS and control groups.

Impact: These results suggest that feeding male sheep on untreated PS (with polyphenols) had improved sperm quality compared to those fed on treated PS (without polyphenols).

Impact of Feeding Male Goats with L-Carnitine on Viability of Their Semen Stored at 4 °C for 72 Hours.

Holmes, B., J. Brown, L. Hunter, J. Woodard, A. Johnson, S. Miller, B. Kouakou, A. R. Moawad.

Objective: Goats have the ability for genetic improvement. Artificial insemination (AI) is a significant technique used to increase genetic gain. Low fertility in goats with AI was attributed to semen quality, which can be affected by cooling/freezing procedures. Cooling of spermatozoa causes reduction in viability, and loss of fertility, mainly because of oxidative stress. L-carnitine (LC) is important for fatty acid metabolism and acts as antioxidant. Many studies have reported positive impact of LC on quality of cooled spermatozoa in different species; however, no research has been done on goats. Here, we investigated the impacts of dietary supplementation of LC on the quality of cooled goat semen.

Procedures: Six mature Alpine bucks were allocated into two groups; control (three bucks were fed a regular diet without LC supplementation), and treatment (three bucks were fed the normal diet plus 0.022 g/kg of BW, LC). Bucks were fed their respective diet for sixty days from January to March (non-breeding season). Semen was collected once/week and evaluated for color, consistency, volume and sperm concentrations. Diluted semen was then stored at 4 °C for 72 h. Sperm motility, viability, and membrane integrity were assessed at 0, 24, 48, and 72 h post-cooling.

Results: Results showed that colors of samples collected from the two groups were white to yellow, consistency ranged from watery to creamy, and sperm concentrations ranged from 8.1 to 12.2 x 109 sperm/ml. Sperm motility, viability and membrane integrity reduced ($P \leq 0.05$) in a time dependent manner in both groups. At 72 h, motility decreased by one-half as compared with 0 h (48.9% vs. 91.4% and 32.5% vs. 80.8%, in LC and control groups, respectively).

Impact: Under our experimental conditions, goat spermatozoa can be stored at 4°C for 72 h without severe loss in quality and additional costs of L-carnitine supplementation is not necessary.

North Carolina A&T State University

In Silico approaches to identify SNPS in Lectin galactoside-binding soluble (LGALS) genes encoding Galectins in goats

Md. R. Uzzaman, Z. Edea, R. Islam, K. Kim and M. Worku
(North Carolina A&T State University)

Objective: To identify LGALS Gene variants related to adaptation, resistance and resilience to diseases.

Procedure: An in Silico approach with Ensembl database (https://useast.ensembl.org/index.html) and SNP BeadChip (perfect matched reference SNP along with their genomic position) was utilized to identify LGALS SNPs. The minor allele frequency (MAF) of SNP was analyzed using plink software (Purcell et al. 2007). Data was used from goats sampled from five distinct Chinese goat breeds (Qinggeli=48, Nanjiang=48, Luoping=48, Liaoning=116, and Guangfeng=48). Nasal swabs were collected using Performagene LIVESTOCK's nasal swabs (DNA Genotek, Kanata, ON, Canada) kit. DNA was isolated following manufacturer's protocol. A total of 308 goats were genotyped with Illumina Goat 50K BeadChip for galectin SNPs.

Results: 1 LGALS SNP was identified on goat chromosome 18 (Table 1). The LGALS SNP was found at variable MAF level across the said goat breeds and diverse environments.

Impact: LGALS encode Galectins, an evolutionarily conserved family of glycan-binding proteins. These proteins play key roles in pregnancy and immunity to parasites. The identified SNP and observed variation in LGALS may have implications for animal health, adaptation and production.

Table 1. Minor allele frequency (MAF) of LGALS variants across five goat populations adapted to different ecological conditions.

Chr	Qinggeli (48)	Nanjiang (48)	Luoping (48)	Liaoning (116)	Guangfeng (48)
18	0.13	0.00	0.06	0.00	0.00

Prairie View A&M University

Incompetent Caprine Corpora Lutea: Abnormal Luteal Regression during Metestrus

W.B. Foxworth, A. Ho, S. Horner, I. Gilmore, K. Phillips, S. Lewis, G. Newton

Objectives: The two objectives of this project are: First, to identify indicators that differentiate does destined to have abnormal luteal regression (early embryonic loss) at an earlier stage by categorizing differences in circulating gonadotropin and steroid serum hormones and their metabolites during proestrus, estrus and metestrus; and categorizing differences in ovarian structures and angiogenesis during the proestrus and metestrus periods using high resolution (2D, 3D/4D) ultrasonography with real-time Doppler capabilities. Second, to identify and differentiate the protein profiles of does from normal day 5, day 17, and day 18 CL, and abnormal regressed day 5 CL, using high-throughput proteomics.

Procedure: Alpine does (n=26) were submitted to a 12-day Co-Synch + CIDR synchronization of estrus/ovulation protocol. Serum samples were collected daily for P_4 profile and metabolomics. P_4 levels were used to categorize the CL status (normal or abnormal) at Day 5. Serial color-Doppler ultrasound imaging was performed on each doe's ovaries from CIDR insertion to day 5, 17, or 18 of the estrous cycle. The recorded Cine loops (40 or 90 frames) were analyzed and scored for (CL) blood perfusion area. The reproductive tracts were aseptically collected on day 5, 17, or 18 to determine the number and type of ovarian structures, and to dissect CL from the ovary, determine size and weight, and prepare for downstream analyses. These include LC-MS/MS of collected CL for proteomics and histological analysis of collected CL.

Results: Initial differential analysis of the proteome between days 5, 17, and 18 of the normal and day 5 of the abnormal estrous cycle demonstrated different profiles of up and down regulated proteins. Four areas of biologic pathways that were highly effected were; programmed cell death (apoptosis and autophagy), cellular response to stimuli (response to stress and hypoxia), and immune system (both innate and adaptive immune systems).

Impact: This study demonstrates that the removal of active luteal tissue prior to CIDR removal is important in the goat. Adjusting the timing of the prostaglandin F2-alpha injection during the Co-Synch protocol to an earlier time point to remove the active CL is critical. This should reduce the CL failure rate during the estrus synchronization process.

Microbiome Research Program Development

G. Newton, W.B. Foxworth, A. Ho, S. Horner, I. Gilmore, K. Phillips

Objectives: The microbiome is a term for the 100 trillion microorganisms that live in the environment, including those that inhabit the bodies of mammals. Sometimes referred to as our 'second genome', commensal bacteria and their metabolites may impact animal health and disease in a variety of ways. Studies in the literature sugggest that, in the gut, commensal bacteria, epithelial cells, and innate immune cells interact to create a protective mechanism against infection caused by pathogenic bacteria Additional studies also suggest that the healthy upper female reproductive tract (UFRT), which was previously thought to be a sterile, harbors unique populations of bacteria in the absence of infection that are associated with diminished implantation rates and reduced pregnancy outcomes after in vitro fertilization. Furthermore, a unique low-abundance placental microbiome has been identified that may influence the subsequent health and wellbeing of the offspring. Our preliminary data, generated using 16s rRNA gene profiling, suggests that distinct bacterial community composition and structural differences exist between vaginal and uterine samples obtained on day three of the goat estrous cycle. Therefore, the role commensal bacteria play in reproductive tract function, especially during the earliest stages of pregnancy, is the focus of this investigation. Our goal is to determine if the UFRT contains a unique population of commensal bacteria that could influence uterine epithelial (UE) cell function and protects against invasion by pathogenic bacteria that may infiltrate the uterus during breeding. Specific objectives of this proposal are to: 1) Identify temporal changes in microbial communities in the UFRT during the estrous cycle and compare the microbial communities found in the UFRT during the estrous cycle with those found on equivalent days of early pregnancy, 2) Evaluate changes in the uterine luminal environment by measuring specific substances that can be attributed to known microbial communities metabolic reactions, 3) Assess the uterine environment and related changes in endometrial lymphocyte and macrophage populations during the estrous cycle and early pregnancy, and 4) Characterize the content of exosomes (potential mediators of the inflammation reaction) found in seminal plasma.

Procedure: Reproductive tracts were collected on Days 1 (n=3), 3 (n=5), 5 (n=5), 10 (n=4) and 16 or 17 (n=6) of the estrous cycle or on Days 1 (n=1), 3 (n=2) and 5 (n=1) after breeding. Vaginal swabs were taken prior to euthanasia. Tracts were transported to a laminar flow hood where endometrial swabs were collected from the ipsilateral horn under aseptic conditions. All swabs were sent to The Alkek Center for Metagenomics and Microbiome Research in the Molecular Virology and Microbiology Department, Baylor College of Medicine. All swabs were processed for 16s v4 rRNA gene profiling to detect bacteria in the uterus and vagina and to determine if the community composition and structure differed between vaginal and uterine samples. The contralateral uterine horns from all reproductive tracts collected were flushed with 10 mL of saline. Protein concentrations were determined, and proteins separated by SDS-PAGE. In addition, concentrations of fucose were measured in the uterine flushings. One cm cross-sections of the uterine horns were fixed immediately in 4% paraformaldehyde for 24 hours, rinsed with PBS, dehydrated using graded ethanol and xylene substitute immersions and embedded in paraffin wax. These tissues were submitted to immunohistochemistry to localize lymphocytes and macrophages.

Results: It was determined that of the sample types submitted, uterine body and horn "tissue" provided a greater diversity when compared to uterine body and horn "swabs." Analysis of all

65 samples collected yielded a total of 1,910,620 mapped reads. Mapped reads ranged from 0 - 14,568 for endometrial swabs and 10,581 - 67,298 for vaginal swabs. This indicates that a low abundance microbiome exists in the upper female reproductive tract. These initial results demonstrate that the microbiome community composition and structure differ between vaginal and uterine samples. Eight different phyla were identified, with Firmicutes (36% relative abundance), Proteobacteria (18% relative abundance), and Bacteroidetes (8% relative abundance) most abundant in both the upper and lower female reproductive tract. Preliminary analysis indicates that concentrations of fucose in uterine flushings are low, see table below, but measurable in 50% of samples.

Sample Types			**Protein Range (µg/ml)**			**Fucose Range (µg/ml)**		
Day of Cycle	Type	Number	Mean	Low	High	Mean	Low	High
1	Cyclic	5	300.2	46	895	0.0036	0.0000	0.0094
1	Bred	5	291.8	104	511	0.0009	0.0000	0.0024
3	Cyclic	5	40.8	12	71	0.0029	0.0000	0.0111
3	Bred	2	11.5	7	16	0.0070	0.0046	0.0094
5	Cyclic	4	39.25	9	62	0.0024	0.0000	0.0094
5	Synch	3	72.67	57	102	0.0126	0.0000	0.0377
5	Bred	5	243.8	15	500	0.0313	0.0000	0.0148
10	Cyclic	3	41	15	66	0.0065	0.0000	0.0114
10	Bred	2	212.5	199	226	0.0014	0.0010	0.0017
11	Cyclic	1	38	38	38	0.0000	0.0000	0
11	Bred	3	273.33	123	366	0.0010	0.0010	0.0010
16	Cyclic	3	45.33	35	63	0.0026	0.0000	0.0077
16	Preg	4	127	57	187	0.0010	0.0010	0.0010
17	Cyclic	3	53.33	19	85	0.0021	0.0000	0.0063
17	Preg	1	356	356	356	0.0017	0.0017	0.0017
18	Cyclic	2	62	36	88	0.0000	0.0000	0.0000

Impact: This study provides initial insights into the differential microbiome of the lower and upper caprine female reproductive tract and the quantification of fucose in the uterine horn ipsilateral to the corpus luteum.

Dietary supplementation with citrulline for increasing endogenous concentrations of arginine for superior reproductive and lactational performance in goats: An experimental model for all ruminant species

G. Wu, F. Bazer and W.B. Foxworth

Objectives: To use an innovative technology of dietary citrulline supplementation to enhance reproductive and lactational performance of meat and dairy goats in the research herds at Prairie View A&M University. The data from this study will provide strong proof of concept for application of this innovative technology to improve reproductive performance of beef cattle and sheep, as well as reproductive and lactational performance of dairy cattle.

Procedure: Experiment 1 will be conducted with pregnant meat goats at Prairie View A&M University. A total of 100 meat goats will be mated and assigned to be fed a diet that meets NRC requirements (N=50 goats) and supplemented with 1% citrulline or the same diet without supplemental citrulline (with alanine being the isonitrogenous control; N=50 goats). Treatments will begin on Day 12 of gestation and continue to Day 70 of gestation as this is the period of placental development that sets the stage for exponential growth of the fetus between Days 70 and term (about 150 days). The first 70 days of gestation are chosen for supplementation with citrulline because most pregnancy losses in goats occur during this period. For meat goats, we will collect blood samples via jugular vein venipuncture every 30 days to obtain plasma for assay of amino acids, ammonia, urea, glucose, ketone bodies, and lipids. Those measurements will allow determination of effects of dietary citrulline on concentrations of arginine and other amino acids beneficial to function of the mammary gland, as well as metabolic status of the lactating goats. At birth, the number of dead-born and live-born kids and their body weights will be recorded. Growth rates and pre-weaning mortality of kids will also be measured to determine if maternal nutrition affects growth performance of the kids raised under practical production conditions to market weight. Experiment 2 will be conducted with lactating dairy goats at Prairie View A&M University. A total of 60 lactating dairy goats will, between Days 1 and 100 of lactation, receive a diet that meets NRC requirements (N=30 goats) and supplemented with 1% citrulline or the same isonitrogenous diet without supplemental citrulline (with alanine being the isonitrogenous control; N=30 goats). Based on statistical power calculation, 30 lactating dairy goats will be used per group. The dose of 1% citrulline was chosen because it was found in our preliminary study to be effective in enhancing arginine availability and milk production in dairy cows (Table 1). For lactating dairy goats, blood samples will be collected every 30 days to obtain plasma for assay of amino acids, ammonia, urea, glucose, ketone bodies, and lipids. Those measurements will allow determination of effects of dietary citrulline on concentrations of arginine and other amino acids beneficial to function of the mammary gland, as well as metabolic status of the lactating goats. The other major outcome will be milk production measured on a daily basis and then used to compare lactation curves. We will assess effects of treatment on composition of milk collected on Day 10, 20, 40 and 50 of lactation to determine contents of fat, protein, casein, whey, lactose, calcium and phosphorous.

Results: The initial sampling for the meat goats has been completed and the kidding process is just begun.

Impact: This project will determine if a simple and effective method for producing and supplementing the diet of ruminant species of livestock with citrulline to reduce early pregnancy losses and increase reproductive efficiency and profitability in livestock enterprises involving ruminant species can be developed.

Tuskegee University

Effects of Low-Fat Distillers Dried Grains with Solubles Supplementation on Growth Performance, Rumen Fermentation, Blood Metabolites, and Carcass Characteristics of Kiko Crossbred Wether Goats

K.B. Ale, J. Scott, C. Okere, F.W. Abrahamsen, R. Gurung, and N.K. Gurung

Objectives: To determine the effect of LF-DDGS on growth performance, rumen fermentation, blood metabolites, and carcass characteristics in growing meat goats.

Procedure: Twenty-four goats, 5–6 months of age, were randomly assigned to one of the four experimental diets (n = 6/diet), 0%, 10%, 20%, and 30% LF-DDGS on an as-fed basis and fed for 84 days. Data were collected on growth performance, growth efficiency, rumen fermentation, blood metabolites, and carcass characteristics.

Results: The data collected were analyzed using an orthogonal contrast test for equally spaced treatments. The average total gains, average daily gains, and gain-to-feed ratios were similar among the treatments ($p > 0.05$). The rumen acetate, propionate, and butyrate concentrations and the acetate: propionate ratios were similar ($p > 0.05$) among the treatments. There were no differences ($p > 0.05$) among the treatments for the dressing percentage, rib eye area, and backfat thickness.

Impact: The results suggest that at least up to 30% LF-DDGS can be included in a male goat diet, completely replacing soybean meal and partly replacing corn without affecting the production performance and carcass characteristics.

University of Florida

Objective: The study aims for the project were to establish and define the reproductive seasonality of Florida Native Sheep (FNS) in both males and females as well as to determine the age to puberty in both males and females.

Procedure: The project was divided into 3 experiments: (1) Transition to cyclicity was characterized by measuring progesterone from weaning to the expected breeding season from serial blood collection from mature FNS ewes, (2) The effect of the season on seminal parameters, testosterone and scrotal circumference was evaluated from blood and semen samples collected monthly for a year from mature FNS rams, (3) Determine the breed’s age at puberty (males and females).

Results: Based on our preliminary analysis we observed that FNS are seasonal breeders (short day breeders) – late July/early August through December and this was representative in both rams and ewes, Florida native ewe lambs reached puberty at 7-8 months of age and ram lambs reach puberty at 7 months of age.

Impact: We are still lacking information on the seasonality of reproduction in Florida native sheep and this project aims to fill this gap. This project will provide information allowing farmers to manage reproduction more efficiently leading to healthier and more productive animals and subsequently improve the efficiency and profitability of the sheep industry.

Virginia State University

Impact of a suspected Cache Valley fever outbreak on lambing performance in a landrace hair sheep flock

S. Wildeus, D. O'Brien, K. Pelzer (Virginia Tech)

Objectives: Cache Valley Fever (CVF) is a mosquito-born, viral disease endemic to North America. While generally not associated with clinical symptoms in ewes, it affects fetal development during the first trimester of pregnancy resulting in malformations and pregnancy loss. .

Procedure: A suspected outbreak of CVF was recorded in a flock of Barbados Blackbelly and St. Croix hair sheep managed under an 8-mo, accelerated mating system with ewes bred in March, July and November. The outbreak was associated with a July breeding, in a summer with unusually high rainfall and standing water in pastures. There had been no previous occurrence of CVF or other abortion storms in the flock (20+ years). Lambing outcome associated with the suspected outbreak of CVF was compared with that of the three prior July matings (CON).

Results: Ewes (n = 32-35) were managed in a pasture-based system under rotational grazing. Ewes were mated in two single sire groups of 16 to 18 ewes to like-breed sires each breeding season. Pregnancy was determined by transrectal ultrasound at end and 21 d after the 25-d breeding season. Ewes lambed on pasture, and lambs were tagged and birth weights recorded within 24 h. Blood samples were collected from all ewes following the CVF lambing, and submitted for CVF antibody testing. All ewes showed CVF antibody titers. Pregnancy rate for the CVF lambing was not different from CON (85.7 vs. 89.8%; P=0.512), whereas lambing rate was lower in CVF for both ewes exposed (74.3 vs. 88.8%; P=0.039) and ewes lambing (86.7 vs. 98.9%; P=0.004). Incidence of stillborn and neonatal death of lambs was higher in CVF than CON (37.0 vs. 15.6%; P=0.002), as was the number of malformed lambs (13.0 vs. 0%; P<0.001). Malformed lambs were associated with breech presentations. Litter size was not different in the CVF lambing (1.77 vs. 1.86; P=0.471), but lamb birth weight tended to be lower (2.80 vs. 3.04 kg; P=0.055) while ewe postpartum weight was not different (45.3 vs. 47.0 kg; P=0.384).

Impact: The outbreak of CVF reduced the lambing rate, and increased the incidence of neonatal death and malformations. The outbreak occurred during a summer with unusually high rainfall, and maybe associated with changing weather patterns linked to climate change. Delaying summer breeding may be considered a mitigation strategy if feasible.

Growth, libido, semen quality, and reproductive organ weights of hair sheep rams rendered short-scrotum at birth or weaning

S. Wildeus and D. O'Brien

Objectives: Rendering male lambs short-scrotum interferes with testicular development and thermoregulation, and has been proposed as a management tool to control male reproduction. This study evaluated the effect of timing of the procedure (birth or weaning) on growth rate, testis size, libido, ejaculate characteristics and carcass traits in male landrace hair sheep lambs.

Procedure: April- (n=31) and August-born (n=23) Barbados Blackbelly (BB) and St. Croix (SC) male hair sheep lambs, balanced by breed and birth type, were rendered short-scrotum (SS) using elastrator bands at birth (B) or weaning (W), or left intact (I). Lambs were born on pasture, weaned at 9 weeks, transitioned in pens for two months post weaning, and then rotationally-grazed as a single group to a target weight of 40 kg. At 6-mo of age (peri-pubertal), and again at target weight (post-pubertal), mating behavior was recorded (day 1) and ejaculate samples collected (day 2). Mating behavior was recorded in a 10-min test with males individually exposed to estrus-induced ewes in a pen. An initial attempt was made to collect semen using an estrus-induced teaser ewe, and if not successful, the semen sample was collected by electro-ejaculation. At target weight lambs were harvested, scrotal content collected, and carcass characteristics (April cohort) determined. Data were analyzed in a model with sex class, breed and cohort as main effects.

Results: Pen and pasture ADG (142 and 129 g/d, respectively) and age at target weight (287 d) was not affected (P>0.1) by SS treatment. However, April-born lambs grew 19 g/d less (P<0.01) and reached target weight 40 d later (P<0.001) than August-born males. As for breed, STX had higher pasture ADG (139 vs 124 g/d; P<0.05) and reached target age 19 d earlier (P<0.05) than BB males. Libido (number of mounts and services) was not affected by SS treatment, breed or cohort. The frequency of ejaculates containing sperm was lower (P<0.001) in SS (26-33%) than I males (97%), and increased with age in SS but not I males. Sperm concentration and motile sperm in ejaculates were higher (P<0.05) in I than SS males. Testis and epididymis were larger (P<0.001) in I (300 and 44.3 g) than in B (134 and 20.0 g) and W (154 and 23.8 g), which were not different. Cohort and breed had no effect (P>0.1) on mating behavior, ejaculate characteristics, and organ weights.

Impact: Results suggest that SS and its timing had no effect on growth rate or on mating behavior. Though the procedure depressed the presence of sperm in the ejaculate and decreased testis weight, the suppression was not complete, and caution is warranted in utilizing the technique to facilitate co-grazing ewe lambs.

Objective IV: Disseminate research results and information to stakeholders

Fort Valley State University

Educational videos posted online.

N.C. Whitley, R. Edwards (FoxPipe Farm), T. Terrill, D. J. Obrien (Virginia State University)

Objective: The objective was to provide educational materials to producers and other ag professionals.

Procedure: Pre-recorded video views from the last year at the following website: https://www.youtube.com/@nikiwhitley981/videos were scanned for this report.

Results: Views for the last year (1/10/22 – 12/7/22):

- Sericea lespedeza growing/harvesting hay/weed control (three videos developed by FVSU over the past few years as part of a funded SARE project): 972 total views in the last year.
- Grazing away parasites - 104 views
- When Deworming is not Enough – 30 views
- Selecting Parasite Resistant Animals (D.J. O'Brien, VSU) – 31 views

Impact: With these videos, producers and other ag professionals can increase their knowledge of these topics to improve small ruminant farms/parasite control.

Online Livestock Integrated Parasite Management/FAMACHA© Training

N. C. Whitley, D.J. O'Brien (Virginia State University); Georgia Extension Agents

Objective: The objective was to train producers and other ag professionals in integrated gastrointestinal parasite control.

Procedure: Online training was offered via pre-recorded videos and links provided at www.wormx.info.

Results: Video has received over 621 views in the last year (1/10/22 – 10/7/22). See Virginia State University report for more information.

Impact: With this training, field staff and farmers are better able to understand how to manage GIN parasites in small ruminants.

ACSRPC publications/fact sheets

Objective: The objective was to provide information related to small ruminant parasite management to producers and other ag professionals, including Spanish-translated versions.

Procedure: Publications developed, reviewed, posted online

Results: See University of Maryland report or contact sschoen@umd.edu for more details.

Impact: With this information, field staff and farmers, including Spanish speakers, are better able to care for their animals

Langston University

Goat and Hair Sheep Field Day

T. Gipson and R. Merkel

Objective: The Goat and Hair Sheep Field Day is an annual producer-education event since 1986 and strives to equip small ruminant producers with the essential skills, knowledge, and abilities to profitably sustain their small ruminant operations. Feedback from participants is always solicited and the themes of future Goat and Hair Sheep Field Days change to reflect that input.

Procedure: The 36th Annual (2022) Goat and Hair Sheep Field Days and Conference was April 30, 2022. The theme was "Back to Basics - Innovative and Sustainable Managemen." The speakers and schedule are presented in the attached program.

Program

8:00 Registration

9:00 Call to Order
Dr. Terry Gipson, Acting Associate Extension Administrator
Langston University

9:05 Welcome to the Goat and Hair Sheep Field Day
Dr. Wesley Whittaker, Dean
Langston University

9:15 Overview of Research & Extension Activities
Dr. Arthur Goetsch, Acting Director, AIGR
Langston University

9:45 Morning Presentations

12:00 Lunch and Announcements
Tent

1:00 Afternoon Presentations

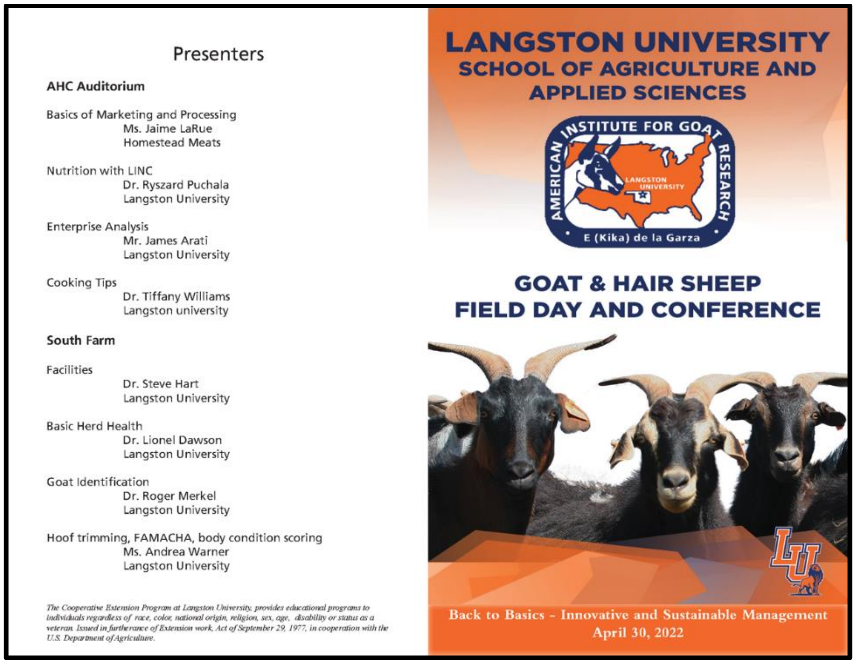
3:15 Follow-up session
Tent

4:15 Closing
Tent

4:30 Langston University's Goat Farm Tour
Tent

Group Schedule for Morning and Afternoon Presentations

Presentation	Location	9:45 – 10:15a	10:15 – 10:45a	10:45 – 11:15a	11:15: - 11:45a	Lunch	1:00 – 1:30p	1:30 – 2:00p	2:00 – 2:30p	2:30 – 3:00p
Basics of marketing and processing	AHC Auditorium	1, 2, 3, 4					5, 6, 7, 8			
Nutrition	AHC Auditorium	1, 2, 3, 4					5, 6, 7, 8			
Enterprise Analysis	AHC Auditorium	1, 2, 3, 4					5, 6, 7, 8			
Cooking Tips	AHC Auditorium	1, 2, 3, 4					5, 6, 7, 8			
Facilities	South Farm	5	6	7	8		1	2	3	4
Basic Herd Health	South Farm	6	7	8	5		2	3	4	1
Goat Identification	South Farm	7	8	5	6		3	4	1	2
Hoof trimming, FAMACHA, body condition scoring	South Farm	8	5	6	7		4	1	2	3


Presenters

AHC Auditorium

Basics of Marketing and Processing
Ms. Jaime LaRue
Homestead Meats

Nutrition with LINC
Dr. Ryszard Puchala
Langston University

Enterprise Analysis
Mr. James Arati
Langston University

Cooking Tips
Dr. Tiffany Williams
Langston university

South Farm

Facilities
Dr. Steve Hart
Langston University

Basic Herd Health
Dr. Lionel Dawson
Langston University

Goat Identification
Dr. Roger Merkel
Langston University

Hoof trimming, FAMACHA, body condition scoring
Ms. Andrea Warner
Langston University

The Cooperative Extension Program at Langston University, provides educational programs to individuals regardless of race, color, national origin, religion, sex, age, disability or status as a veteran. Issued in furtherance of Extension work, Act of September 29, 1977, in cooperation with the U.S. Department of Agriculture.

LANGSTON UNIVERSITY
SCHOOL OF AGRICULTURE AND APPLIED SCIENCES

AMERICAN INSTITUTE FOR GOAT RESEARCH
E (Kika) de la Garza

GOAT & HAIR SHEEP FIELD DAY AND CONFERENCE

Back to Basics - Innovative and Sustainable Management
April 30, 2022

Results:

2022 GOAT & HAIR SHEEP FIELD DAY AND CONFERENCE Evaluation Results

How would you rate the sessions, overall?

8 excellent
1 good
1 satisfactory
0 unsatisfactory

How would you rate the subject matter of the sessions?

9 very interesting and timely
1 of moderate interest
0 not interesting

How would you rate the speakers of the sessions?

10 very qualified
Comment: Maybe overqualified for us goat farmers
0 somewhat qualified
0 not qualified

Did the Goat and Hair Sheep Field Day meet your expectations?

9 YES 1 NO

Were your objectives for attending the Goat and Hair Sheep Field Day satisfied?

9 YES 1 NO

Please rate the following as to overall quality: (1=poor, 2=satisfactory, 3=good, 4=excellent)

Accommodations	**4**: 9, **3**: 0, **2**: 0, **1**: 1
Registration	**4**: 9, **3**: 0, **2**: 0, **1**: 1
Lunch	**4**: 7, **3**: 0, **2**: 0, **1**: 2

Was enough time given for discussion and networking?

9 YES 0 NO

What single aspect did you like about the Goat and Hair Sheep Field Day?

1. Lunch
2. Talk with Dr. Gibbs [Gipson] about an off topic of DHI
3. The speakers
4. Very hands-on activities
5. The hands-on activities
6. Learning about how many types of diseases goat & sheep can contact
7. I came specifically for nutrition portion. It was great!
8. I like the barn the best!
9. Glad to be back! I would like to be able to pick our own classes again. More hands-on experience. And more barn time. Thank you so much! I look forward to coming every year!

What did you dislike about the Goat and Hair Sheep Field Day?

1. Some speakers just showing computer use
2. Nothing
3. Nothing
4. The speaker [where] ruff with the goats
5. Would like proceedings
6. Not being able to pick our own classes
7. Nothing

Comments or suggestions for future Goat and Hair Sheep Field Days?

1. Back to old days.
2. Vegan meal options
3. Maybe more on hair sheep research and management

4. Keep me posted and maybe help with info about how to buy cattle

Impact: Small ruminant producers were educated in new and in established technologies for goat production. Only about 50% of registered participants attended the Zoom sessions and even though, those attending were repeatedly encouraged to complete evaluations, only about 25% did so.

Internal parasite workshop and FAMACHA training

S. Hart and T. Gipson

Objective: The Internal Parasite workshop and FAMACHA training is an annual producer-education event since 1990. The objective of the workshop is to educate small ruminant producers in sustainable internal parasite control. Feedback from participants is always solicited. In the early years, the workshop/training focused upon fecal egg counts (FEC) as the instrument for assessing parasite burden; however, in recent years, the workshop has emphasized the use of FAMACHA. Participants are exposed to FEC but not provided experiential learning as in past workshops.

Procedure: In 2022, an in-person workshop was held on June 2. The program for the workshop was:

Time*	Topic
9:00-10:00	Primer on Parasites
10:00-10:15	Questions and break
10:15-11:00	Dewormer and Dewormer Resistance
11:00-11:15	FAMACHA training (video)
11:15-11:30	FAMACHA practice and fecal sample
11:30-12:00	Quiz (FAMACHA card and certificate)
12:00-1:30	Lunch break
1:30-2:15	Doing your own fecal egg count

*Central Daylight Time

Four goats were used for the FAMACHA training session. A tablet equipped with Zoom provided the video/audio feed for the live animal FAMACHA training and for the laboratory session for FEC.

Results: Four persons registered for the in-person workshop. All four took and passed the required quiz, and submitted the required video of COVER, PUSH, PULL, POP (30 sec max). Thus, all four participants received certificates and purchased FAMACHA cards.

Impact: Small ruminant producers were educated in sustainable internal parasite control, which should reduce the reliance upon anthelmintics.

> Thanks again for volunteering your Saturday to put on this training. What we've learned at the training confirmed two of our goats we've been watching (but not yet wormed) are in need of worming and we're in the process of scoring the rest of our little herd. Have been internet shopping for a microscope and should have our fecal egg counting up and going in a couple of weeks.
>
> - *D. Miller, 2022 workshop participant*

Online meat and dairy goat certification courses

R. Merkel, and T. Gipson

Objective: Many goat producers obtain information from the World Wide Web. While proper, science-based information does exist on the internet, producers with little to no livestock experience have no background to discern "good" versus "bad" information. Langston University led a consortium of fellow universities and goat associations to develop an authenticated, science-based online presence. The objectives of this program are 1) to provide reliable educational information incorporating a Quality Assurance Program that is suitable for dairy and meat goat producers, county agents, and other agriculture professionals and 2) to provide testing methodologies allowing for certification of dairy and meat goat production for those producers desiring certification.

Procedure: The online certification site (http://certification.goats.langston.edu) has training modules for a dairy goat track and a meat goat track. To qualify for Dairy Goat Producer Certification, a participant must successfully complete 18 core modules and 7 of 10 elective modules. To qualify for Meat Goat Producer Certification, a participant must successfully complete 21 core modules and 9 of 12 elective modules. In both tracks, participants are required to take a pre-test before accessing module contents. Participants have one attempt at the pre-test and then later an unlimited number of attempts to take the post-test. Participants cannot access the module contents before taking the pre-test. The objective of the pre-test is to measure participant's knowledge before reading module content and the objective of the post-test is to measure knowledge after reading module content. The difference between the post and pre-tests is an indication of knowledge transfer.

In 2020, Spanish versions of the certification courses were added. Further, the English and Spanish courses were loaded onto small, handheld computers called Raspberry Pi for use by producers who have limited or no internet access. A limited number of these computers were given to persons in Oklahoma and Puerto Rico to test the system before more widespread distribution in 2021.

Results: To date, 1,015 and 2,512 participants have enrolled in the Meat Goat and Dairy Goat certification course (English), respectively, and 57 and 161 participants have enrolled in the Meat Goat and Dairy Goat certification course (Spanish), respectively. The number of participants completing and receiving certification for the Meat Goat course is 487 and 14 and for the Dairy Goat course is 194 and 41 for the English and Spanish versions, respectively. Certified participants represent 49 US states, Puerto Rico, and 18 countries.

Overall pretest scores for required and elective modules averaged approximately 71%; thus, most producers were required to study module content and take the post-test (Table 1). Post-test scores are roughly 25% higher than pre-test scores, indicating a gain in knowledge by the producer.

Table 1. Pre- and post-test scores by course and requirement.

	Dairy		Meat	
	pre	**post**	**pre**	**post**
Required	68.2 ± 0.59	96.3 ± 0.17	76.4 ± 0.69	97.2 ± 0.21
Elective	71.1 ± 0.64	97.5 ± 0.19	70.1 ± 0.75	97.8 ± 0.22

Impact: Some small ruminant producers may not have extensive livestock production experience. These certification courses are a trusted source of science-based goat production information. The online availability of these resources allows producers to access and find needed information, using it to enhance farm productivity and income and to safeguard the health and welfare of their animals.

Artificial insemination workshop

T. Gipson and L. Hutchens (Reproductive Enterprise, Inc.)

Objective: Many goat producers believe that artificial insemination (AI) will increase the rate of genetic progress in their herds but feel that they lack the knowledge, skills and abilities necessary to use artificial insemination.

Procedure: The morning session of the workshop on Artificial Insemination was held in the multimedia room of the Agricultural Research, Extension and Education complex on the Langston University campus. The hands-on afternoon session was held at the Small Ruminant Education, Research, and Extension Facility at the South Farm. In the morning session, a presentation on basic anatomy and physiology of female reproduction and a presentation on the small ruminant reproduction emphasizing estrus detection and estrus synchronization. Hand-on activities included examination of harvested female reproductive tracts AI kit contents, and semen tanks and semen handling. A practical hands-on insemination of live animals concluded the workshop.

Results: Four participants registered for the in-person workshop (full-day) and nine participants registered for the Zoom workshop (morning).

Impact: The artificial insemination workshop provided practical knowledge, skills and abilities necessary producers to immediately use artificial insemination in their herds.

American Institute for Goat Research website

T. Gipson, and R. Merkel

Objective: Many goat producers look to the Internet for information. While proper, scientifically-based information does exist on the Internet, producers with little to no livestock experience have no background to discern “good” versus “bad” information. Many producers have turned to the Langston University website for unbiased, research-based information.

Procedure: In 2015, the American Institute for Goat Research unveiled a Drupal server to meet branding requirements of Langston University. Tracking code for Google Analytics, which is the enterprise-class web analytics package that evaluates website traffic, was enabled for the site and merit review was based upon pageviews and bounce rate from Google Analytics.

Results: Overall in 2022, there were 101,459 visits (down 20% from 2021). This decrease is attributed to server downtime from January 31 to February 29, 2022 (8 days), June 29, 2022 (1 day), September 3 to September 8, 2022 (6 days), and December 13 to December 14, 2022 (2 days) for a total of 17 days (5% of the year). American Institute for Goat Research (AIGR) has a stand-alone server, but the URL is dependent on the university’s internal DNS. All instances were due to power failures that cause the server to improperly reboot and had to be manually rebooted. Visitors spent an average 1 minutes and 01 seconds, which is down slightly from 2022 (1 minutes, 17 seconds). The United States accounted for 42% of all users. The top 25 countries (users) are listed in Table 1.

Table 1. Number of visits by country.

Country	Users	Sessions	Pages / Session	Avg. Session Duration (min)	Bounce Rate
United States	45,354	53,617	1.52	65.69	81.00%
Philippines	8,153	9,977	1.34	84.23	81.90%
India	7,045	8,100	1.27	51.76	84.77%
Nigeria	5,043	5,656	1.36	74.53	81.29%
South Africa	3,012	3,542	1.39	70.53	82.61%
Kenya	2,784	3,177	1.40	75.08	81.49%
Canada	2,314	2,656	1.50	54.17	82.72%
Ethiopia	1,989	2,438	1.43	95.62	78.42%
Pakistan	1,900	2,414	1.58	97.39	76.43%
United Kingdom	1,816	2,007	1.28	44.68	86.50%
Australia	1,662	1,889	1.42	53.89	87.51%
Uganda	1,472	1,679	1.27	79.91	83.26%
China	1,147	1,220	1.44	48.99	91.97%
Zimbabwe	1,040	1,255	1.38	79.76	81.20%
Malaysia	982	1,303	1.33	71.00	83.65%
Indonesia	913	1,100	1.42	78.08	83.36%
Ghana	909	1,041	1.29	55.46	83.57%
Zambia	850	1,042	1.31	93.20	79.85%
Bangladesh	825	1,002	1.45	74.19	79.44%
Nepal	760	905	1.41	62.51	82.98%
Tanzania	717	812	1.39	72.85	82.27%

Country	Users	Sessions	Pages / Session	Avg. Session Duration (min)	Bounce Rate
Sri Lanka	584	726	1.33	71.78	81.68%
Botswana	556	704	1.35	75.19	83.52%
Netherlands	465	563	1.40	52.64	82.77%
New Zealand	458	511	1.30	54.09	86.11%

Every state in the union including the District of Columbia visited the web site with Texas accounting for the most users. Individual states are listed in Table 2.

Table 2. Number of visits by state for the overall web site.

Country	Users	Sessions	Pages / Session	Avg. Session Duration (min)	Bounce Rate
Texas	5,274	5,956	1.47	62.48	81.26%
Washington	4,511	5,099	1.38	51.65	83.84%
California	3,014	3,459	1.51	80.79	82.83%
Virginia	2,028	2,189	1.30	39.79	86.52%
(not set)	1,977	2,065	1.19	28.48	91.77%
North Carolina	1,703	1,964	1.44	67.21	82.74%
New York	1,643	1,822	1.39	57.47	82.66%
Florida	1,624	1,893	1.85	86.70	78.24%
Illinois	1,538	1,736	1.47	54.63	81.80%
Oklahoma	1,530	2,255	2.47	139.65	55.12%
Minnesota	1,480	1,703	1.40	49.30	83.97%
Georgia	1,275	1,416	1.50	63.98	80.86%
Ohio	1,217	1,392	1.49	61.62	82.04%
Tennessee	1,205	1,424	1.42	58.26	83.36%
Pennsylvania	1,078	1,252	1.37	64.95	82.19%
Missouri	1,061	1,312	1.80	87.82	76.83%
Colorado	928	1,058	1.49	58.77	82.04%
Wisconsin	889	988	1.50	70.17	81.07%
Indiana	871	1,015	1.59	64.67	79.31%
Kansas	831	942	1.78	83.05	77.92%
Michigan	830	924	1.55	70.64	79.76%
Oregon	773	863	1.45	46.23	82.85%
Alabama	645	751	1.41	49.89	83.62%
District of Columbia	623	714	1.46	51.58	83.47%
Arizona	591	698	1.42	57.63	77.79%
Iowa	584	663	1.41	55.05	82.35%
Kentucky	549	590	1.42	38.01	79.15%

Country	Users	Sessions	Pages / Session	Avg. Session Duration (min)	Bounce Rate
Arkansas	484	572	1.67	69.57	78.67%
Massachusetts	473	519	1.32	44.59	87.09%
Nebraska	411	509	2.07	104.94	70.53%
Maryland	406	476	1.42	52.33	82.98%
South Dakota	405	447	1.72	44.51	80.54%
Utah	400	456	1.31	62.64	82.89%
Connecticut	378	477	2.31	221.58	74.00%
New Jersey	356	394	1.30	39.20	84.26%
South Carolina	352	392	1.51	65.66	82.91%
Louisiana	340	399	1.50	55.13	80.45%
Mississippi	304	354	1.90	82.49	79.10%
Idaho	301	365	1.55	55.19	83.01%
West Virginia	258	277	1.34	41.97	83.75%
Maine	192	223	1.49	91.02	79.37%
New Mexico	185	214	1.40	62.53	84.11%
Wyoming	177	212	1.51	94.09	76.42%
Montana	169	205	1.60	48.72	79.51%
Nevada	167	188	1.58	92.61	76.06%
New Hampshire	144	169	1.38	82.24	82.84%
Hawaii	125	146	1.26	46.66	80.82%
North Dakota	119	160	1.44	96.71	78.75%
Vermont	119	135	1.37	70.15	77.78%
Delaware	61	71	1.30	42.46	83.10%
Alaska	60	72	1.50	78.79	75.00%
Rhode Island	39	42	1.21	45.69	90.48%

The trend toward mobile devices (smart phone) is also observed with visits to the website (Table 3). Over a 6-year period, mobile visits have increased greatly. Desktop visits accounted for the majority in the early years but have been declining, percentagewise.

Table 3. Number of visits by device for the overall website.

Device Category	2022	2021	2020	2019	2018	2017
mobile	63,118	80,066	48,030	56,105	29,989	12,032
desktop	38,704	48,092	32,016	40,519	29,244	14,060
tablet	1,612	2,253	1,835	3,866	3,202	1,434

The vast majority of users enter the web site via a search engine such as Google, Bing, DuckDuckGo, etc., as can be seen in Table 4. The second major avenue is bookmarked entry, followed by linked referrals from other web sites, and then links embedded in the AIGR

Facebook page. As expected with the majority of visit coming from outside of the U.S. and the predominance of mobile device, Android accounts for the operating system with the largest number of visits (Table 5).

Table 4. Number of visits by entry for the overall website.

Origin	Users	Sessions	Pages / Session	Avg. Session Duration	Bounce Rate
Search Engine	72,666	85,736	1.43	69.31	82.29%
Bookmarked	29,030	32,901	1.46	67.70	80.75%
Linked Referral	1,271	1,853	2.19	128.14	61.85%
Social Media	1,221	1,393	1.64	71.40	73.94%

Table 5. Number of visits by Operating System for the overall website.

Operating System	2022	2021	2020	2019
Android	40,423	53,806	30,982	36,946
Windows	27,630	36,145	24,071	31,389
iOS	23,355	27,462	17,689	21,936
Macintosh	6,976	8,249	5,627	6,009
Chrome OS	2,208	2,183	1,423	2,240
(not set)	1,294	1,594	877	916
Linux	1,170	973	692	784
OS/2	11	36		
Tizen	9	20	17	39
BlackBerry	4	9	10	27
Windows Phone	0	0	6	44

Impact: Delivering science-based information to goat producers is a top priority for land-grant universities and the preferred delivery system has been a presence on the Internet. An informative website is available 24/7 from anywhere in the world. Mobile devices, especially those using the Android operating system, are increasing in popularity and have become the preferred device for accessing the Internet. University web developers must keep the mobile user in mind when developing web sites.

North Carolina A&T University

Presentations:

Oral Presentations to Small Farms Week virtual workshop
Title: Small Ruminant Production Basics and our current research
Tuesday, March 22nd, 2022, 9:00am-10:00am virtual presentation.
Mulumebet Worku

Oral Presentations to National conference on Next -generation Sustainable Technologies for Small-scale Producers was held on Thursday, September 8, 2022. North Carolina A&T State University, Greensboro, NC.
Title: Evaluation of Garlic Extracts for Sustainable Meat Goat Production.
Authors: Sowmya Jagana, Sreenavya Inupala, Priyanka Pande, Md. Rasel Uzzaman, Mulumebet Worku.

Poster Presentations to ASAS-CSAS Annual Meeting, Jun 26-30, 2022, Oklahoma.
Title: Analysis of Galectin Gene Variants from Diverse Sheep and Goat Populations Genotyped with the Illumina Beadchip
Authors: Uzzman, M.R., Edea, Z., Islam, R., Kim, K. S., Worku, M. (2022, Jun 26-30).

Poster presentation Next-generation Sustainable Technologies for Small-scale Producers. NC A&T State University, NC, USA.
Title: Identification of single nucleotide polymorphisms for small ruminants' health and adaptation.
Authors: Uzzman, M.R., Edea, Z., Islam, R., Kim, K. S., Worku, M. (2022, September 7-9).

Poster Presentations to the 10th Annual CAES Student Showcase of Excellence was held on Sept 8, 2021. North Carolina A&T State University, Greensboro, NC.
Title: Effect of Garlic Barrier on Fecal Egg Count and Protein Secretion in Goats.
Author(s): Sowmya Jagana, SreeNavya Inupala, Priyanka Pande, Md. Rasel Uzzaman and Mulumebet Worku.

Poster Presentations to ASAS-CSAS Annual Meeting, Jun 26-30, 2022, Oklahoma.
Title: Effect of Garlic Barrier on Fecal Egg Count and Protein Secretion in Goats.
Author(s): Sowmya Jagana, SreeNavya Inupala, Priyanka Pande, Md. Rasel Uzzaman and Mulumebet Worku.

Prairie View A&M University

4th Texas Hispanic Farmer & Rancher Conference

R. Zamora, J. Ozuna, A. Pellerin

Objectives: Provide workshop opportunities for small ruminant producers and industry stakeholders.

Procedure: A virtual conference was conducted. The following major topics were presented and discussed as a part of the conference. Ashley Pellerin, Extension Specialist at Prairie View A&M University spoke concerning Goat Production & Marketing:

- USDA Programs for Producers
- Goat Production & Marketing
- Crop Insurance

- 2022 Ag Census
- Sustainable Production Methods
- Soil Health
- Farmer Mental Health & Risk Management
- Managing Herd Health

Results: Participants of various skill levels and industry focuses were present (n= 106).

Impact: Post event survey indicated: 57% did not know there were USDA programs to help with heir's property, sustainable production, cooperative and marketing. 100% gained knowledge in these areas. Post event survey indicated: 81% will make beneficial production and marketing changes to their operation as a result of attending this conference.

Small Ruminant Workshop – Willacy Co., TX

R. Zamora, J. Ozuna

Objectives: Provide workshop opportunities for small ruminant producers and stakeholders.

Procedure: A educational workshop was conducted with the following major topic presented and discussed by Rolando Zamora and Joseph Ozuna, PVAMU County Extension Agents in the Rio Grande Valley region:

- Developing a Small Ruminant Cooperative in the Rio Grande Valley (RGV)
- Recordkeeping & Business Planning

Results: Participants of various skill levels and industry focuses were present (n= 45).

Impact: Of the survey responses obtained, 100% of respondents indicated increased knowledge gain after attending the program. Overall, feedback from participants was positive.

Quad Counties Small Ruminant Workshop

A. Pellerin, S. Horner, S. Brod (Texas A&M AgriLife Extension), K. Davis (Texas A&M AgriLife Extension), C. Zoeller (Texas A&M AgriLife Extension), J. Humphrey (Texas A&M AgriLife Extension)

Objectives: Provide workshop opportunities for small ruminant producers and industry stakeholders.

Procedure: An educational workshop was conducted with the following major topic presented and discussed by speakers Scott Horner and Ashley Pellerin:

- Biosecurity & Farm Safety
- FAMACHA
- Parasite Management in Goats

Results: Participants of various skill levels and industry focuses were present (n= 17).

Impact: Of the survey responses obtained, 93% of respondents indicated increase in knowledge gain after attending the program and 93% indicated that this program will potentially save them between $100-1,000 annually. Overall, feedback from participants was positive.

Increasing Small Ruminant Production Workshop

R. Zamora, J. Ozuna, A. Pellerin, W.B. Foxworth, and L. Kinman

Objectives: Provide workshop opportunities for small ruminant producers and stakeholders.

Procedure: An educational workshop was conducted by Rolando Zamora (Willacy Co. agent) and Joseph Ozuna (Starr Co. Agent). Speakers were Ashley Pellerin, Dr. William Foxworth, & Dr. Leah Ann Kinman:

- Parasite Control for Goats
- Meat Goat Processing
- Selecting the best breed for meat goat production

Results: Participants of various skill levels and industry focuses were present (n= 48).

Impact: Of the survey responses obtained, 93% of respondents indicated increased knowledge gain after attending the program and 81% indicated that this program will increase their participation in more federal, state, and local programs. Overall, feedback from participants was positive.

Goat Judging Workshop & Contest

S. Horner, W.B. Foxworth, and A. Pellerin

Objectives: Provide educational workshop & practice contest for show Goat owners & producers.

Procedure: An educational workshop & practice contest was conducted for youth and adults.

- Goat Judging Strategies & Techniques

Results: Participants of various skill levels and industry focuses were present (n= 48).

Impact: Overall, feedback from participants was positive.

Small Ruminant Production & Water Resource Management (Virtual)

B. Hawkins

Objectives: Provide workshop opportunities for small ruminant producers and stakeholders.

Procedure: A virtual educational workshop was conducted with the following major topic presented and discussed by Asha Tillman (National Center of Appropriate Technology) & Brandon Hawkins (PVAMU Extension Agent for Bowie Co.):

- Common Parasites in Goats
- Goat Management Practices
- General Pond Management

Results: Participants of various skill levels and industry focuses were present (n= 18).

Impact: Of the survey responses obtained, 100% of respondents indicated increased knowledge gain and 87% of respondents reported that this program would may increase their participation in more federal, state, and local programs.

Agroforestry and Sivopasture Educational Program

B. Hawkins, A. Pellerin, and E. Washington

Objectives: Provide workshop opportunities for small ruminant producers and stakeholders in North East Texas (Bowie Co., TX).

Procedure: An in person educational workshop was conducted with the following major topic presented and discussed:

- Managing Livestock on Silvopasture Systems
- Timber Management for Silvopasture Systems

Results: Participants of various skill levels and industry focuses were present (n= 10).

Impact: Of the survey responses obtained, 100% of respondents indicated increased knowledge gain and indicated that information presented in this program will increase their participation in more federal, state, and local programs. Overall, feedback from participants was positive.

PVAMU Goat AI Clinic

W.B. Foxworth, S. Horner, and A. Pellerin

Objectives: Provided and in-person workshop opportunity for goat producers on proper techniques for Goat Artificial Insemination

Procedure: An in person educational workshop was conducted with the following major topic presented :

- Artificial Insemination- Technical Lecture
- Hands-on Demonstration/ Class Participation

Results: Participants of various skill levels and industry focuses were present (n= 12).

Impact: Of the survey responses obtained, 100% of respondents indicated increased knowledge gain. Respondents also indicated that this program will potentially save them up to $5,000. Overall, feedback from participants was overwhelmingly positive.

Increasing Small Ruminant Production Workshop- Virtual

S.Horner, W.B. Foxworth, C. Hicks and R. Redden (Texas A&M AgriLife)

Objectives: Provide workshop opportunities for small ruminant producers and industry stakeholders.

Procedure: A virtual program was conducted. The following major topics were presented and discussed by PVAMU International Goat Research Center Researchers, William Foxworth & Scott Horner along with Texas A&M AgriLife Small Ruminant Specialist, Reid Redden:

- Goat Market Update
- Nutrition Requirements for Pregnancy Maintenance
- Research Update from the IGRC

Results: Participants of various skill levels and industry focuses were present (n=26).

Impact: Of the survey responses obtained, 97% of survey respondents stated that they were satisfies with the workshop as a whole.

Small Ruminant Production & Water Resource Management (Virtual)

P. Agboola, A. Pellerin, and B. Costanzo (Texas A&M AgriLife Extension Service)

Objectives: Provide workshop opportunities for small ruminant producers and stakeholders.

Procedure: A virtual educational workshop was conducted with the following major topic presented and discussed by Ashley Pellerin (PVAMU Extension Program Specialist) & Bill Costanzo (Texas A&M AgriLife Livestock Guardian Dog Specialist):

- Getting Started with Goats on Small Acreage
- Predator Control for Small Ruminant Producers

Results: Participants of various skill levels and industry focuses were present (n= 16).

Impact: Of the survey responses obtained, 87% of respondents indicated increased knowledge gain and 87% of respondents reported that this program would may increase their participation in more federal, state, and local programs.

Getting Started in Sheep and Goat Production in South Central Texas

S. Harrington, L. Kinman, and A. Pellerin

Objectives: Provide workshop opportunities for small ruminant producers and stakeholders.

Procedure: A in-person educational workshop was conducted with the following major topic presented and discussed by Lea Ann Kinman (PVAMU Meat Lab Director) , Ashley Pellerin (Extension Program Specialist) and John Calentine (Federal Trapper w/ USDA APHIS):

- Meat Goat and Lamb Processing
- Getting started with Sheep and Goats on Small Acreage
- Predator Control for Small Ruminants

Results: Participants of various skill levels and industry focuses were present (n= 8).

Impact: Of the survey responses obtained, 100% of respondents indicated increased knowledge gain.

Tuskegee University

Development of Training Handbook on the Integrated Approach for Preventing Diseases and Parasites in Small Ruminants in the Southeast USA

U. Karki, N. Whitley (Fort Valley State University), J. Burke (USDA-ERS), L. Karki (University of Maryland Eastern Shore), S. Hart (Langston University), and S. Kerr (Washington State University)

Objectives: To develop training curricula on the integrated approach for preventing diseases and parasites in small ruminants

Procedure: Chapter(s) was/were allocated to each author based on her/his expertise. Chapter outlines were developed for each chapter by the relevant author and content following the outline developed. The draft of each chapter was reviewed by at least two experts from within the handbook team and outside. Authors revised the chapters based on the review comments. Revised chapters were edited, compiled, formatted, and printed for the training. Language editing and indexing are going on for finalizing the handbook and publication. The Handbook contains nine chapters.

Results: Draft handbook printed and used for conducting Trainers' Training on the Integrated Approach for Preventing Diseases and Parasites in Small Ruminants in the Southeast USA

Impact: The training handbook served as a timely educational material for the trainers and trainees. It is expected to serve as a valuable training and educational resource for all educators working with the small-ruminant producers in the Southeast USA. Additionally, this handbook serves a great resource to all small-ruminant producers who are eager to learn on their own and apply in their animal production to improve animal health and wellbeing.

Trainers' Training on the Integrated Approach for Preventing Diseases and Parasites in Small Ruminants in the Southeast USA

U. Karki, N. Whitley, J. Burke, L. Karki, S. Hart, S. Kerr, and N. Gurung

Objectives: To conduct curricula-based, hands-on training and demonstrations for Extension educators and lead producers on the integrated approach for preventing diseases and parasites in small ruminants.

Procedure: A 3-day training conducted at the Tuskegee University Caprine Research and Education Unit (CREU) from November 9 to 11, 2022. Small-ruminant Extension educators working with various institutions in the southeast USA were invited to participate in the training. Similarly, lead small-ruminant producers from Alabama were invited to the training. All presentations were in-person, but one, which was virtual. Hand-on activities, demonstrations, and site tours were conducted using CREU indoor facilities and Atkins Agroforestry Research and Demonstration Site. The

Results: Twelve educators and professionals from Alabama, Georgia, Mississippi, and North Carolina attended the training. Similarly, six small-ruminant producers and four graduate students participated in the training. Experts from Fort Valley State University, Langston

University, Washington State University, University of Maryland Eastern Shore, USDA-ERS (Dale Bumpers Small Farms Research Center, Booneville, AR), and Tuskegee University served as trainers. Training curricula were based on the content of the Training Handbook: Integrated Approach for Preventing Diseases and Parasites in Small Ruminants in the Southeast USA. The draft Training Handbook was included in the package of training materials prepared for the participants (the handbook is being finalized and will be distributed to the participants and others relevant stakeholders when ready).

Impact: Participants expressed that the training and the training materials including the Training Handbook were very useful to them for improving the Extension education (educators) and small-ruminant health (producers). Follow-up impact study will be conducted later in 2023.

Tuskegee University 2022 Annual Goat Day

N. Gurung

Objectives: To educate participants on the buck selection principle for limited- Resources Meat Goat Producers.

Procedure: The event was held in person on Saturday, April 23, 2022, from 8:30 am -3:30 pm. The theme of Goat day was usually designed to focus on the ongoing problems of the producers and covers subjects ranging from nutrition, reproduction, and health, to marketing and enterprise budgeting. The featured speakers included Dr. Chuck Okere. He serves as an interim Head of the Department of Agricultural and Environmental Sciences at the College of Agriculture, Environment, and Nutrition Sciences at Tuskegee University. Henry Dorough, and Richard Petcher were our other noted speakers. Mr. Henry Dorough, CCA, PAS spoke on “Regenerative Agriculture: Re-Introducing Our Grandfather’s Farming Lessons.” Mr. Dorough is the County Extension Coordinator in Talladega County for the Alabama Cooperative Extension System, Auburn University. Mr. Richard Petcher shared producers’ perspectives on forage/pasture production for small ruminants. He owns Petcher Seeds in Fruitdale, Alabama and specializes in cover crops for soil improvement. These speakers have many years of experience in their respective fields of expertise. Further, Dr. Gurung, Director of the TU Caprine Research and Education Unit, provided an update on the status of goat research and extension/outreach activities at the unit. Dr. Clarissa Harris of the Caprine Research and Education Unit moderated a roundtable discussion that featured sustainable goat production practices, challenges, and opportunities in meat goat production. The afternoon sessions are hands-on sessions where producers learned how to evaluate an animal, did fecal egg counts and pasture management, etc.

Results: There were 90 participants. The survey result showed that over 95% of participants would recommend the continuity of the event.

Impact: The program provided goat producers, agricultural professionals, students, researchers, and other stakeholders with increased knowledge and awareness of buck selection.

University of Florida

Small Ruminant Short Course (September 16-17, 2022)

Objective: Small ruminant short course was aimed at bringing researchers, extension agents, industry professionals, and small ruminant producers on one platform for sharing information and resources, helping producers to improve the management and productivity of their operations.

Method: The event was a collaboration among UF/IFAS Extension, the UF College of Veterinary Medicine, the UF/IFAS Agronomy Department, and the UF/IFAS Department of Animal Sciences. We welcomed producers, extension specialists and agents, researchers, students, and allied industry members to attend the in-person, educational event. The program included lectures and demonstrations on parasite control, herd health, marketing, management, and more. Susan Schoenian, Sheep & Goat Specialist at the University of Maryland, brought her industry expertise as the featured speaker. UF/IFAS Small Ruminant Faculty and Staff provided research updates. The event was held in conjunction with the 2022 University of Florida Ram Test and Sale.

Agenda:

Friday, September 16

Location: Straughn Professional Development Center

7:30 - 8:30: Registration
8:30 - 8:40: Opening - *Dr. Andra Johnson, Dean & Director UF/IFAS Extension*
8:40-9:40: Latest Recommendation for Parasite Control - *Susan Schoenian*
9:40-10:00: Refreshment Break
10:00-10:10: UF Research Efforts & Grazing Trial *Dr. Marcelo Wallau*
10:10-10:20: Natural Alternatives for the Prevention and Control of Gastro-intestinal Parasites - *Emmanuel Duvalsaint*
10:20-10:30: Goat Dystocia Study *Lisette Coll-Roman*
10:30-10:40: Status of Small Ruminant Production in Florida - *Dr. John Lai*
10:40-10:50: Seasonality of FN Sheep *Dr. Catalina Cabrera*
10:50-11:00: Question Session
11:00-12:00: Developing a Flock/Herd Health Program - *Susan Schoenian*
12:00-1:30: Lunch
1:30-1:50: Feeding Strategies for Improving Small Ruminant Productivity in the Southeast - *Dr. Diwakar Vyas*
1:50-2:10: Florida Regulations for Meat Sales *Dr. Chad Carr*
2:10-2:40: Marketing: How to Make a Small Farm Productive - *Susan Schoenian*
2:40-3:00: Mastitis in Small Ruminants *Dr. Izabella Toldeo*
3:00-3:20: Refreshment Break
3:20-5:00: Producer Panel “Knowledge Exchange” - *Dr. Marcelo Wallau & Angela McKenzie-Jakes*

Saturday, September 17

Location: Beef Teaching Unit

8:30-9:00: Registration
9:00-9:15: Opening - *Dr. John Arthington, UF/IFAS Department of Animal Sciences Chair*
9:15-10:00: Refreshments
9:15-11:15: Short Rotations
Rotational Grazing- *Caetano Sales*
FEC and Interpretation for Selection- *Dr. Kevin Korus*
Managing Males for Successful Breeding- *Alicia Halbritter*
Managing BCS- *Cassidy Dossin*
Foot Rot- *Lizzie Whitehead*
How to Evaluate Males- *Paulette Tomlinson*
Cooking Demonstration and Nutrition Facts- *Dr. Marcelo and Annie Wallau*
11:15-12:00 Ram Test Data Overview
- *Dr. Brittany Diehl*
12:00-1:00 Lunch
1:00-3:00: Ram Sale

Impact: Small ruminant short course provided information and resources to farmers and small ruminant producers. These events was an important source of information and support for producers, helping them to improve the management and productivity of their operations in various aspects including animal health, breeding and genetics, nutrition, pasture and parasite management, and financial planning. Small ruminant producers learnt about best practices and new technologies that can help them to increase the efficiency and profitability of their operations. This event also provided an opportunity for producers to network with other industry professionals and learn from their experiences.

Ram test (May-August 2022)

Objective: Our 2nd annual UF Ram Test was designed to quantify the desirable qualities of the consigned rams within a standardized environment. The primary qualities identified to quantify through this test include growth performance and parasite resistance. This program provides an opportunity for unbiased data to be collected for comparison as well as educational and networking opportunities for both producers and university personnel (faculty, staff, extension agents). We had participation from 13 producers in FL and GA with 37 rams being consigned, initially. At the conclusion of the test, the data parameters are quantified into ratio indices to compare each ram. The top performing rams were eligible for auction.

Results: This year there were 9 rams sold, consisting of FL Native and Katahdin breeds.

Impact: Best rams sold to the producers have an economic impact as producers invest in superior breeding stock, improve the genetic traits of a flock, leading to healthier and more productive sheep, expand their farm, and improve efficiency of their operations.

Virginia State University

Game changer – mobile processing provides ease of access to inspected slaughter in Virginia

D. O'Brien and S. Wildeus

Objectives: Small Ruminant producers in central, southern and eastern Virginia have limited access to inspected processing facilities and must endure excessive time and mileage to get their animals processed and many experience scheduling delays and oftentimes get bumped for more lucrative processing. Due to these processing bottlenecks, small farmers are often left out of lucrative market opportunities for locally produced meats. Without addressing the critical issues of lack of accessible, affordable slaughter facilities, and an inability to meet market demand for locally produced value added meat products, the Virginia small ruminant industry will remain incapable of taking full advantage of producer profitability in the growing local food system marketplace. To sell meat products directly to customers, small farmers must have access to a state or federally inspected processing facility.

Procedure: During 2022, the MPU certification program was held at VSU and twenty-three producers and extension agents were trained. Program collaborators included Drs. Theresa Nartea (Virginia State University), Derris Devost-Burnett (Mississippi State University), Roger Merkel (Langston University), Kwame Matthews (Delaware State University), and Neil Zahradka (Virginia Department of Environment Quality). Additionally, train-the-trainer workshops, field day presentations, demonstrations and farm tours featuring the MPU were conducted.

Results: Twenty-three producers and extension agents were trained for a total of 43 MPU-certified graduates. Additionally, train-the-trainer workshops, field day presentations, demonstrations and farm tours reached an estimated 2,400 individuals. In 2022, five more graduates also started the process for obtaining individual grants of inspection and three MPU certified participants came together to lease the unit and process the animals from two farms. In total, 18 animals were processed under USDA-inspection on the MPU is 2022, while an additional 50 were processed under custom slaughter.

Impact: Impact was determined by a survey emailed to all certification program participants 6-months after the program ended. **Knowledge gained**: 100% of participants indicated that the online portion of the MPU certification program increased their knowledge on the science of red meat processing, composting and wastewater disposal; 100% of participants also indicated that the 2-day hands on class not only increased their skill but also their comfort level in human slaughter and carcass fabrication. **Producer livelihoods improved**: Producers utilizing the MPU in 2022 estimated that they saved between $2,500 - $5,000 each in processing costs ($5,000 - $10,000 in total savings). Of those participants planning to lease the MPU in 2023, 85% estimate that they would save between $2,501 - $5,000, while 15% estimate savings of $5,001 - $10,000, annually by processing their own animals. Based on survey responses, it is estimated that the MPU will be leased 20 times in 2023 with savings projected to be approximately $100,000 in processing costs by small ruminant producers in 2023.

Small ruminant tool bag - new small ruminant resource available for farmer trainings in Virginia

D. O'Brien and S. Wildeus

Objectives: The objective of this extension program was to create Virginia Cooperative Extension driven training tools and resources to overcome the lack of small ruminant resources available in the state.

Procedure: To better equip Virginia Cooperative Extension Agents with end-user resources for small ruminant programming in 2022, Small Ruminant Tool Bags developed in 2021 were distributed to extension agents, several how-to-videos were edited or developed, and a series of factsheets were developed for publication.

Results: Small Ruminant Tool Bags were distributed to ten extension agents in different counties in the state to use and determine effectiveness in extension programming. Additionally, 12 previously developed how-to-videos (how to put on a marking harness on a ram/buck; how to collect a fecal sample; how to trim hooves; how-to process lambs on pasture; how to tube feed a lamb/kid; how to give injections to sheep and goats; how to calculate medication dose; how to castrate a lamb/kid; how to short-scrotum a lamb/goat; how to process lambs; how to process rabbits) were edited and 3 additional ones created (how to fabricate a lamb/goat carcass; how to pull up injections; how to correctly drench). Factsheets developed include: VSU Small Ruminant Program Brochure (updated); Cache Valley Virus: A Case Study Report; A Protocol for Breeding Sheep and Goats Outside of the Normal Breeding Season; Castration in Sheep and Goats; Assisting in Difficult Births during Lambing and Kidding; Five Point Check; Body Condition Scoring in Sheep and Goats; Dystocia in Sheep and Goats; Stages of Lambing and Kidding; and How to do a Fecal Egg Count – McMaster Technique.

Impact: With the creation and availability of these resources, VCE extension agents and producers will now have access to additional tools, resources and short, easy to interpret videos on performing specific activities in small ruminant production. This will increase their knowledge and comfort level in performing or demonstrating these activities in the field. Agents receiving the Small Ruminant Tool Bag in 2022 were surveyed to evaluate value and effect on small ruminant programming. All other resources developed will be evaluated in 2023. Results for the Small Ruminant Tool Bag evaluation indicated that 100% of agents found the overall quality of the tool bag to be excellent; 100% found the tool bag moderately to extremely useful in small ruminant programming; 75% utilized the tool bag in an average of 5 small ruminant programs reaching 1 – 20 clients each in 2022; and all agents plan to utilize the tool bag in 2023 programming.

Objective V: Identify producers' challenges and opportunities in marketing goats and goat products

University of Florida

Understanding consumer preferences for goat and lamb meat in Florida

W. Basen, J. Lai, B. Kassas, M. Wallau

Objective: We aimed to determine market potential for lamb and goat meat products in Florida, provide agribusiness decision makers with insight into how consumer perceptions impact the willingness to pay (WTP) for lamb and goat meat product and provide a benchmark study for further expansion of research into the lamb and goat meat industry.

Methods: Data were collected via online survey that was pretested by extension specialists ensuring all questions were appropriate to participants. A sample of 1,022 adult Floridians was collected after screening on primary shoppers in their household, who incorporated any source of meat into their diet, resided in Florida, and were over 18 years old. After dropping outlier observations, the final sample used in this analysis contained 924 responses (a retention rate of 90.4%).

Results:

- The WTP for goat meat was reported to be lower than the willingness to pay for lamb meat.
- Positive correlations for lamb meat WTP was observed for Adventurousness when eating meat, perceiving lamb to have a higher flavor quality when compared to beef, having tasted/liked lamb recently, importance on food security, and being among Gen Z and millennials.
- Positive correlations for goat meat WTP was observed for Adventurousness when eating meat, perceiving goat to have a higher flavor quality when compared to beef, having tasted/liked lamb recently, and being among Gen Z and Millennials.

Impact:

- Younger, adventurous consumers who value the flavor of lamb and goat meat are WTP a premium price for each respective meat product.
- In-depth sensory analyses of taste preferences as it relates to lamb and goat meat, using results of study as a base could prove valuable to market decision makers.
- Health and environmental preferences are not determinants

Collaboration

Station Name: Fort Valley State University

James Miller, Louisiana State University
Felipe Torres-Acosta, Universidad Autónoma de Yucatan Merida, Mexico
Joan Burke, USDA/ARS/DBSFRC, Booneville, AR
Ibukun Ogunade, West Virginia University
Zaira M. Estrada-Reyes, NC A&T State University
Harley Naumann, University of Missouri
Byeng Min, Texas Agrilife
Jim Muir, Texas AgriLife Research & Extension Center, Stephenville
Susan Schoenian, University of Maryland Extension
Dahlia O'Brien, Virginia State University
Stephan Wildeus, Virginia State University
Kwame Matthews, Delaware State University
Moges Woldemeskel, University of Georgia
Multiple FVSU and UGA Cooperative Extension field staff

Station Name: North Carolina State University

Collaboration with continued between North Carolina State University, Virginia Tech, and West Virginia University. Ongoing research at the Southwest Virginia Agricultural Research and Extension Center (SWAREC) include projects from all three institutions. The divergent breeding model for FEC EBV has resulted in publications related to EBV validation, immune mechanisms of resistance, and feeding behavior and efficiency. The Southwest Virginia Ram Test located at the SWAREC has provided a platform for research and education related to parasite resistance and ram selection.

Station Name: Prairie View A&M University

Fuller Bazer and Guyao Wu (Texas A&M University)

Station Name: USDA, ARS, DBSFRC

Scientists from USDA, ARS, DBSFRC collaborated with members from USDA, ARS, MARC, Clay Center, NE and U.S. Sheep Experiment Station, Dubois, ID, Fort Valley State University, Louisiana State University, University of Rhode Island, University of Idaho; and non-members/associations from University of Nebraska-Lincoln, Purdue University, University of Arkansas, Virginia Tech, and USDA, ARS, Fort Collins, ARS, MARC on research that addressed management of gastrointestinal nematodes and out-of-season breeding. Collaborative research was conducted, and resources shared.

Station Name: Virginia State University

VSU cooperated with Virginia Tech on pasture research development, and with the University of Maryland, Fort Valley State University and Delaware State University in planning and implementing extension and research programs. Additionally, VSU cooperated with Langston University, Tuskegee University and Florida A&M University in the development of a marketing survey for meat goat producers.

Publications

Station Name: Fort Valley State University

Journal Articles**:**

Whitley, N.C., J. M. Burke, E. Smith, K. Lyte, T. H. Terrill. 2022. Determining the efficacy of Red Cell® in combination with anthelmintics against gastrointestinal nematode parasitism in sheep and goat. Sm. Rumin. Res. 209 https://doi.org/10.1016/j.smallrumres.2022.106656.

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Heikal, R., J. Hicks, B. Holmes, J. Brown, G. Dykes, L. Wartley, N. Mendez, A. Neha, A. Shaik, S. Chandan Chelkapally, D. Brown, J. Crumpler, N.C. Whitley, A. Pech-Cervantes, T. Reese, M. Woldemeskel, T.H. Terrill, A.R. Moawad. 2022. Effects of Dietary Supplementation with Lespedeza on the Semen Quality and Fertility of Male Goats. J. Anim. Sci. 100(3):19-20. https://doi.org/10.1093/jas/skac247.036

Hicks, J., B. Holmes, G. Dykes, N. Mendez, A. Neha, A. Shaik, S. Chandan Chelkapally, D. Brown, J. Crumpler, N.C. Whitley, A. Pech-Cervantes, T.H. Terrill. 2002. Can Annual Lespedeza (Kummerowia Stipulacea) be Used as an Anti-Parasitic Hay for Goats? J. Anim. Sci. 100(3):17-18. https://doi.org/10.1093/jas/skac247.032

Moawad, A.R., T. Reese, S. Miller, M. Singh, B. Kouakou. 2002. Influence of Breeds on the Quality of Chilled Goat Semen Collected by Artificial Vagina. J. Anim. Sci. 100(3):230. https://doi.org/10.1093/jas/skac247.416

Moawad A.R., M. Osbie, M. Xiaoling, M. Singh, B. Kouakou, T. H. Terrill and A. A. Pech-Cervantes. 2022. Effects of dietary supplementation of peanut skins on sperm quality and fertility parameters of growing male sheep. Repro. Fertil. Dev. 35:214. https://doi.org/10.1071/RDv35n2Ab173

Holmes, B., J. Brown, L. Hunter, J. Woodard, A. Johnson, S. Miller, B. Kouakou, A. R. Moawad. 2022. Impact of Feeding Male Goats with L-Carnitine on Viability of Their Semen Stored at 4 °C for 72 Hours. J. Anim. Sci. 100(3):24-25. https://doi.org/10.1093/jas/skac247.046

Station Name: Langston University

Journal Articles:

Hussein, A. H., A. K. Patra, R. Puchala, B. K. Wilson, and A. L. Goetsch. 2022. Effects of restricted availability of drinking water on blood characteristics and constituents in Dorper, Katahdin, and St. Croix sheep from different regions of the USA. Animals, 12, 3167. doi.org/10.3390/ani2223167.

Tadesse, D., A. K. Patra, R. Puchala, and A. L. Goetsch. 2022. Effects of high heat load conditions on blood constituent concentrations in Dorper, Katahdin, and St. Croix sheep from different regions of the USA. Animals, 12, 2273. doi.org/10.3390/ani1212273.

Wang, W., A. K. Patra, R. Puchala, L. Ribeiro, T. A. Gipson, and A. L. Goetsch. 2022. Effects of dietary inclusion of Sericea lespedeza hay on feed intake, digestion, nutrient utilization, growth performance, and ruminal fermentation and methane emission of Alpine doelings and Katahdin ewe lambs. Animals, 12, 2064. doi.org/10.3390/ani12162064.

Wang, W., A. K. Patra, R. Puchala, L. Ribeiro, T. A. Gipson, and A. L. Goetsch. 2022. Effects of dietary inclusion of tannin-rich Sericea lespedeza hay on relationships among linear body measurements, body condition score, body mass indexes, and performance of growing Alpine doelings and Katahdin ewe lambs. Animals, 12, 3183. doi.org/10.3390/ani2223183.

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Quijada, J., R. Merkel, Z. Wang, and T. Gipson. 2022. Evaluating Potential Synergistic Effects of *Duddingtonia flagrans* (Livamol® with Bioworma®) and COWP in Controlling *Haemonchus Contortus* in Grazing Spanish Doelings – Animal Parameters. Association of 1890 Research Directors, 20th Biennial Research Symposium, April 2-5, 2022, Atlanta, GA. Pp. 318.

Sawyon, K., J. Quijada, R. Merkel, W. Wang, T. Gipson, and A. Goetsch. 2022. Comparing Pooled Fecal Samples Collected from Pen Floors versus Pooled and Individual Fecal Samples from Penned Goats as a Method to Estimate Parasite Burden. Association of 1890 Research Directors, 20th Biennial Research Symposium, April 2-5, 2022, Atlanta, GA. Pp. 231.

Tsukahara, Y., R. Puchala, and A. L. Goetsch. 2022. Predicting feedstuff associative effects on basal forage intake in goats. 13th International Conference on Goats.

Ribeiro, L. P. S., R. Puchala, T. A. Gipson, R. V. Lourencon, and A. L. Goetsch. 2022. Effects of dietary concentrate level and limited feed access on feed intake, digestion, and heat energy by lactating dairy goats. 13th International Conference on Goats.

Tsukahara, Y., T. A. Gipson, S. P. Hart, L. J. Dawson, Z. Wang, R. Puchala, T. Sahlu, and A. L. Goetsch. 2022. Genetic selection for resistance to gastrointestinal parasitism in meat goats through a performance test with artificial infection of *Haemonchus contortus*. 13th International Conference on Goats.

Ribeiro, L. P. S., R. Puchala, A. Moehlenpah, C. Merera, and A. L. Goetsch. 2022. Effects of levels of minerals of a natural source of brackish water and NaCl on digestion and ruminal methane emission by different breeds of goats and hair sheep. J. Anim. Sci. 100(Suppl. 3):400. doi.org/10.1093/jas/skac247.732.

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Station Name: North Carolina A&T University

Journal Articles:

Jagana, S., Inupala, S.N., Pandey, P., Uzzman, M.R., Worku, M. 2022. Modulation of Goat Plasma Proteins Using Different Preparations of Garlic. *Journal of Animal Science*, Volume 100, Issue Supplement_3, Pages 395–396, https://doi.org/10.1093/jas/skac247.723

Jagana, S., Inupala, S.N., Pandey, P., Uzzman, M.R., Worku, M. 2022. Effect of Garlic Barrier on Fecal egg Count and Protein Secretion in Goats. *Journal of Animal Science*, Volume 100, Issue Supplement_3, Pages 235–236, https://doi.org/10.1093/jas/skac247.427

Uzzman, M.R., Edea, Z., Islam, R., Kim, K. S., Worku, M. 2022. Analysis of Galectin Gene Variants from Diverse Sheep and Goat Populations Genotyped with the Illumina Beadchip, *Journal of Animal Science*, Volume 100, Issue Supplement_3, Pages 299–300, https://doi.org/10.1093/jas/skac247.545

Station Name: North Carolina State University

Journal Articles:

Maierle, C.L., A.R. Weaver, E.E. Felton, S.P. Greiner, and S.A. Bowdridge. 2022. Evaluation of terminal sire breeds for hair sheep production systems: Feedlot environment. Small Ruminant Research (213). doi.org/10.1016/j.smallrumres.2022.106726

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Valliere, N.K., D.L. Wright, S.P. Greiner, S.A. Bowdridge, A.R. Weaver. 2023. Evaluation of supplemental feeding behavior and growth performance in Katahdin lambs divergently selected for fecal egg count estimated breeding value. Southern Section ASAS, Raleigh, NC. Accepted.

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Bentley, K., A.R Weaver, D.L. Wright, S.P. Greiner, S.A. Bowdridge. 2023. The effect of postweaning fecal egg count EBV on colostrum IgG concentration in Katahdin dams. Southern Section ASAS, Raleigh, NC. Accepted.

Popular Press:

Valliere, N.K., A.R. Weaver. 2022. NC State Sheep Research Update. Eastern Alliance for Production Katahdins Newsletter.

Weaver, A.R. 2022. Quantifying Inputs. Eastern Alliance for Production Katahdins Newsletter.

Weaver, A.R. 2022. Late Gestation Management Considerations. Eastern Alliance for Production Katahdins Newsletter.

Weaver, A.R. 2022. Managing Feed Costs in a Time of Expensive Inputs. Eastern Alliance for Production Katahdins Newsletter.

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