Sustainable Small Ruminant Production in the Southeastern U.S.

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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 non-animal 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 non-animal 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 1: Utilization of gastrointestinal nematode (GIN) control methods including feeding Duddingtonia flagrans, forage/grazing management, and animal selection for GIN resistance

North Carolina State University

Effect of copper oxide wire particles on parasitism and growth in Katahdin lambs divergently selected for fecal egg count estimated breeding value

V.M. Geniac, D.L. Wright, S.P. Greiner, S.A. Bowdridge, A.R. Weaver

Objectives: The objective of this project was to determine the effects and interactions of COWP and genetic selection based on fecal egg count (FEC) estimated breeding value (EBV) on gastrointestinal nematode (GIN) infection and performance in naturally infected Katahdin lambs.

Procedure: Spring-born Katahdin ram lambs (n = 52) selected for extremely high FEC EBV (HighFEC, PFEC EBV = +100%) or low FEC EBV (LowFEC, PFEC EBV = -81%) were managed on a fescue-based pasture at the Southwest Virginia Agricultural Research and Extension Center (Glade Spring, VA). At weaning (June 29), lambs were dewormed with a three-combination treatment and rested for 21 days. At the start of the project (July 18), a random subset of lambs (HighFEC, n = 11; LowFEC, n = 15) were given a 2 g copper oxide wire particle bolus, while an equal number of remaining lambs were managed as controls without a copper bolus. All lambs were managed as one contemporary group. Fecal egg counts, FAMACHA scores, body weights, and packed cell volume (PCV) were measured bi-weekly for 10 weeks. Statistical analysis was performed using PROC Mixed Procedure of SAS (SAS Institute, Cary, NC) and FEC data were log transformed for normality.

Results: There were no effects of COWP treatment on FEC ($P = 0.18$). However, LowFEC-selected lambs had lower FEC than HighFEC-selected lambs (230 vs. 565 eggs/g, respectively; $P < 0.01$). There was no interaction of COWP treatment and FEC genotype ($P = 0.37$). Copper oxide wire particle treatment had no effect on lamb body weight ($P = 0.21$), PCV ($P = 0.69$), FAMACHA score ($P = 0.41$), or overall ADG ($P = 0.12$). Lamb FEC genotype did not affect FAMACHA score or overall ADG ($P = 0.10$ and $P = 0.22$, respectively). LowFEC-selected lambs had lower body weights (27.7 vs. 30.6 kg, respectively) and PCV (29.2% vs. 30.4%, respectively) than the HighFEC-selected lambs ($P < 0.05$). None of the 52 lambs met the requirement for deworming (FAMACHA ≥ 3) during the study.

Impact: These results indicate that lamb FEC genotype may have a greater effect on parasitism than COWP treatment when given once during the post-weaning period. Even so, multiple tools should be considered, in addition to selection, for an integrated parasite management plan.

Effect of grazing native warm season grasses on parasitism and growth in weaned Katahdin lambs

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Objectives: The objective here was to evaluate Native Warm Season Grasses (NWSG) as a forage for post-weaning development of lambs in spring lambing, forage-based systems.

Procedure: Over two years, Katahdin lambs (Year 1, n = 30; Year 2, n = 31) were managed at a producer farm in the piedmont region of North Carolina. Beginning two weeks post-weaning, lambs were randomly assigned to graze on either NWSG (Big Bluestem and Indiangrass) or cool season grass (CSG, Kentucky 31 Tall Fescue base) pasture. Lambs were continuously grazed for 70 days in Year 1 and 55 days in Year 2. Fecal egg count (FEC), FAMACHA score, and body weight (BW) were measured every two weeks. Lambs were dewormed at FAMACHA ≥ 3. Forage analysis was conducted at the start and end of the grazing period. Statistical analysis were performance using the PROC Mixed procedure of SAS.

Results: Lambs in each group were raised in similar litter sizes and sire and sex were evenly distributed between groups. Fecal egg count and growth estimated breeding values (EBV) were similar between NWSG and CSG groups. In Year 1 and 2, no differences were observed in FEC between grazing groups ($P > 0.05$). However, FEC did increase in both groups throughout the grazing period ($P < 0.05$). In Year 1, no differences were observed in total weight gain ($P = 0.74$). However, in Year 2, lambs grazing CSG had greater total weight gain than the NWSG group ($P < 0.05$). In both years, there were no differences in the percentage of lambs requiring deworming (Year 1, $P = 0.36$; Year 2, $P = 0.47$) but lambs requiring treatment had greater FEC EBVs ($P < 0.05$). Nutrient quality of NWSG pasture was reduced compared to CSG pastures. Total digestible nutrients and crude protein were lower in NWSG compared to CSG pastures (Year 2: 61.5% vs. 63.9% and 8.9% vs. 13.6%, respectively) and neutral detergent fiber was greater (Year 2: 74.1% vs. 65.2%, respectively) resulting in decreased nutrient availability for NWSG group.

Impact: While NWSG may provide additional biomass for summer grazing, rapid maturity rates may limit nutrient availability for lambs resulting in decreased growth performance despite similar levels of parasitism. Lamb FEC EBV may play a role in parasite resistance and deworming requirements regardless of forage type. Thus, genetics must be considered along with grazing management as part of an integrated parasite management plan.

University of Florida

Inclusion of black soldier fly (*Hermetia illucens*) larvae frass as an alternative protein source in the diet of Florida native yearling ewes.

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Objective: The objective of the study was to evaluate the effects of partially replacing soybean meal (SBM) with black soldier fly larvae frass (BSFL) on nutrient digestibility, growth performance, and blood profile of ewes consuming diets with approximately 10% SBM on a DM basis.

Procedure: Six yearling Florida native ewes, averaging (mean ± SD) 44 ± 3 kg BW were enrolled in a replicated 3 × 3 Latin square design with 3 experimental periods of 21 d each (14 d adaptation + 4 d samples collection + 3 d washout). First 14 d of each period, ewes were housed in 7.4 × 1.8 m individual pens with rubber mats, one automatic waterer and two plastic feeders. During collection, ewes were moved to 1.4 × 0.7 m metabolic crates equipped with an individual waterer and feeder and two trays for the collection of feces and urine. Animals were fed TMR ad libitum twice daily at 0730 and 1530 h consisting of different levels of SBM replacement with BSFL, as follows: no replacement (CON), partial replacement of SBM with 25% BSFL (BSFL25) and 50% BSFL (BSFL50) on a DM basis. Data on DM and nutrient intake, excretion, and apparent digestibility, and also plasma concentrations of glucose and blood urea nitrogen (BUN), and urine concentrations of allantoin, urine blood nitrogen, and uric acid, were collected. Data were analyzed with SAS 9.4 evaluating orthogonal polynomial contrasts to determine linear and quadratic effects of SBM replacement with BSFL for each response variable.

Results: The intakes of DM, NDF, ADF, EE, and starch were greater for BSFL25 compared with control while no differences were observed between BSFL25 and BSFL50. Similarly apparent digestibilities of DM, NDF, ADF and starch was lower for BSFL25 than CON. Intake of CP linearly increased with BSFL, while apparent digestibility of CP linearly decreased and that of EE increased, with inclusion of BSFL. There was a quadratic effect of BSFL on total feces excretion and water consumption being greater in BSFL25 compared to CON. Urine BUN and urine nitrogen linearly increased with BSFL inclusion. Results indicate that partial replacement of SBM with BSFL in the diet of yearling Florida native ewes may quadratically increase feed intake and decrease nutrient apparent digestibility.

Impact: Further research is needed to explore the long-term implications of incorporating BSFL into animal diets, considering their impact on overall growth and performance.

Can choline feeding during the breeding period improve the performance of sheep and resultant lambs?

Masroor Sagheer, Quinn Hoorn, Daniel Carbalho, Brittany Diehl, and Peter Hansen

Objective: The study was aimed to evaluate if choline feeding during the preimplantation period program development can change postnatal phenotype of the lambs.

Procedure: 53 multiparous ewes were used at the sheep unit and blocked by breed and age. Ewes were synchronized for natural breeding with 5 rams and rams were assigned randomly among treatment groups. Individual bolus feeding of 5 g of choline (ReaSure-XC®; 60% choline chloride) in a gelatin capsule was dosed in treated animals for 7 days while empty gelatin capsule was dosed in control animals. Pregnancy rates, and pregnancy associated glycoproteins were recorded at d 30 and 84. Birthweight, litter size, sex ratio, litter size, sex ratio, weaning weight, longissimus muscle area, fat thickness, and hormone concentrations of IGF-1, GH, AMH was estimated.

Results: No effects of supplemental choline was observed on pregnancy rate and pregnancy loss. Similarly, birth weight and litter size was not influenced by choline supplementation. No treatment effects were observed on body weight from birth to weaning. In conclusion, rumen protected choline supplementation during the periconceptional period did not affect pregnancy rate, pregnancy loss, birth weight, litter size and body weight at weaning. Data will be observed on maternal placental function and DNA methylation in response to choline supplementation.

Impact: Strategies to improve pregnancy rates, birth weight, and weaning weight play crucial role in enhancing the overall performance and sustainability of sheep farming operations. The outcomes of such research benefit farmers, contribute to food production, and align with broader agricultural and environmental goals.

USDA, Agricultural Research Service, Booneville, AR

Viability of feeding *Duddingtonia flagrans* spores in trace mineral mix with or without coccidiostat to lambs for control of gastrointestinal nematodes

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

Objective: Providing spores of *D. flagrans* to livestock in the diet leads to fewer gastrointestinal nematode (GIN) larvae on pasture. The objective was to determine the viability of *D. flagrans* (Df; BioWorma®) fed in a mineral mix compared with a feed supplement with or without coccidiostat to naturally infected (predominantly *Haemonchus contortus* and *Trichostrongylus* spp.) lambs to reduce cultured GIN larvae through a series of experiments.

Procedure: Weaned lambs were fed a similar 12% crude protein grain supplement with trace mineral and coccidiostat added without Df (CON), Df mixed in feed (DfC) or in trace mineral

(DfM; n = 8/treatment) for 27 days. Fecal samples were collected twice weekly for coprocultures and larval recovery. *Exp. 2*: To determine if coccidiostat interfered with activity of Df, lambs were fed same supplement without coccidiostat or Df (CON), no coccidiostat and Df (-Coc+Df), coccidiostat and no Df (+Coc-Df), or both (+Coc+Df; n = 8/treatment) for 21 days. *Exp. 3*: To determine viability of spores contained in new lot of BioWorma®, lambs were fed a control supplement without Df (CON) or with Df (n = 8/treatment) for 7 days; feces were collected every other day for three cultures. *Exp. 4*: *Exp. 1* was repeated using the new lot of BioWorma®; treatments and conditions were the same.

Results: *Exp. 1*: Unexpectedly, larval recovery was similar among treatments ($P > 0.10$). *Exp. 2*: Again, recovered larvae from coproculture were similar among treatments ($P > 0.10$). It was discovered that spore count in BioWorma® was 10-fold less than expected for lot used in *Exp. 1* and *2*. *Exp. 3*: Feeding Df led to a 73% reduction in L3 ($P = 0.005$). *Exp. 4*: Larval recovery was reduced in both Df groups (Fig. 1; $P < 0.001$), and the L3 recovery was lower in DfM than DfC ($P = 0.001$).

Impact: Further research on Df interaction with coccidiostat is needed. Including Df in a trace mineral mix offers promise for flocks that do not offer grain supplements.

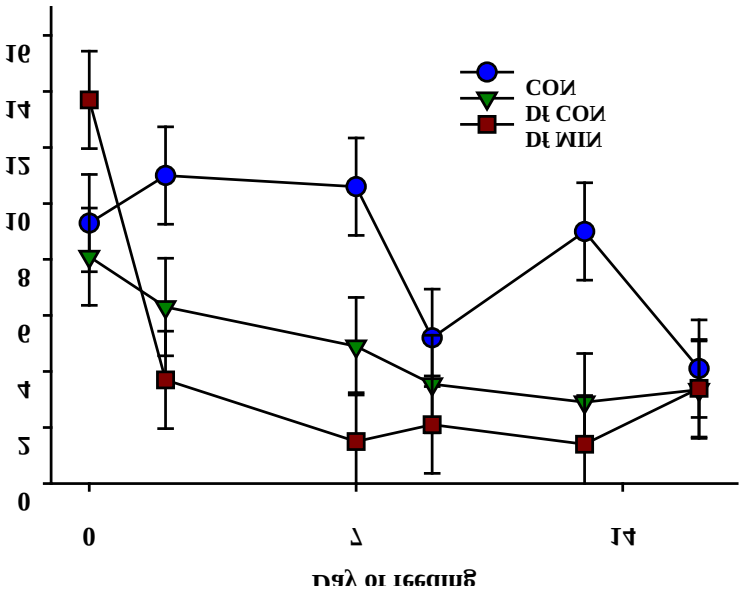

Fig. 1. Least squares means of larval recovery of control (CON) or D. flagrans supplemented lambs, as recommended in feed (Df CON) or in mineral mix (DfMIN) in Exp. 4.

Virginia State University

Supplementation with soy hull during late gestation and lactation on parasite indicators in hair sheep ewes

D. O'Brien, K. Matthews (Delaware State University), S. Wildeus

Objectives: Prior to lambing and up to eight weeks during lactation, ewes experience a temporary loss of immunity to gastrointestinal nematodes (GIN). This can result in a periparturient rise in fecal egg counts (FEC) along with clinical symptoms of parasitism. This rise in FEC can lead to greater larval numbers on pasture, consequently exposing lambs to a greater level of infection that can impair production. Adequate supplementation during late gestation and lactation has been shown to reduce the impact of this temporary loss in immunity and lower GIN infection levels in ewes. This study evaluated the supplementation of an agro-byproduct (soy hull) on GIN infection parameters in hair sheep ewes.

Procedure: Pregnant ewes (n=36) were allocated, balanced by breed, parity and fetal numbers to either corn/soybean (CS) or soy hull (SH) supplementation during the last trimester of pregnancy. Ewes rotationally grazed predominantly fescue pastures subdivided into 6 sections (0.13 ha) using electro-netting (3 sections of 6 ewes/supplement type). Ewes were supplemented at either 0.75% BW (late gestation) or 1.5% BW (lactation) using a single feeder per section. Ewes lambed on pasture and lambs were weaned at app. 63 d. Lambs had access to the supplement provided to their dams. Blood and fecal samples were collected in prepartum, postpartum and at weaning for determination of packed cell volume (PCV) and FEC. Pooled treatment group feces were also collected and cultured to determine GIN genera. Body condition scores (BCS) were also recorded at each sampling. Data was analyzed in a model with supplement type and breed as the main effects and FEC were log transformed prior to analysis.

Results: There was a mixed population of GIN throughout the study with *H. contortus* (49.5%) and *Tricostrongylu*s spp. (46.6%) being the most common. Supplement type had no effect on ewe BCS prepartum, postpartum or at weaning (averaging 2.6±0.1, 2.3±0.1 and 2.0±0.1, respectively). Supplement type influenced PCV at weaning only, with ewes supplemented with CS having a higher ($P<0.03$) PCV than those supplemented with SH (33.0±0.7% and 30.8±0.7%, respectively). PCV was similar between treatments prepartum (38.4±1.3%) and postpartum (34.4±0.9%). Ewe FEC was similar between CS and SH supplemented ewes prepartum (271.6±0.5 epg) and at weaning (298.5±80.5 epg), however, at postpartum sampling CS ewes tended ($P=0.09$) to have lower FEC (234.1±62.0 epg) compared to SH (414.1±59.6 epg) supplemented ewes. At weaning, lamb FEC was not influenced by supplementation or breed and averaged 502.3±83.2 epg.

Impact: Data indicate that substituting SH for a more traditional corn-based supplement in landrace hair sheep ewes managed in a pasture-based system had no influence on GIN infection. Agro-byproduct supplementation should be explored further for their use in sustainable, forage-based sheep production systems.

Deworming to improve growth in early-weaned spring born hair sheep lambs

D. O'Brien, K. Matthews (Delaware State University), S. Wildeus

Objectives: In lambs, the stress of weaning and the lack of a fully developed immune system can increase susceptibility to gastrointestinal nematodes (GIN). Lack of an effective GIN control strategy around this time can have a significant impact on lamb growth, productivity and mortality. The objective of this study was to determine the influence of deworming at weaning on growth performance in hair sheep lambs.

Procedure: St. Croix (STX) and Barbados Blackbelly (BB) lambs used in the study were born on pasture, weaned at 60.2 ± 0.4 d of age, and transitioned in pens for 87 d post-weaning before turning out to pasture. After accounting for initial FAMACHA© eyelid color score, breed, and birth type (single or multiple) at weaning, 54 STX (n=32) and BB (n=22) lambs weighing 11.7 ± 0.4 kg were dewormed (DEW) or not (CON) with a combination of levamisol (Prohibit®; 8 mg/kg BW) moxidectin (Cydectin®; 0.2 mg/kg BW) and albendazole (Valbazen ®; 7.5 mg/kg BW). To evaluate the effect of deworming treatment, BW and body condition scores (BCS; scale 1-5)) were recorded at weaning and at end of transition to pasture. Blood and fecal samples were also collected for determination of packed cell volume (PCV) and fecal egg counts (FEC). Pooled treatment group feces (d 0 – 98) were collected and cultured to determine GIN genera at weaning. Data were analyzed using repeated measures in a mixed model, and FEC were log transformed prior to analysis.

Results: There was a mixed population of GIN at weaning averaging 65% and 35% for *H. contortus* and *Tricostrongylus* spp. At weaning, BCS, PCV, and FEC were similar between treatment groups and averaged 1.6 ± 0.07, 36.5 ± 0.6%, and 399 ± 54.4 epg, respectively. Combination deworming reduced FEC by 99%. At turnout, DEW lambs (2.3 ± 0. 1) tended (P=0.08) to have higher BCS than CON lambs (2.0 ± 0.1) and PCV was greater (P< 0.001) in DEW versus CON lambs (37.2 ± 0.9 and 33.3 ± 0.8%, respectively). There was also a tendency (P=0.09) for breed to influence BCS (2.3 ± 0.1 and 2.0 ± 0.1 for BB and STX respectively). FEC at turnout was not influenced by treatment or breed (496.7 ± 75.1 epg). Additionally, DEW lambs (131.8 ± 5.2) tended (P=0.09) to grow faster than CON (119.9 ± 4.7 g/day) lambs, a difference more pronounced in STX DEW (g/day) than STX CON lambs (136 ± 6.1 vs 110 ± 6.5 g/day; P< 0.05).

Impact: Even though deworming tended to promote faster growth rates in lambs used in this study, alternative, more sustainable, parasite control strategies should be considered in the wake of increasing dewormer resistance.

The Efficacy of a Natural Fungus (Duddingtonia flagrans) in Reducing Gastrointestinal Nematode Indicators in Lambs

Dahlia O'Brien, Kwame Matthews (Delaware State University), Stephan Wildeus

Objectives: Sustainable and profitable small ruminant production in the US is affected by infections with gastrointestinal nematodes (GIN), especially the blood sucking GIN, *Haemonchus contortus*. The overuse and mis-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 larval counts and other GIN indicators in hair sheep wethers.

Procedure: Eighteen St. Croix (n = 9) and Barbados Blackbelly (n = 9) wethers (227 ± 1.4 days of age and 29.7 ± 0.6 kg BW) were dewormed (d 0) with a combination of levamisol (Prohibit®; 8 mg/kg BW) moxidectin (Cydectin®; 0.2 mg/kg BW) and albendazole (Valbazen®; 7.5 mg/kg BW) prior to the start of feeding according to the manufacturer's recommendations for feeding BioWorma®. At this time, lambs were separated into two treatment groups (n = 9/group), split into 3 replications per treatment group and placed on six pasture paddocks (0.06 ha; n = 3 per paddock) after accounting for breed, initial fecal egg count (FEC) and BW. Lambs were then fed daily either a grain supplement ration (corn and soybean meal) with Livamol with Bioworma® (LIV) or without (CON) at 2% of their BW for 98 d. LIV was added to the ration based on total lamb BW/paddock. To evaluate the effect of LIV treatment, BW and body condition scores (BCS) were recorded every 2 weeks for 98 d. Blood and fecal samples were also collected for determination of packed cell volume (PCV) and FEC. Pooled treatment group feces (d 0 – 98) were collected and cultured to determine GIN genera. A subset of animals/treatment (n = 3) was harvested to determine abomasal worm counts. 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 100% by d 14. There was a mixed population of GIN at the start of the study (averaging 54%, 42%, 1.2% and 1.8% for *H. contortus*, *Tricostrongylu*s spp., *Oesphagostomum* spp. and *Nematodirus* spp., respectively). LIV with Bioworma® supplementation had no impact on BW, BCS, PCV or FEC in this study averaging 34.2 ± 0.3 kg, 2.5 ± 0.04, 34.7 ± 0.5% and 150.9 eggs per gram, respectively.

Impact: Under the conditions of this study, Bioworma® supplementation had no influence on GIN indicators measured up to 100 d of grazing. This research will be continued during subsequent grazing seasons to determine the effect of continued supplementation on lamb parasite load and performance as well as pasture infestation levels.

West Virginia University

Effect of post-weaning fecal egg count EBV on grazing ewe behavior after weaning

G.T. Vaughan, D. L. Wright, S.P. Greiner, S.A. Bowdridge

Objectives: Post weaning fecal egg count (PFEC) estimated breeding value (EBV) has been recently linked with improved immune competence and lamb survival to weaning, thus improving health though selection. Animal movement is also linked to animal health, however little is known about behavior differences in sheep with divergent PFEC EBV.

Procedure: Thirty Katahdin ewes were selected after weaning from the Southwest Virginia Agricultural Research and Extension Center. Where high PFEC ewes (EBV > 172) and 15 low PFEC (EBV < -84) were selected. Upon placement into pastures, ewes were fitted with Digitanimal ™ GPS collars that measure GPS location every 15 minutes and store data on a micro SD card. Additional data collection included bi weekly weights, FAMACHA™ scores, body condition scores and fecal egg count.

Results: There was no difference in any physiological measurement in these ewes for the duration of this 4-week study. However, significant differences were observed between groups for daily distance traveled. On average, High-PFEC ewes traveled 4.52 km, where low ewes traveled only 4.16 km ($P < 0.0001$). The average distance traveled between GPS signals (every 15 min) was 48.6 m for high ewes and 47.0 m for Low-PFEC ewes ($P < 0.0001$). Interestingly, the time of day where maximum activity occurred (1506h vs 1448h; High and Low-PFEC respectively) was not different, nor was the distance those ewes traveled in that hour (522.6 vs 519.2 m).

Impact: These data provide a preliminary snapshot of movement differences that occur between PFEC groups and may inform future studies to evaluate linkage between health and movement in grazing livestock.

Ancylostoma caninum-derived neutrophil inhibitory factor impairs ovine neutrophil chemotaxis to Haemonchus contortus larval antigen in Suffolk but not St. Croix sheep

H.G. Teddleton, S.P. Greiner, S.A. Bowdridge

Objectives: Parasite-resistant St. Croix sheep (STC) generate a potent neutrophilic response to larval stages of *Haemonchus contortus (Hc)* as demonstrated by abomasal neutrophil infiltration as early as 3 days after infection. This phenomenon is delayed in parasite-susceptible Suffolk sheep (SUF) potentially contributing to larval establishment. An excretory/secretory (E/S) product, common to many helminths, is neutrophil inhibitory factor (NIF) which negatively

affects neutrophil migration and activity. Due to differences in neutrophil accumulation between STC and SUF sheep, we hypothesized that *Hc*-NIF may inhibit migration of SUF and not STC neutrophils. To determine the concentration of NIF to use in subsequent experiments, neutrophils from STC and SUF were cultured with varying concentrations of *Ancylostoma caninum*-derived NIF (*Ac*-NIF) prior to exposure to larval H. contortus third-stage larval antigen (*Hc*LA).

Procedure: To test our hypothesis, neutrophils were cultured from STC and SUF sheep in the presence of *Ancylostoma caninum*-derived NIF (*Ac*-NIF) and measure chemotaxis to Interleukin-8 (IL-8), *Hc*LA or *H. contortus* third-stage excretory/secretory (E/S) products. Neutrophils were isolated then incubated with *Ac*-NIF(0.125µg/ml) or complete media for 1 hour. Neutrophils (1,000,000 cell/mL) were applied to cell migration inserts, and placed into a reservoir containing *Hc*LA (20µg/ml), E/S (20µg/ml), IL-8 (50ng/ml), or complete media. Migration plates were incubated (37°C, 5% CO2) for 24 hours, afterwhich, migrating cells were quantified using fluorescence.

Results: *Ac*-NIF inhibited SUF neutrophil migration towards IL-8 compared to STC (6.47% vs 9.95%, respectively) (P=0.0025). In response to HcLA alone, 64.0% of STC neutrophils migrated, while only 40.9% of SUF had the ability to migrate (P<0.001). Towards HcLA, *Ac*-NIF inhibited SUF neutrophil migration compared to STC (8.40% vs 13.8%, respectively) (P<0.001). Even more dramatically, in response to E/S products alone, only 24.3% of SUF neutrophils had the ability to migrate, while 76.4% of STC neutrophils migrated towards E/S (P<0.001). In response to E/S, only 1.52% of SUF Ac-NIF-treated neutrophils were able to migrate, while 23.27% of STC neutrophils migrated (P<0.001).

Impact: Taken together, these data demonstrate that STC neutrophils are resistant to effects of neutrophil inhibition that is artificially applied or derived from HcE/S, which may explain breed differences in neutrophil migration in vivo.

The effect of postweaning fecal egg count EBV on colostrum IgG concentration and color in Katahdin dams

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

Objectives: Selection for postweaning fecal egg count (PFEC) EBV has revealed that low-PFEC sheep have greater resistance to gastrointestinal nematode infection, higher survivability to weaning, and greater anamnestic response to booster clostridial vaccination. Therefore, it can be hypothesized that selection for PFEC may result in improved generalized immunity. It has also been reported that good-quality colostrum has a thick consistency and yellowish color. Thus, the aim of this study was to compare IgG concentration and color of colostrum in Katahdin ewes divergent in their PFEC EBV

Procedure: All lactating ewes at the SWAREC were analyzed and were sorted into three groups: low-PFEC (PFEC < -50, n=39), mid-PFEC (-49 < PFEC < +49, n=38), and high-PFEC (PFEC > +50, n=23) and sampled within 6-hrs post-partition. Upon parturition, a 20mL colostrum sample

was sterile collected by milking 10mL from each half of the ewes' udder; all samples were placed into pre-labeled 50mL tubes and frozen on-site. Colostrum samples were thawed and diluted in 36% ammonium sulfate and centrifuged at 3,000 x *g* for 20 minutes at 4ºC. The removed whey portion was dialyzed using a 3,000 MW membrane cassette in 1L of PBS (pH 7.4) at 4ºC for 12 hours. Total IgG from colostrum was measured using an ovine-specific enzyme-linked immunosorbent assay (ELISA), and color parameters were measured using a Minolta chromameter. To evaluate IgG and color differences, data were analyzed using the General Linear Model (GLM) procedure of SAS with Tukey's HSD test to compare the effects of ewe PFEC genotype on colostrum IgG, Yellowness Index (*YI*), Whiteness Index (*WI*), *L**, *b** and *a** values.

Results: Main effects of ewe PFEC genotype displayed a stepwise decrease in average colostrum IgG from low-PFEC to high-PFEC groupings (825 ng/mL, 513 ng/mL, and 258 ng/mL, respectively; $P < 0.0429$). Likewise, a stepwise decrease in *b** value, indicating relative yellowness, occurs from low-PFEC to high-PFEC groups (18.97, 16.91, and 15.22, respectively; $P < 0.0459$).

Impact: These data suggest low-PFEC Katahdin ewes generate greater antibody concentration and yellowness within colostrum. Therefore, lambs born to these ewes would have a significant advantage in passive immunity from their dams, potentially contributing to lamb survivability.

<u>Objective 2:</u> Emphasis of forage feeding systems for year-round grazing to meet nutritional requirements that mitigate drought and other plant and animal stressors.

North Carolina State University

Pastureland Ecology 1 provides hands-on training in grazing management for USDA-NRCS professionals

M. H. Poore, A. D. Shaeffer, J.R. Rogers, A. R. Weaver, P. D. Siciliano and D. D. Harmon

<u>Objectives:</u> The objective here was to provide a train-the-trainer program for USDA-NRCS staff on pasture ecology including topics such as plant biology, animal nutritional needs, pasture design, soil health, and grazing management for small ruminants, horses, and cattle.

<u>Procedure:</u> Pastureland Ecology 1 is a two-week continuing education course taught by cooperating faculty at NC State University for USDA-NRCS Staff. The course was founded in the early 1990s and has been taught 23 times to over 500 participants from all 50 states. Participants primarily include grazing specialists, soil conservationists, and district conservationists. Instruction is split between classroom lectures and hands-on experience with grazing management. Lecture topics include; introduction to pasture ecology, principles of plant growth, determining animal forage needs, pasture design, principles of soil health, principles of grazing management, and grazing management systems for small ruminants, horses and cattle. Small groups of students work with groups of goats, sheep, horses, and beef cattle throughout the course, learning concepts of forage allocation, temporary electric fence, and adaptive management. Popular demonstrations developed over the years include; the reel race, dung beetle buckets, burying underwear to demonstrate soil health, exploring root diversity, and troubleshooting electric fence. Farm tours are conducted to show how concepts being taught are applied on commercial farms.

<u>Results:</u> In 2023 there were 29 students from 13 states including VA (4), MD (4), PA (3), OK (4), MI (1), UT (2), TN (3), WV (1), MA (1), OH (1), NM (1), WA (3), and RI (1). Participants had 8.4±1.39 (AVG±SEM) years of experience with NRCS with a range of 1 to 27 years. Students self-assessed their understanding of major concepts before and after the course. On a 1 to 5 scale students increased their understanding by an average of 1.05±0.129, averaged over all topics. Topics more familiar to participants had less increase including; Soil Health (0.38), Pasture Condition Evaluation (0.51), and Grazing Management for Beef Cattle (0.79). Less familiar topics had higher increases including Grazing Management for Horses (1.27) and Small Ruminants (1.27), and Temporary Electric Fence (1.43).

<u>Impact:</u> Pastureland Ecology 1 remains a critical part of the Amazing Grazing Program at NC State University, impacting pasture-based livestock producers across the country. This

educational model has proven to be an effective way of teaching the principles of pastureland ecology.

Amazing Grazing webinar and workshop series improves producers understanding of pasture ecology.

J.R. Rogers, M. H. Poore, A. D. Shaeffer, A. R. Weaver, P. D. Siciliano and D. D. Harmon

Objectives: The objective here was to provide trainings for producers on pasture ecology including topics such as plant biology, animal nutritional needs, pasture design, soil health, and grazing management for small ruminants, horses, and cattle.

Procedure: Amazing Grazing conducted a webinar series (April 2023) followed by on-farm workshops in July/August 2023. Webinars were held on consecutive Wednesday evenings with 237 average registered attendees. Topics covered during the first webinar were pasture ecology basics, plant growth principles, livestock forage demand and grazing management principles. The following week covered pasture layout and design, pasture renovation techniques and pasture soil health concepts. The final evening featured topics on electric fence basics, grazing systems for horses and small ruminants and a synopsis. NC Extension Livestock Agents assisted in the sight selection and execution of workshops (n=8) that were held on working farms. These events provide the opportunity for hands-on instruction to demonstrate the concepts covered in the webinar series.

Results: Total workshop registration was 196, with 148 evaluations completed. Participants were 72% farmers, 1% extension agents, 10% Soil and Water Conservation District Employee, 7% NRCS employee and 10% other. The total number of pasture hectares grazed by participants was 3217 with 1257 ha as hay. Livestock inventories for attendees were 4323 beef cattle, 1366 sheep, 455 goats and 51 horses. Attendees were asked about their pre- and post- workshop knowledge (1 = Very Low; 5 = Very High) of topics presented. Participants indicated a knowledge gain (average pre = 2.78 and post = 3.91) in Concepts of Pastureland Ecology, Adaptive Management, Managing Nutrient Distribution, Pasture Renovation, Temporary Electric Fence, Troubleshooting Electric Fence and Pasture Plant Identification. Workshop impact was determined by asking attendees their post workshop intentions regarding management practices (1 = No, 2 = Maybe, 3 = Yes, 4 = Already Doing). Attendees plan to spending more time walking pasture to determine plant condition , learn more about soil, plant, animal and human interactions, increase use of temporary electric fence and adopt an adaptive management style (average score = 3.91).

Impact: Continued workshop participation indicates the demand for hands-on education in these areas and that the on-farm format is an effective teaching environment for topics related to pastureland ecology.

Virginia State University

Use of soy hull as a supplement during late gestation and lactation for landrace hair sheep ewes in a forage-based system

Stephan Wildeus and Dahlia O'Brien

Objectives: Forage-based production systems can be limiting in providing adequate nutrition as the result of seasonal fluctuations in forage quality and quantity, especially during periods of increased nutritional demands such as late gestation and lactation. This study evaluated the use of an agro-byproduct supplementation (soy hull) to fill these demands.

Procedure: Barbados Blackbelly (BB) and St. Croix (STX) hair sheep ewes were bred November 1 in a 25-d breeding season in two single-sire groups to like breed sires, and initially managed as one group. Pregnant ewes (n=36) were allocated, balanced by breed, parity and fetal numbers to either a corn/soybean (CS) or soy hull (SH) supplementation starting the last trimester of pregnancy. Ewes rotationally grazed predominantly fescue pastures subdivided into 6 sections (0.13 ha) using electro-netting (3 sections of 6 ewes per supplement type). Ewes were supplemented at either 0.75% BW (late gestation) or 1.5% BW (lactation) using a single group feeder per section. Ewes lambed on pasture and lambs were weaned at app. 63 d. Lambs had access to the supplement provided to their dams. Data were collected on ewe BW changes and reproductive performance, and analyzed in a model with supplement type and breed as main effects. Results are presented as LSM.

Results: Supplement type had no effect on ewe prepartum (54.7 kg), postpartum (47.3 kg) and weaning BW (44.7 kg), whereas BW was consistently higher in STX than BB ewes. Ewe late gestation (61 g/d) and lactation ADG (-51 g/d) were not affected by supplement type though breeds differed ($P<0.01$) in lactation ADG (BB: -14 vs STX: -78 g/d). Lambing performance was also not affected by supplement type with 1.97 lambs born live, and 1.69 lambs weaned per ewe. There was a supplement type by breed interaction ($P<0.05$) for number of lambs weaned with STX ewes receiving SH having a larger litter size at weaning than ewes receiving CS (1.40 vs. 2.10 lambs per ewe) with no difference in BB ewes (1.71 vs. 1.50 lambs per ewe, respectively). Neither litter birth (6.14 kg) and weaning weights (19.9 kg) nor litter ADG (233 g/d) were affected by supplement type. Litter BW was significantly greater ($P<0.01$) in STX than BB (6.85 vs 5.18 kg), but not different at weaning. Lamb birth and weaning weights were not affected by supplement type, though preweaning ADG tended ($P<0.1$) to be higher in CS than SH (162 vs. 142 g/d).

Impact: Data indicate that substituting SH for a more traditional corn-based supplement in landrace hair sheep ewes managed in a pasture-based system did not affect ewe growth, reproductive performance, and lamb performance. Agro-byproduct supplementation should be explored further for use in sustainable, forage-based sheep production systems.

Objective 3: Strategies for the improvement of small ruminant reproduction

Langston University

Evaluation of Splashing as a simplified Artificial Insemination Technique in Alpine, Spanish and Kiko Goats at Langston University farm.

Authors: J. Kiptanui, K. Brown, K. Hedge, A. Ghnenis, F. Encinas, L. Hutchens, R. Merkel, and T. Gipson.

Objective: The procedures currently used by the artificial insemination (AI) industry for breeding goats with thawed, frozen semen are based on transcervical or laparoscopic-aided intrauterine insemination. These methods have become unsustainable due to cost and technological challenges for small ruminant producers in many countries including the United States. The main goal for this project was to evaluate splashing (vaginal insemination) as a simplified technique for artificial insemination, which would allow farmers to easily inseminate their own animals and to genetically improve their herds with minimal costs, inputs, and technical skills. The objectives of the project were 1) to investigate the effect of breed on pregnancy success rate using fresh cooled semen, 2) to investigate the effect of total number of spermatozoa given (200 million motile sperm [mms] versus 400mms) on pregnancy success rate and 3) to compare the success rate of splashing using cooled, fresh semen to natural mating (NM) in Alpine goats.

Procedure: Semen was collected from Alpine (n=3), Spanish (n=4), and Kiko (n=4) bucks using an artificial vagina. Semen parameters were analyzed using a Minitube CASA system, diluted into 200mms or 400mms spermatozoa/ml using a milk-based extender, and cooled at 4ºC till use. Estrus synchronization in Spanish (n=40), Kiko (n=40), and Alpine does (n= 60) was done using 2 doses of PGF2α twelve days apart. Does were randomly divided into two groups (200mms/mL) and (400mms/mL). Does were inseminated at a fixed time point (48 – 72 hours) after the second injection of prostaglandin using a 5ml syringe attached to 9-inch catheter straw without the use of a speculum. Another group of Alpine goats (n=20) was bred by natural breeding to be used as a control. Success rate (pregnancy rate) was determined using ultrasound at 45 days post AI. Data will be analyzed using the PROC GLIMMIX of SAS.

Results: Overall pregnancy rate for splashing was 10.5%, with breed pregnancy rate at 3.6, 7.7, and 23.1% for Alpine, Spanish, and Kiko does, respectively. The success rate by number of spermatozoa were 9.0% for the 200mms/ml and 11.9% for 400mms/ml. The pregnancy rate for the Alpine on natural mating was 55%.

Impact: Splashing is a viable and sustainable simplified AI technique that can help small ruminant producers maximize offspring from genetically superior bucks. Despite the low success rate, it is recommended that further trials be conducted to improve and perfect the technique because it can potentially impact millions of small ruminant producers and their families worldwide.

Effects of extenders on sperm motility of buck semen stored at room and cooled temperatures.

Authors: J. Kiptanui, K. Hedge, K. Brown, R. Merkel, T. Gipson, A. Ghnenis, F. Encinas, L. Hutchens

Objective: Semen extenders are special liquid diluents added to semen to preserve its fertilizing ability during storage and transportation for artificial insemination. Currently, there are a wide range of semen extenders available commercially but no ideal extender provides desired sperm quality because each livestock species requires different conditions. For most small goat producers, choosing an appropriate semen extender may be a challenge. The objective of the study was to evaluate the effects of three different semen extenders on the motility of sperm cells from Alpine, Spanish, and Kiko bucks stored at room (20-25°C) and chilled temperatures (4-5°C).

Procedure: Semen was collected twice over 2 weeks from Alpine (n=2), Spanish (n=2), and Kiko (n=2) bucks using an artificial vagina. Semen was analyzed for basic quality checks for volume, concentration, and motility using the iSperm mCASA. Subsequently semen was subdivided into three aliquots, which was then extended using different extenders (milk-based Andromed®, milked-based INRA 96® and a home-made reconstituted skin milk extender) to a dilution of 50 million motile sperms per mL. The extended aliquot was further subdivided and kept at room (20-25°C) and chilled temperatures (4-5°C). Motility was monitored at 7 different time points (10-30 minutes, 6 hours, 12 hours, 24 hours, 48 hours, 72 hours, and 96 hours) post collection and results recorded.

Results: Analysis of results is ongoing but preliminary findings showed INRA 96® and Andromed® had promising percentages of spermatozoa motility up to 24 hours post collection with INRA 96® recording a better motility rate over time as compared with Andromed®. Some spermatozoa were still alive and motile at 144 hours post collection. The homemade reconstituted milk extender gave good performance in the first 12 hours psot collection but deteriorated thereafter.

Impact: Findings from the study may provide guidance on practical, cheap, and easy solutions for goat producers who would wish to use fresh or chilled semen when breeding their animals for improved genetics and productivity. Full results from this study may also offer goat producers correct information on the best option of semen extenders to use for the artificial insemination.

Tennessee State University

Comparisons of Myotonic sires with Kiko and Spanish sires for meat goat kid and doe performance traits

Hayes, E. G., Meador, H., Browning, R., Jr.

Objective: Heritage breeds represent a source of genetic diversity that may benefit ruminant livestock production systems. The Myotonic goat is a heritage breed that has the potential to enhance performance in meat goat breeds. Previous studies at this location have shown that Myotonic does consistently maintain lower gastrointestinal nematode egg counts that other meat goat doe breeds. The value of the Myotonic goat as a sire breed remains to be determined. The current project is assessing the performance of progeny from Myotonic sires compared to Kiko and Spanish sires.

Procedure: In one breeding group, Myotonic (M; n = 6) and Kiko (K; n = 5) sires mated to Kiko-influenced does produced 139 kids. In a second breeding group, Myotonic (n = 6) and Spanish (S; n = 4) sires bred to Spanish-influenced does produced 123 kids. Kids were produced in breeding group over two years. Kids were weighed at birth and weaning (3 months of age). The reproductive performance of the does (weaning rate = proportion of does weaning kids; litter size = the number of kids weaning; litter weight = total weight of weaned kids) was also evaluated.

Results: Birth to weaning kid performance traits were influenced ($P < 0.05$) by litter size, dam age, and kid sex, but were not significantly affected by sire breed within either the Kiko doe group (M = 16.4 ± 0.6 kg vs K = 16.9 ± 0.6 kg) or the Spanish doe group (M = 15.0 ± 0.6 kg vs S = 15.4 ± 0.6 kg). Service sire breed did not affect ($P > 0.05$) observed doe fertility or litter size weaned within either doe group. Doe age influenced ($P < 0.05$) litter weight weaned within the Kiko doe group, but not ($P > 0.05$) within the Spanish group. Service sire breed did not affect ($P > 0.05$) doe litter weight weaned between Myotonic (23.7 ± 1.5 kg) and Kiko service sires (23.7 ± 1.5 kg). Myotonic service sires produced lighter ($P < 0.05$) litters at weaning (21.1 ± 0.8 kg) than Spanish service sires 23.6 ± 0.9 kg) when bred to Spanish does.

Impact: Preliminary findings were that Myotonic sires did not significantly reduce weaning kid weights compared with Kiko and Spanish sires. The influence of Myotonic service sires on doe herd performance was dependent on the doe breed. The next phase of the project is to assess the reproductive performance of replacement doelings from these kid crops as daughters of the sire breeds.

University of Florida

Strategies for the improvement of small ruminant reproduction.

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.

USDA, Agricultural Research Service, Booneville, AR

Identification of traits of longevity and robustness in sheep

J.M. Burke, T. Murphy, B. Freking, C. Wilson, B. Taylor, R. Lewis, L. Brito, E. Wood, C. Lee

Objective: Approximately half of ewes in the U.S. are culled each year because of age, whereas the rest are culled prematurely for reasons including failure to lamb (7.7%), teeth problems (7.6%), and mastitis (6.7%; USDA APHIS, 2014). Other factors affecting ewe health and longevity include internal parasites and foot rot. Satellite Katahdin flocks at USDA, ARS locations in Booneville, Clay Center, NE (USMARC) and Dubois, ID (USSES) with shared genetic linkages have been assembled to study complex traits to understand reasons for premature culling and genetic heritability of traits as part of the GEMS project (USDA NIFA # 2022-67015-36073). Udder health will be presented here.

Procedure: In Oct. 2021 (n = 109), Jan. and Oct. 2022 (n = 22; n = 110, resp.), Jan. and Oct. 2023 (n = 38; n = 54, resp.), yearling (n = 34), 2- (n = 113), 3- (n = 76), and ≥4-yr (n = 110) old Katahdin ewes gave birth to live lambs (those that lost lambs were not used). A limitation of these data is that month of lambing is confounded with age of ewe in that most yearling ewes lamb in Jan. and most older ewes lamb in Oct. For milk collection and udder conformation, milk was collected from 1- and 3-yr-old ewes 5-8 d post-lambing after a separation from lambs for 30 to 120 min and administration of 0.5 ml oxytocin. Milk was collected from each half of the udder to determine California Mastitis Test score (CMT, 0-3; estimates somatic cell count; all ewes had scores of ≤ 0.5 except two with scores of 1). Udder conformation traits were recorded on all ewes at this time, and again at ~60 d post-lambing by a single technician; traits were teat placement, degree of separation of the udder halves, udder depth, teat position (Casu et al., 2006), teat length, udder hardness and palpation scores, exterior damage to the teat surface, and absence/presence of secondary teats. Maternal bonding score was recorded (1 = dam bonds with all offspring; 5 = dam does not bond to offspring). For this preliminary analysis, general linear models was used and included year, age, and the interaction in the model.

Other traits recorded included pictures of mouth/teeth (to be analyzed later), foot health as an indicator of foot scald or rot; gastrointestinal nematode infection was estimated around the time of lambing, 30 and 60 d post-lambing by determining fecal egg counts, FAMACHA, and packed cell volume. Body weight and body condition score were determined at breeding, post-breeding, 30 and 60 d post-lambing.

Results: For udder traits, there were significant year effects for udder depth (higher in 2021; $P = 0.002$), teat position (higher in 2021; $P = 0.04$), teat damage on both left and right sides (lower in 2021; $P < 0.001$) just after lambing, and teat position (higher in 2021; $P = 0.05$), udder symmetry (higher in 2023; $P = 0.002$), udder palpation score (higher in 2023; $P = 0.001$), and teat damage (higher in 2023; $P < 0.001$) 60 d post-lambing. There were age influences just after lambing on udder depth (decreased with age; $P < 0.001$), teat length (increased with age; $P = 0.03$), and teat damage to both sides (increased with age; $P < 0.001$); and 60 d post-lambing on udder depth (lowest in ≥4-yr old ewes; $P < 0.001$) and teat damage (increased with age; $P < 0.001$). There were year × age interactions for udder hardness ($P = 0.003$) and palpation scores (for both of these traits, increased with age in 2021 and 2022 and decreased with age in 2023; $P < 0.001$), and bonding (unfavorably higher in yearling ewes in 2022 and lower in yearling ewes in 2023; $P < 0.001$) shortly after lambing but none detected later post-lambing. A change in udder hardness and palpation scores between early and late lactation were calculated. Udder hardness score tended ($P = 0.06$) to decrease (favorable) less in 2023 than 2021 and 2022; and change in udder palpation score in yearling ewes in 2023 was less favorable (year × age, $P < 0.001$). The unfavorable responses in udder health in yearlings in 2023 could be reflected in a high incidence of Cache Valley Virus infection in January confirmed by antibody titers (see Abstr. 57).

Impact: The traits included in this report are for the Booneville flock. Future analyses will include additional years and Katahdins at USMARC, USSES, and Rambouillet, Suffolk, and Polypay breeds coupled with NSIP GEBV. Genetic analyses will estimate trait variation and heritability to examine what subset of traits can be most useful in selection schemes to improve

productive ewe longevity. Little is known on the effect of Cache Valley Virus on udder health or lasting health issues after lambing and needs to be further explored.

Virginia State University

Effect of Age on Pregnancy Rates of Landrace Hair Sheep Replacement Ewe Lambs during Different Seasons

Stephan Wildeus and Dahlia O'Brien

Objectives: This project evaluated the impact on pregnancy outcome after exposing Barbados Blackbelly and St. Croix ewe lambs at 7- and 11-month of age.

Procedure: Breeding ewes were managed under accelerated mating (8-month cycle) in a forage-based production system using rotational grazing. Two sub-flocks were bred 4 months apart in July, November, and March in a 25-day mating period. Pregnancy was recorded by transrectal ultrasound at the end of breeding and again 22 days later. In this study, 7- and 11-month old Barbados and St. Croix ewe lambs (n = 4 – 12 lambs/age group/season) were introduced for breeding. To be assigned to breeding, ewe lambs had to exceed 25 kg at 7 months of age. Mating, pregnancy and fetal number data were collected during four breeding seasons and were analyzed by frequency analysis (estrus and pregnancy response), and analysis of variance (body weight and fetal numbers).

Results: Body weight at breeding ranged from 58.8% to 85.5% of adult ewe weight for 7- and 11-month old ewe lambs, respectively. During November breeding pregnancy rates for all age groups was 100%, but fetal numbers increased significantly from 1.10 to 1.50 to 1.94, in the three age groups. During July and March matings no 7-month old lambs became pregnant, though 75% and 60 % were bred, respectively. In contrast, pregnancy rates were 86 and 92% for 11-month old lambs during July and March matings and not different from adult ewes, while fetal number were significantly lower in both July (1.12 vs. 1.61) and March (1.40 vs. 1.72).

Impact: Results suggest that season rather than age and body weight had the greatest influence on pregnancy outcome in replacement ewe lambs.

Objective 4: Disseminate research results and information to stakeholders

Langston University

Langston University Conference on Goats, Hair Sheep, & Sustainable Farming

Terry Gipson and Roger Merkel

Objective: Since 1986, the Goat and Hair Sheep Field Day has been an annual producer-education event that 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: In 2023, a change was made to the traditional field day format whereby the Goat and Hair Sheep Field Day was combined with the Small Farmers Conference that has been presented by Langston University. The two-day event was held on April 21 and 22, 2023. In the inaugural year of this combined event, the theme for the Friday session was "Sustainable and Profitable Plant Systems for Small-Scale Producers" and had sessions on crops, human nutrition, farm machinery and plant production. The theme for the Saturday session was "Producer to Consumer: Cost-effective Hair Sheep, Dairy & Meat Goat Operations." The Saturday program is printed below. Hands-on and classroom sessions were presented.

Results: This was the first year for the combined workshop. Plans for the 2024 combined event include more integration of livestock sessions with other presentations over both days, rather than the 2023 format where all animal sessions were held on Saturday.

Overall response from attendees was positive with some suggestions to avoid conflicts among different presentations and suggestions for other topics.

LANGSTON UNIVERSITY

Sherman Lewis School of Agriculture and Applied Sciences

Langston University Conference on Goats, 'Hair Sheep' & Sustainable Farming

Goat & Hair Sheep Field Day Program/ Producer to Consumer: Cost-effective Hair Sheep, Dairy & Meat Goat Operations

Saturday April 22, 2023

	Location
8:00 Registration 9:00 Moderator/ **Dr. Maytubby**/ Langston University 9:05 Welcome to Goat & Hair Sheep Field Day/ **Dr. Wesley Whittaker**, Dean/ Langston University 9:15 Overview of Research at SLSAAS/ **Dr. Zaisen Wang** / Langston University 9:25 Mitigating Lack of Access to Small Ruminant Processing in Virginia/ **Dr. Dahlia O'Brien**/ Virginia State University 10:10 Break 10:30 Internal Parasite control/ **Dr. Barry Whitworth**/ Oklahoma State University 11:15 The Master Goat and Sheep Certification Program/ **Dr. Angela McKenzie-Jakes**/ Florida A&M University 12:00 Announcements and LUNCH	Allied Health Center Auditorium

Afternoon Workshops

Time: 1 :30 To 3 :00 Conference Room 334	Time: 1 :30 To 3 :00 South Farm	Time: 1 :30 To 3 :00 Room 331	Time: 2 :00 To 3 :00 Dairy Farm Arena	Time: 1 :30 To 4 :30 Dairy Farm Creamery
USDA Programs: Climate Change **Dr. Andres Ciblis** Conservation programs **Mr. Nick Jones** Farm loans **Ms. Kimberly White** **Mr. Brian Cooper** Wildlife Services **Mr. Scott Alls**	Basic Herd Health and Management **Dr. Lionel Dawson** Oklahoma State University Basic Goat Husbandry **Dr. Roger Merkel** Langston University	Nutrition with LINC **Dr. Ryszard Puchala** Langston University Dairy Herd Improvement **Dr. Luana McCaughey** Langston University	Fitting and Showing for Youth and Adults **Ms. Amanda Manley** Langston University	Cheesemaking: Crafting Soft Lactic and Semi Hard Goat **Dr. Carlos Alvarado** Langston University
Time: 3 :00 To 4 :30 **Conference Room 334**	**Time: 3 :00 To 4 :30** **South Farm**	**Time: 3 :00 To 4 :30** **Room 331**	**Time: 3 :30 To 4 :30** **Dairy Farm Arena**	
USDA Programs: Climate Change **Dr. Andres Ciblis** Conservation programs **Mr. Nick Jones** Farm loans **Ms. Kimberly White** **Mr. Brian Cooper** Wildlife Services **Mr. Scott Alls**	Basic Herd Health and Management **Dr. Lionel Dawson** Oklahoma State University Basic Goat Husbandry **Dr. Roger Merkel** Langston University	Cookery **Dr. Tiffany Williams** Langston University Budgets **Dr. Nirodha De Silva** Langston University	Fitting and Showing for Youth and Adults **Ms. Amanda Manley** Langston University	
Time: 4:30 To 5:30 **Dairy Farm**	Langston University's Goat Farm Tour/ **Dr. Steve Hart**/ Langston University			

Artificial insemination workshop

Terry Gipson, Jerono Kiptanui, Lionel Dawson, Les 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 Main 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.

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

University of Florida

Small Ruminant Short Course (September 29-30, 2023)

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 2023 University of Florida Ram Test and Sale.

Agenda:

Friday, September 29

Location: Straughn Professional Development Center

7:30 - 8:30 Registration

8:30 - 8:40 Opening

8:40-9:40 Small Ruminant Parasite Management

9:40-10:00 Refreshment Break

10:00-11:00 Research Updates

11:00-12:00 Small Ruminant Nutrition

12:00-1:00 Lunch

1:00-2:00 Breakout Sessions - 3 Options

2:00-2:20 Refreshment Break 2:20-3:00 Marketing & Economics

3:00-4:00 Producer Panel

4:00-5:30 Meats Lab Demonstration

6:00-8:00 HTU - Producer Mixer & Trade Show Sale Rams Available for Viewing

Saturday, September 30

Location: Horse Teaching Unit

8:00 Registration

8:00-8:15 Opening

8:15-9:00 Ram Test Data Overview

9:00-12:00 Short Rotations & Trade Show Sale Rams Available for Viewing

12:00-1:00 Lunch

1:00-2:00 FAMACHA Training Advanced Registration Required

2:30-3:30 FAMACHA Certification

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 (June-September 2023)

Objective: Our 3rd 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 producers in FL and GA with 41 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 17 rams were eligible for auction.

Results: Rams were sold online (Willoughby Sales online auction) for an average of $922/ram and the highest selling ram sold for $5,350. NSIP enrolled rams, average sale price was $3,575/ram.

Impact: This program just completed its 3rd year and has grown in popularity amongst sheep producers. In response to the small ruminant industry's desire for expansion of these programs, we will be launching our inaugural UF Buck Test & Sale in 2024. This Buck Test will run parallel but separately from our UF Ram Test. The online sale of the top performing rams and bucks will take place at the 2024 UF/IFAS Small Ruminant Short Course.

Virginia State University

Pasture Lambing Workshop

Dahlia O'Brien and Stephan Wildeus

Objectives: Hair sheep have been a growing segment of the U.S. sheep and small ruminant industry. They are well suited for sustainable, pasture-based production and are a good fit for novice producers. Pasture lambing is an option for sheep producers who wish to cut down on labor demands and feed costs associated with barn/in-door lambing systems. This workshop is meant to explore pasture lambing as an option for VA's hair sheep producers. In this workshop, the biology of gestation and parturition, preparation for lambing, supplies needed, demonstration

of lambing positions, dealing with complications and the unexpected and the processing of newborn lambs, were covered. There was also an opportunity for hands-on exposure to activities associated with lambing.

Procedure: This workshop was conducted during the peak of lambing of the VSU research flock in July. During the morning session, participants were provided with information on sheep reproductive biology, advanced reproductive techniques in sheep and theoretical background on ewe gestation and parturition, on preparation for lambing and supplies needed, and demonstration of lambing position and dealing with complications and the unexpected, using a simulator and stillborn lambs. In the afternoon session participants observed and processed lambs born on pasture. The workshop was limited to 12 participants.

Results: Participants were provided with an evaluation form to rate their experience and knowledge gained, provide comments and also to indicate the need for additional educational events. All participants indicated that the workshop met or exceeded their expectations and acknowledged the hands-on experience and opportunities for one-to-one dialogue with speakers as highlights.

Impact: The participant evaluation indicated that the workshop filled an educational need, increased participants skills in lamb processing and encouraged producers to explore the option of low-input pasture lambing in their operation.

Online FAMACHA© Certification Program Aids in the Battle Against Small Ruminant Internal Parasites in Virginia and Beyond

Dahlia O'Brien and Niki Whitley

Objectives: Even though small ruminant production can be profitable, infections with worms impact the productivity of grazing animals significantly. Worm infections, especially by the barber pole worm (*Haemonchus contortus*), is the number one health problem affecting sheep and goats on pasture. Traditionally, producers relied on chemical treatments (dewormers) to control infections. However, due to mis-use and over-use, internal parasites have developed resistance to multiple classes of available dewormers. There is an urgent need for producers to adapt sustainable integrated control strategies, such as the FAMACHA© system, for parasite control and reduce reliance on chemical dewormers to prolong drug efficacy on farms. In addition, they need to be aware of current recommendations for effective parasite control on farms.

Procedure: Virginia State University Cooperative Extension collaborated with Fort Valley State University to develop and implement an online integrated parasite management and FAMACHA© certification program for extension agents and producers in VA and GA in 2020.

Since then, this program was made available on the website of the American Consortium for Small Ruminant Parasite Control. To receive certification, all participants are required to watch a recorded YouTube video (https://www.wormx.info/online-famacha-certification), take an online quiz (passing grade of 70%) and submit a video of themselves conducting the FAMACHA© eye score on a sheep, goat, llama or alpaca using the correct technique. A certificate and FAMACHA card were mailed to each successful participant. To evaluate the impact of this program since its inception in 2020, a follow-up survey was emailed to 110 producers completely certified through the online program.

Results: There was a response rate of 45% (50/110). To date, this program has reached: 1,600 views of the YouTube video, 386 producers have taken the on-line quiz (24% of viewers), 110 participants have submitted video demonstrations and were certified (28% of quiz takers), 98% of respondents are located in the US (one respondent was from Jamaica;2%), US respondents were from Alabama (9%), Arkansas (3%), Georgia (9%), Indiana (3%), Kentucky (6%), Maryland (3%), North Carolina (12%), Ohio (6%), Oklahoma (12%), Tennessee (3%), Texas (3%), Virginia (24%), Washington (3%) and West Virginia (3%). In terms of program satisfaction:100% of respondents moderately to extremely satisfied with the program and 100% would recommend program to other producers/stakeholders. Additionally, 96% use their FAMACHA cards to make deworming decisions to save animal life, 100% indicated that this training made a difference in their ability to control internal parasites in their flock/herd and 57% of respondents indicated that they have seen an economic benefit from what they learned from the program ($100 - $300 each)

Impact: This program conducted under this topic area resulted in increased knowledge in producers, agents and youth on small ruminant internal parasite management and resulted in 110 individuals receiving FAMACHA© certification virtually.

Homesteaders Gains New Skill and Marketing Opportunity Utilizing VSU's Small Ruminant Mobile Processing Unit (MPU)

Dahlia O'Brien and Stephan Wildeus

Objectives: Shortage and high-costs of accessible processing facilities for Virginia's small ruminant producers means missing out on lucrative market opportunities for locally produced meats. Without addressing this critical issue, the small, limited resource sheep and goat producers that we serve in Virginia 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 more state or federally inspected processing facilities. Through a grant awarded from the USDA (2015-38821-24338), Virginia State University (VSU) designed and built a Mobile Processing Unit (MPU) to enhance marketing opportunities for Virginia's small ruminant producers.

Procedure: In 2021, VSU's MPU certification program was launched with the model of training producers to be their own butchers. As certified butchers, farmers can apply for a Grant of Inspection and lease the MPU from VSU. During 2023, homesteaders Fiona Balestrieri and Seth Swingle, MPU certified in 2022, leased VSU's MPU to process goats under USDA inspection at their farm in Stanardsville, VA. Over a 4-day leasing period in July of 2023, Fiona and Seth processed 12 of their own goats on their farm under USDA-inspection.

Results: As a result of utilizing the MPU in 2023, the following results were generated by Hollow Bone Farm: **Knowledge/skill gained:** increased understanding of food safety procedures in an-inspected facility, skill development in humane slaughter and processing, and skill development in goat carcass fabrication, packaging and labeling. **Producer livelihoods improved**: economic benefit of utilizing the MPU in 2023 with profits totaling approximately $3,500 and new marketing opportunities in the form of direct meat sales to producers and local farmers market.

Impact: The development of this unit provides small and limited resource producers access to an additional USDA-inspected slaughter facility so they can process their own animals and take full advantage of profitability in the growing local food system marketplace.

West Virginia University

West Virginia Buck Performance Test

S.A. Bowdridge

Objectives: This program was established to provide producers an unbiased evaluation of economically important traits in young bucks using a common environment.

Procedure: At delivery bucks will be weighed, vaccinated for clostridial diseases and soremouth, be dewormed and any other procedures as recommended by our clinical veterinarian. Bucks will be randomly allocated to one of four pens. After a two-week adjustment period, bucks will start on test. At this time all bucks will receive 5,000 Haemonchus contortus larvae and fecal samples will be taken on-test, 35 days and off-test. Weights will be taken at the beginning of the test, 21 days, 3 5 days, 49 days and off test (63 days). Average weights, 12 hours apart will be used for on and off test weights. The following performance measures will be determined: Test Average Daily Gain (ADG)= total weight gain / number of days on test ADG Ratio = individual ADG / test group average ADG Ultrasound Loin Muscle Area (REA) = adjusted to 100 lbs of live weight REA Ratio = individual adjusted REA / test group average REA Fecal Egg Count (FEC) = Average FEC over three samplings FEC Ratio = adjusted FEC I test group average Overall Index = (0.4*FEC Ratio)+ (0.3*REA Ratio)+ (0.3*ADG Ratio) Bucks will be fed ad-libitum a pelleted ration containing approximately 75% TDN and 16% CP. Ultrasonic evaluation for

carcass merit will be conducted approximately 1 week before the conclusion of the test. FAMACHA scores will be performed weekly to determine if a buck requires deworming. Bucks requiring deworming will be removed from ranking consideration.

Results: 231 bucks arrived at the test from 52 different producers representing 17 different states

Impact: This test is the largest goat performance test in the US and provides Kiko producers a consistent testing site to evaluate potential herd sires

Objective 5: Identify producers' challenges and opportunities in marketing goats and goat products

Langston University

Consumer Preference for Goat Meat

N. DeSilva

Objective: To determine factors that influence consumer preferences for goat meat.

Procedure: A survey on consumer preferences for goat meat and potential factors that influence goat meat demand was conducted in 40 counties in Oklahoma. The primary research question is to determine the consumers' willingness to purchase goat meat. The sample size was determined by the probability sampling method.

Results: Results of the survey conducted indicate that respondents' education level, gender, household income, price specials, and safety assurances, such as USDA inspections of goat meat, significantly affect consumers' willingness to purchase goat meat. Age and ethnicity variables had no statistically significant effect on the consumers' goat meat consumption.

Inferences show that gender has a positive and statistically significant effect on the probability of purchasing goat meat. The marginal effect indicates that males are 13% more likely to consume goat meat than females. Education level was positive and significant at the 10% level. The marginal effect of education implied that individuals with a university/college degree are 14.6% more likely to buy goat meat than individuals with some school. This is likely because education increases individuals' awareness of healthy food and nutritional values.

Impact: Preliminary conclusions recommend that marketers should focus on all consumers and all ethnic groups. The goat meat industry should focus on an educational campaign about all aspects of the product. If goat meat products are sold as prepackaged cuts with cooking instructions and promoted as a healthy alternative to other meats, consumers will likely be encouraged to purchase them regularly. Producers will benefit as they will better understand the goat meat characteristics that the consumer desires.

Publications and Collaborations

North Carolina State University

Journal Articles:

Bentley, K.L., A.R. Weaver, D.L. Wright, S.P. Greiner, S.A. Bowdridge. 2023. Post-weaning fecal egg count estimated breeding value is associated with greater antibody production after clostridial vaccination in Katahdin lambs. Small Ruminant Research (229). doi.org/10.1016/j.smallrumres.2023.107128

Weaver, A.R., D.L. Wright, S.P. Greiner, S.A. Bowdridge. 2023. Effect of sire fecal egg count estimated breeding value on parasite resistance traits in *Haemonchus contortus* infected Katahdin lambs. Small Ruminant Research (223). doi.org/10.1016/j.smallrumres.2023.106970

Weaver, A.R., D.L. Wright, S.P. Greiner, S.A. Bowdridge. 2023. Effect of sire fecal egg count estimated breeding value on Katahdin lamb parasite resistance in pasture-based system. Small Ruminant Research (224). doi.org/10.1016/j.smallrumres.2023.106984

Abstracts and Proceedings:

Weaver, A.R., J. Smith, A. Brown, J.R. Rogers, D. Holcomb, L. Holcomb. 2024. Effect of grazing native warm season grasses on parasitism and growth in weaned Katahdin lambs. Southern Section ASAS, Louisville, KY. Accepted.

Geniac, V.M., D.L. Wright, S.P. Greiner, S.A. Bowdridge, A.R. Weaver. 2024. Effect of copper oxide wire particles on parasitism and growth in Katahdin lambs divergently selected for fecal egg count estimated breeding value. Southern Section ASAS, Louisville, KY. Accepted.

Bentley, K.L., A.R. Weaver, D.L. Wright, S.P. Greiner, S.A. Bowdridge. 2024. The effect of postweaning fecal egg count EBV on colostrum IgG concentration and color in Katahdin dams. Southern Section ASAS, Louisville, KY. Accepted.

Valliere, N.K., D.L. Wright, A.R. Weaver, S.A. Bowdridge, S.P. Greiner. 2024. Evaluation of feed efficiency and feeding behavior in Katahdin lambs house in a Vytelle Sense system. Southern Section ASAS, Louisville, KY. Accepted.

Williams, K.G., A.R. Weaver, D.H. Poole, C.L Pickworth. 2024. Evaluation of internal parasite burden in grazing beef cattle in North Carolina over a production lifecycle. Southern Section ASAS, Louisville, KY. Accepted.

Rogers, J.R., M.H. Poore, A.D. Shaeffer, A.R. Weaver, P. Siciliano, D.D. Harmon. Amazing Grazing webinar and workshop series improves producers understanding of pasture ecology. Southern Section ASAS, Louisville, KY. Accepted.

Poore, M.H., A.D Shaeffer, J.R. Rogers, A.R. Weaver, P. Siciliano, D.D. Harmon. Pastureland Ecology 1 provides hands-on training in grazing management for USDA-NRCS professionals. Southern Section ASAS, Louisville, KY. Accepted.

Others:

Weaver, A.R., C.L. Maierle. 2023. Quantifying the Climate Benefits of Prescribed Grazing. Eastern Alliance for Production Katahdins Newsletter.

Weaver, A.R. 2023. Impact of NSIP Status on Ram Value. Eastern Alliance for Production Katahdins Newsletter.

Weaver, A.R., J.R. Rogers. 2023. Making the Most of Your Pastures with Multi-species Grazing. Cattlemen's Connection.

Collaborations:

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.

Tennessee State University

Journal Articles:

da Silva, M. S., Browning Jr, R., Leite-Browning, M. L., and Lobo, R. N. B. 2023. Genetic parameters for fecal eggs count and reproductive/maternal efficiency of does raised in humid subtropical climate. Small Ruminant Research, 220, 106929. https://doi.org/10.1016/j.smallrumres.2023.106929

Abstracts and Proceedings:

Hayes, E. G., Stevens, L., Thomas, S., Hillin, K., and Browning, R. 2023. Residual effects of creep feed management on reproductive performance of meat goat does across multiple years. J. Anim. Sci. 101:101 (Suppl. 1). https://doi.org/10.1093/jas/skad068.121

Landskroener, C., Hayes, E. G., and Browning, R. 2023. The effects of co-twin sex on fitness traits in young meat goat does. J. Anim. Sci. (abstr.). ASAS-CSAS Annual meeting, July 16-20, Albuquerque, NM.

USDA, Agricultural Research Service, Booneville, AR

Journal Articles:

Acharya, R.S., Burke, J.M., Joshi, N., 2024. Assessing pollinator-seed mix plantings for the presence of undesirable plant species in the livestock pasture system. J. Entomol. Sci. (In Press).

Nilson, S.M., Burke, J.M., Murdoch, B.M., Morgan, J.L.M., Lewis, R.M., 2024. Pedigree diversity and implications for genomic selection of Katahdin sheep. J. Anim. Breed. Genet. 00, 1-13. https://doi.org/10.1111/jbg.12842

Arisman, B.C., Burke, J.M., Morgan, J.L.M., Lewis, R.M., 2023. Genotype by environment interaction and heteroscedasticity influence the expression of parasite resistance in Katahdin sheep. J. Anim. Sci. skad228, https://doi.org/10.1093/jas/skad228.

Burke, J.M., Miller, J.E., Orlik, S.T., Garza, J.J., Acharya, M., Wood, E., Terrill, T.H., 2023. Case study: Sericea lespedeza leaf meal fed to sheep and goats reduces serum concentrations of trace minerals. Sheep Goat Res. J. 38, 1-10.

Arisman, B.C., Burke, J.M., Morgan, J.L.M., Lewis, R.M., 2023. Clustering climate and management practices to define environmental challenges affecting gastrointestinal parasitism in Katahdin sheep. J. Anim. Sci. 101, 1-10; https://doi.org/10.1093/jas/skad002.

Abstracts and Proceedings:

Gunes, H.Y., Howard, R., Fudolig, M., Burke, J.M., Lewis, R.M. 2023. Fit of the zero-inflated negative binomial model to analyze fecal egg counts. J. Anim. Sci. (abstr. National ASAS, July 2023).

Lewis, R.M., Freking, B.A., Heaton, M.P., Gore, K., Burke, J.M., Pejsar, B.G., Burgett, R.L., Brown, D.J., 2023. Determining genetic conditions in U.S. sheep with a medium density ovine bead array. J. Anim. Sci. (abstr. Western Sec. ASAS).

Rocha, A.O., Gloria, L.S., Araujo, A.C., Wen, H., Freking, B.A., Murphy, T.W., Burke, J.M., Lewis, R.M., Brito, L.F., 2023. The impact of genotyping strategies on accuracy of genomic prediction in sheep populations: preliminary results of a simulation study. J. Anim. Sci. (abstr. National ASAS, July 2023).

Hess, A.S., Murphy, T.W., Miller, J.E., Burke, J.M., 2023. Genetic parameter estimates of post-weaning growth and gastrointestinal nematode infection traits of Katahdin lambs. J. Anim. Sci. (abstr. National ASAS, July 2023).

Murphy, T.W., Hess, A.S., Burke, J.M., Miller, J.E., 2023. Birth season (fall vs. winter) and production system (conventional vs. organic) effects on post-weaning growth and gastrointestinal nematode infection of Katahdin lambs. J. Anim. Sci. (abstr. National ASAS, July 2023).

Becker, G.M., Thorne, J.W., Burke, J.M., Lewis, R.M., Notter, D.R., Morgan, J.L.M., Schauer, C.S., Stewart, W.C., Redden, R.R., Murdoch, B.M. 2023. Genetic diversity of United States Rambouillet, Dorper, and Katahdin sheep. Int. Soc. Anim. Genet. Conf., S. Africa, Jul 2023.

Nilson, S.M., Burke, J.M., Lewis, R.M., 2023. Pedigree effective population size affects genomic prediction accuracy in Katahdin sheep. J. Anim. Sci. (abstr. Midwest ASAS).

Nilson, S.M., Burke, J.M., Lewis, R.M., 2023. Pedigree inbreeding and relatedness in Katahdin sheep in the National Sheep Improvement Program. Plant & Anim. Gen. Conf., San Diego, CA.

Burke, J.M., Lewis, R.M., Notter, D.R., 2023. The impact of sire parasite resistance on offspring gastrointestinal nematode indicators, and relative impact of lamb breeding values on sale value of ram lambs. Southern Section ASAS, Raleigh, NC Jan 2023.

Others:

Lewis, R., Murphy, T., Freking, B., Burke, J., 2023. Sheep GEMS update: lambing assistance and udder health scores. Eastern Alliance for Production Katahdins Winter 2023 Newsletter.

Burke, J.M., Lewis, R.M., Notter, D.R., 2023. How does selection for parasite resistance in Katahdin sheep affect other important traits? Eastern Alliance for Production Katahdins Newsletter.

Burke, J.M. (Apr 2023). Use of Red Cell to hasten recovery from anemia associated with barber pole worm. For the Love of Goats. Podcast.

Collaborations:

Statement: Scientists from USDA, ARS, DBSFRC collaborated with members from Tuskegee, North Carolina State University, and nonmembers from USDA, ARS, MARC, Clay Center, NE and U.S. Sheep Experiment Station, Dubois, ID, Louisiana State University, University of Rhode Island, University of Idaho, University of Nebraska-Lincoln, Purdue University, University of

Arkansas, Virginia Tech, on research that addressed management of gastrointestinal nematodes and out-of-season breeding. Collaborative research was conducted, and resources shared.

Virginia State University

Journal Articles:

Lee, J.H., Wildeus, S., Lemma, B.B., Kouakou, B. 2023. Carcass and meat quality characteristics of purebred (hair) and crossbred (wool × hair) sheep lambs grazing fescue pasture as influenced by breed type, sex, and supplementation. Journal of Applied Animal Science Research 52(1):1-14. https://doi.org/10.1080/09712119.2023.2290131

Abstracts and Proceedings:

Wildeus, S. and D. O'Brien, D. 2023. Growth, Libido, Semen Quality, and Reproductive Organ Weights of Hair Sheep Rams Rendered Short-Scrotum at Birth or Weaning. J. Anim. Sci., Vol. 101, Suppl.1: 104–105. https://doi.org/10.1093/jas/skad068.125

Robertson, M., S. Wildeus, D. O'Brien, K. Pelzer. 2023. Impact of a Cache Valley Fever Outbreak on Lambing Performance in a Landrace Hair Sheep Flock: A Case Study. J. Anim. Sci., Vol. 101, Suppl.1: 122. https://doi.org/10.1093/jas/skad068.146

Beal, D., J.H. Lee, S. Wildeus, D. O'Brien, A. Singh, B. Kouakou. 2023. Meat Quality of Barbados Blackbelly and St. Croix Hair Sheep Lambs Rendered Short Scrotum or Castrated at Weaning. J. Anim. Sci., Vol. 101, Suppl. 1: 103–104. https://doi.org/10.1093/jas/skad068.124

O'Brien, D., K. Matthews, S. Wildeus, N.C. Whitley, S. Schoenian. 2023. The efficacy of copper oxide wire particles alone or in combination with moxidection to reduce parasite loads in meat goat kids. J. Anim. Sci., Vol. 101, Suppl.1: 107-108. https://doi.org/10.1093/jas/skad068.129

Davis, J., D. O'Brien, K. Matthews, S. Wildeus, N.C. Whitley, S. Schoenian. 2023. The efficacy of a natural fungus (Duddingtonia Flagrans) in controlling gastrointestinal nematodes in lactating meat goat does. J. Anim. Sci., Vol. 101, Suppl.1: 119-120. https://doi.org/10.1093/jas/skad068.143

Collaboration:

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.

West Virginia University

Journal Articles:

Bentley, K.L., A.R. Weaver, D.L. Wright, S.P. Greiner, and S.A. Bowdridge. 2023. Post-weaning fecal egg count estimated breeding value is associated with greater antibody production after clostridial vaccination in Katahdin lambs. Sm. Rum. Res. 229:107128.

Weaver, A.R., D.L. Wright, S.P. Greiner, and S.A. Bowdridge. 2023. Effect of sire fecal egg count estimated breeding value on parasite resistance traits in Haemonchus contortus infected Katahdin lambs. Sm. Rum. Res. 222: 106970. DOI:10.1016/j.smallrumres.2023.106970.

Weaver, A.R., D.L. Wright, S.P. Greiner, and S.A. Bowdridge. 2023. Effect of sire fecal egg count estimated breeding value on Katahdin lamb parasite resistance in pasture-based system. Sm. Rum. Res. 224:106984. DOI:10.1016/j.smallrumres.2023.106984.

Abstracts and Proceedings:

Thorne, J.W., Redden, R., Bowdridge, S.A., Bentley, K.L.,Becker, G.M., Stegemiller, M.R. and Murdoch, B.M. 2023. PSII-5 Evaluating *Haemonchus Contortus* Resistance in Hair Sheep Lambs Under Divergent Selection for Reduced Fecal Egg Count. J. Anim. Sci. 101:Suppl_3. DOI: 10.1093/jas/skad281.760.

Johnson, S.R., Middleton, D., Greiner, S.P. and Bowdridge, S.A. 2023. The effect of innate immune receptor activation on differential breed responses to Haemonchus contortus in sheep. J. Anim. Sci, 101:Suppl_1. DOI: 10.1093/jas/skad068.132

Teddleton, H.G. J.J. Garza, S.P. Greiner, and S.A. Bowdridge. 2023. Effect of sheep breed on neutrophil chemotaxis to Haemonchus contortus larval antigen. J. Anim. Sci. 101:Suppl_1. DOI:10.1093/jas/skad068.126.

Bentley, K.L., D.L. Wright, S.P. Greiner, and S.A. Bowdridge. 2023. Evaluating lipopolysaccharide-induced behavioral and immune response differences in sheep divergently bred for parasite resistance. J. Anim. Sci. 101:Suppl_1. DOI:10.1093/jas/skad068.127.

Valliere, N.K., D.L. Wright, S.P. Greiner, S.A. Bowdridge and A.R. Weaver. 2023. Evaluation of supplemental feeding behavior and growth performance in Katahdin lambs divergently selected for fecal egg count estimated breeding value. J. Anim. Sci. 101:Suppl_1. DOI:10.1093/jas/skad068.128.

Bentley, K.L., A.R. Weaver, D.L. Wright, S.P. Greiner, and S.A. Bowdridge. 2023. The effect of postweaning fecal egg count EBV on colostrum IgG concentration in Katahdin dams. J. Anim. Sci. 101:Suppl_1. DOI: 10/1093/jas/skad068.130.

Maierle, C.L., A.R. Weaver, S.P. Greiner, E.E Felton, and S.A. Bowdridge. 2023. Evaluation of feeding behavior of Katahdin lambs during Haemonchus contortus infection. J. Anim. Sci. 101:Suppl_1. DOI:10.1093/jas/skad068.131.