Research Overview
Dr. Arthur Goetsch
Goat Research Leader

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

A large proportion of the Institute’s research program is made possible by grants, many of which are through USDA programs. Although dissemination of information generated from all of these projects occurs, some entail strong extension components. Likewise, there are projects listed in our international section that entail significant research components.

To provide an idea about our research program since the last Field Day, listed below are research projects and experiments we have been involved with in 2009, abstracts for 2010, and summaries of scientific articles that were published in 2009 and 2010 or currently are “in press.”.

Standard Abbreviations Used

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tbody>
<tr>
<td>BW</td>
<td>body weight</td>
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<td>CP</td>
<td>crude protein</td>
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<td>dL</td>
<td>decaliter</td>
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<tr>
<td>DMI</td>
<td>dry matter intake</td>
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<td>kg</td>
<td>kilogram</td>
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<td>M</td>
<td>mole</td>
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<tr>
<td>MEI</td>
<td>ME intake</td>
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<td>mm</td>
<td>millimeters</td>
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<tr>
<td>ng</td>
<td>nanogram</td>
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<tr>
<td>OM</td>
<td>organic matter</td>
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<td>SE</td>
<td>standard error</td>
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<td>wt</td>
<td>weight</td>
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<td>vs</td>
<td>versus</td>
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<td>centimeters</td>
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<td>d</td>
<td>day</td>
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<tr>
<td>DM</td>
<td>dry matter</td>
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<td>g</td>
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<td>L</td>
<td>liter</td>
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<tr>
<td>ME</td>
<td>metabolizable energy</td>
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<td>mL</td>
<td>milliliter</td>
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<tr>
<td>mo</td>
<td>month</td>
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<tr>
<td>NDF</td>
<td>neutral detergent fiber</td>
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<tr>
<td>P</td>
<td>probability</td>
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<td>TDN</td>
<td>total digestible nutrients</td>
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<tr>
<td>vol</td>
<td>volume</td>
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<td>µ</td>
<td>micro</td>
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Research Projects
Current Research Projects (2007-2010)

<table>
<thead>
<tr>
<th>Title:</th>
<th>Enhanced Goat Production and Products in the South-Central U.S.</th>
</tr>
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<tbody>
<tr>
<td>Type:</td>
<td>CSREES project</td>
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<tr>
<td>Project Number:</td>
<td>OKLX-SAHLU</td>
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<tr>
<td>Period:</td>
<td>2006-2011</td>
</tr>
<tr>
<td>Institution:</td>
<td>Langston University</td>
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<tr>
<td>Objective:</td>
<td>Study goat feeding and management, relevant health issues, and milk product technologies in order to increase the level and efficiency of goat productivity for increased profitability from goat production and lower costs to consumers of goat products.</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Title:</th>
<th>Characterization of the Energy Requirement for Activity by Grazing Ruminants</th>
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<tbody>
<tr>
<td>Type:</td>
<td>USDA 1890 Institution Research Capacity Building</td>
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<tr>
<td>Project Number:</td>
<td>2005-38814-16352</td>
</tr>
<tr>
<td>Period:</td>
<td>T. Sahlu¹, R. Puchala¹, A. L. Goetsch¹, T. A. Gipson¹, and B. Kouakou²</td>
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<tr>
<td>Institutions:</td>
<td>¹Langston University and ²Fort Valley State University</td>
</tr>
<tr>
<td>Objectives:</td>
<td>Develop and evaluate a system to predict the grazing activity energy cost for ruminants by determining effects of animal and dietary conditions on energy expenditure, metabolizable energy intake, the grazing activity energy cost, grazing and walking times, and horizontal and vertical distances traveled.</td>
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<thead>
<tr>
<th>Title:</th>
<th>The Ability of Goats to Withstand Harsh Nutritional Environments</th>
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<tr>
<td>Type:</td>
<td>USDA 1890 Institution Research Capacity Building</td>
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<tr>
<td>Project Number:</td>
<td>2005-38814-16353</td>
</tr>
<tr>
<td>Period:</td>
<td>2005-2010</td>
</tr>
<tr>
<td>Investigators:</td>
<td>A. L. Goetsch¹, R. Puchala¹, T. Sahlu¹, and H. C. Freetly²</td>
</tr>
<tr>
<td>Institutions:</td>
<td>¹Langston University and ²Meat Animal Research Center</td>
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<tr>
<td>Objectives:</td>
<td>Determine if there are differences between goats and sheep and between meat goat species of the US in the ability to utilize diets with limited supplies of nitrogen and energy and to characterize the physiological bases of any such differences.</td>
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<tr>
<th>Title:</th>
<th>International Collaboration in Goat Research and Production Web-Based Decision Support Aids</th>
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<tr>
<td>Type:</td>
<td>USDA International Science and Education Competitive Grants Program</td>
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<tr>
<td>Project Number:</td>
<td>2005-51160-02281</td>
</tr>
<tr>
<td>Period:</td>
<td>2005-2009</td>
</tr>
<tr>
<td>Investigators:</td>
<td>A. L. Goetsch and T. A. Gipson</td>
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<tr>
<td>Institution:</td>
<td>Langston University</td>
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<tr>
<td>Goal:</td>
<td>Facilitate future collaborative research between the American Institute for Goat Research (AIGR) and institutions in Arabic-, Chinese-, French-, and Spanish-speaking countries, as well as to gain knowledge of goat research and production practices in other areas of the world.</td>
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<tr>
<td>Objectives:</td>
<td>Translate and adapt two web-based goat production and research decision-support tools developed at the AIGR (goat nutrient requirements and feed intake; goat production system simulation model) for use and future collaborative research in the Middle East, China, France and other French-speaking countries, and Central and South America.</td>
</tr>
</tbody>
</table>
Title: Energy Expenditure for Activity in Free-Ranging Ruminants: A Nutritional Frontier
Type: United States - Israel Binational Agricultural Research and Development Fund
Project Number: US-3694-05 R
Period: 2005-2009
Investigators: A. L. Goetsch¹, Y. Aharoni², A. Brosh², R. Puchala¹, T. A. Gipson¹, Z. Henkin³, and E. Ungar⁴
Institutions: ¹Langston University, ²Newe Ya’ar Research Center, Agricultural Research Organization, ³MIGAL-Galilee Technology Center, and ⁴Agronomy and Natural Resources, Agricultural Research Organization
Objectives: Develop and evaluate a system(s) to predict the grazing activity energy cost of ruminants by determining effects of stocking rate (influencing available forage mass and forage quality) and animal production state and season (affecting energy demand) on energy expenditure, metabolizable energy intake, energy expended in grazing activity, grazing and walking times, horizontal and vertical distances traveled, and diet quality with grazing females of two breeds of cattle and goats.

Title: The Grazing Activity Energy Cost of Goats
Type: United States - Egypt Joint Science and Technology Fund Program
Project Number: BIO11-001-005
Period: 2007-2010
Investigators: A. L. Goetsch¹, R. Puchala¹, T. A. Gipson¹, H. El Shaer², and A. Helal²
Institutions: ¹Langston University and ²Desert Research Center
Objective: • Determine the magnitude of the grazing activity energy cost of goats under different common production settings in an arid region of Egypt and in the south-central U.S.
• Develop simple means of predicting the grazing activity energy cost of goats based on factors relatively easily estimable by farmers.

Title: Impact of Sub-Clinical Mastitis on Production and Quality of Goat Milk and Cheese
Type: USDA 1890 Institution Research Capacity Building
Project Number: 2007-38814-18474
Period: 2007-2010
Investigators: S. S. Zeng¹, D. Bannerman², and L. Spicer³
Institutions: ¹Langston University, ²USDA ARS Bovine Functional Genomics Laboratory, and ³Oklahoma State University
Objective: • Assess prevalence of subclinical mastitis in dairy goats during a year-round lactation in Oklahoma
• Quantify and qualify losses in milk yield and cheese production associated with subclinical mastitis test the impact of major types of CNS bacteria
• Test the impact of major types of CNS bacteria species causing IMI (S. epidermidis, S. simulans, S. caprae, and S. chromogenes) on the inflammatory response in milk and to relate it to caseinolysis, coagulation properties, and cheese yield
• Study the mechanism by which CNS affects caseinolysis and in turn the coagulation properties
• Investigate changes in PL and SCC of milk caused by subclinical mastitis and their effects on milk coagulation, and cheese yield and texture
Title: Effects of Nutritional Plane on the Maintenance Energy Requirement of Goats
Type: United States - Egypt Joint Science and Technology Fund Program
Project Number: BIO12-001-016
Period: 2008-2010
Investigators: R. Puchala¹, A. L. Goetsch¹, T. A. Gipson¹, A. R. Askar², and A. Helal²
Institutions: ¹Langston University and ²Desert Research Center
Objective:
- Determine how nutrient restriction impacts energy expenditure (EE) and the maintenance energy requirement (MEₘ) with common goat genotypes of Egypt and Oklahoma
- Determine how adequate nutrient intake following nutrient restriction affects EE and MEₘ with common goat genotypes of Egypt and Oklahoma
- Use data from specific objectives 1 and 2 to develop a method of predicting the impact of low nutritional planes on MEₘ

Title: Boer Goat Selection for Residual Feed Intake
Type: USDA 1890 Institution Research Capacity Building
Project Number: 2008-38814-02661
Period: 2008-2011
Investigators: T. A. Gipson¹, A. L. Goetsch¹, R. Puchala¹, T. Sahlu¹, and C. Ferrell²
Institutions: ¹Langston University, and ²USDA ARS Meat Animal Research Center, Nutrition Research Unit
Objective:
- Determine and demonstrate efficacy of use of residual feed intake to achieve genetic progress in improving efficiency of feed utilization without elevating mature size or body fatness compared with selection based on growth rate.
- Characterize relationships between residual feed intake and animal activities, feeding and social behaviors, and energy expenditure, and assess potential means of prediction of residual feed intake at an early age.

Title: Establishing a Pilot Tannery and Capability for Goat Leather Research at Langston University
Type: USDA 1890 Institution Research Capacity Building
Project Number: 2008-38814-02520
Period: 2008-2011
Investigators: R. C. Merkel¹ and C. K. Liu²
Institutions: ¹Langston University and ²USDA ARS Eastern Regional Research Center
Objective:
- Establish a pilot tannery and capability for goat leather research at the LU campus
- Determine the effects of goat breed, diet and age upon skin chemical composition and the mechanical properties of resulting leather
- Evaluate environmentally friendly tanning methods on U.S. goat skins

Title: Enhanced Safety and Product Quality from On-Farm Thermization/Pasteurization of Goat Milk in the Middle East
Type: United States - Israel Binational Agricultural Research and Development Fund
Project Number: FG-9503-09R
Period: 2010-2011
Investigators: T. Sahlu¹, A. L. Goetsch¹, S. Zeng¹, Z. Abdeen², M. Fanum², K. Azmi², N. Silanikove³, G. Leitner³, K. Ereifej³, L. Alrousan³, and K. Al-Qudah⁴
Institutions: ¹Langston University; ²Al-Quds University, East Jerusalem, Palestine; ³Agricultural Research Organization, Bet Dagen, Israel; ⁴Jordan University of Science and Technology, Irbid, Jordan
Objectives:
- Develop specifications of an inexpensive thermization/pasteurization equipment system suitable for use on small goat farms in the Middle East, conduct preliminary evaluations of the prototype for possible refinement, and determine procedures for an associated MERC grant proposal to be developed.
Experiments Active in 2009/2010

Title: **Effects of gender and age on the maintenance energy requirement of Boer goats**  
Experiment Number: ITL-08-06  
Project Number: OKLX-SAHLU  
Objectives:  
1) Determine effects of gender and age of Boer goats on a) fasting heat production, b) maintenance energy requirement, c) efficiency of metabolizable energy utilization for maintenance, and d) efficiency of energy utilization for growth  
2) Determine the relationship between heart rate and heat production measured in growing Boer goats with ad libitum consumption and when fed near maintenance and fasted

Title: **Development of a model to evaluate methods of modifying cattle barb wire fence for goat containment**  
Experiment Number: AG-08-07  
Project Number: OKLX-SAHLU  
Objectives: Develop and evaluate an accurate and repeatable method of evaluating methods of modifying cattle barb wire fence for goat containment

Title: **Accuracy and precision of fixes and calculated distances of GPS animal collars**  
Experiment Number: TG-09-01  
Project Number: 2005-38814-16352  
Investigators: T. A. Gipson, I. Tovar-Luna, A. L. Goetsch, and G. D. Detweiler  
Objectives:  
1) Evaluate the accuracy and precision of post-differentially corrected and uncorrected stationary GPS collar fixes  
2) Examine the effect of post-differential correction versus raw fix data on distance traveled on mobile GPS collars

Title: **Investigation of CNS bacteria related to subclinical mastitis: changes in goat milk composition, casein fractions, and the plasmin system**  
Experiment Number: LW-09-02  
Project Number: 2007-38814-18474  
Investigators: L. Wang, S. Zeng, R. Shangguan, L. Spicer, and D. Bannerman  
Objectives: Test the impact of major types of CNS bacterial species causing intramammary infection (Staphylococcus epidermidis) on the inflammatory response in milk and blood, and to investigate changes in the plasmin system and somatic cell count of milk caused by subclinical mastitis, in order to study the mechanism by which CNS affects caseinolysis

Title: **Investigation of CNS bacteria related to subclinical mastitis: changes in cheese yield, quality, and microstructure**  
Experiment Number: LW-09-03  
Project Number: 2007-38814-18474  
Investigators: L. Wang, S. Zeng, R. Shangguan, L. Spicer, and D. Bannerman  
Objectives: Assess effects of subclinical mastitis in dairy goats on milk production, composition, and caseinolysis, milk coagulation properties, and curd yield and microstructure profiles
Title: Effects of CNS bacteria induced subclinical mastitis on the gene profile of dairy goats and casein fractions and the plasmin system of goat milk
Experiment Number: RS-09-04
Project Number: 2007-38814-18474
Objectives: Investigate the effect of subclinical mastitis caused by major types of CNS bacteria species (S. Epidermidis, S. Simulans, S. Caprae, and S. Chromogenes) on the plasmin system, casein fractions, the mechanism by which CNS affects caseinolysis, and gene profiles in Alpine and Nubian dairy goats

Title: Effects of goat breed on energy expenditure during and after a low nutritional plane
Experiment Number: AH-09-05
Project Number: BIO12-001-016
Objectives: 1) Determine how nutrient restriction impacts energy expenditure (EE) and the maintenance energy requirement ME\textsubscript{m} with common goat breeds of the USA
2) Determine how adequate nutrient intake following nutrient restriction affects EE and ME\textsubscript{m} with common goat breeds of the USA
3) Use data from specific objectives 1 and 2 to develop a method of predicting the impact of low nutritional planes on ME\textsubscript{m}

Title: Selection for residual feed intake in young Boer bucks - phase 1
Experiment Number: WH-09-06
Project Number: 2008-38814-02661
Investigators: W. Hu, T. A. Gipson, R. Puchala, T. Sahlu, and A. L. Goetsch
Objectives: 1) Determine and demonstrate efficacy of use of residual feed intake to achieve genetic progress in improving efficiency of feed utilization without elevating mature size or body fatness compared with selection based on growth rate
2) Characterize relationships between residual feed intake and animal activities, feeding and social behaviors, and energy expenditure, and assess potential means of prediction of residual feed intake at an early age

Title: Effects of garlic on performance of goats infected with nematodes
Experiment Number: ZW-09-07
Project Number: OKLX-SAHLU
Objectives: Determine effects of garlic on performance and fecundity of Haemonchus contortus in the gastrointestinal tract of goat does and their suckling kids

Title: Effects of goat breed, diet, and age on skin chemical composition and the mechanical properties of resulting leather
Experiment Number: RM-09-08
Project Number: 2008-38814-02520
Investigators: R. C. Merkel, A. L. Goetsch, and T. A. Gipson
Objectives: Determine effects of goat breed (Boer vs Spanish), diet (high and low nutritive plane), and age on skin chemical composition and the mechanical properties of resulting leather
Title: Evaluate intra-operative and post-operative complications with three different methods of castration in goats
Experiment Number: LD-09-09
Project Number: OKLX-SAHLU
Objectives: Evaluate intra-operative and post-operative complications with three different methods of castration. The three methods include castration with a Henderson tool, emasculation, and banding. Evaluation of the patients after surgery will include packed cell volume, total protein, feed intake daily, weekly weight gain and feed efficiency.

Title: Observations of effects of Carolina horsenettle on performance and immunity in goats infected with nematode parasites
Experiment Number: ZW-09-10
Project Number: OKLX-SAHLU
Objectives: Determine effects of S. Carolinense on body weight change, immune responses (measured by concentrations of antibodies IgA, IgM, and IgG), and internal parasite load (measured by fecal egg count).

Title: Management of lactating Alpine goats to minimize internal parasitism and the activity energy cost
Experiment Number: AG-09-11
Project Number: OKLX-SAHLU
Objectives: Determine effects of different pasture access schemes conceivably impacting ingestion of infective larvae of Haemonchus contortus and the activity energy cost on production and behavior of Alpine dairy goats.

Title: Effects of method of processing broiler litter on feed intake and performance by meat goat doelings
Experiment Number: AG-09-12
Project Number: OKLX-SAHLU
Investigators: A. L. Goetsch, G. D. Detweiler, J. Hayes, and T. Sahlu
Objectives: Compare feed intake, growth rate, and efficiency of feed utilization of meat goat doelings consuming diets with deep-stacked versus ensiled broiler litter.
Abstracts

2010 National Meetings of the American Society of Animal Science (Journal of Animal Science, Volume 87, ESupplement 2; the American Society of Animal Science has copyright ownership and the Journal of Animal Science is the source of this information) and the 10th International Conference on Goats in 2010
Conditions to test electric fence modifications of cattle barb wire fence for goat containment


American Institute for Goat Research, Langston University, Langston, OK

Two simultaneous 6 x 6 Latin squares were conducted, each with 24 yearling meat goat doelings previously exposed to electric fence. After overnight fasting, groups of 4 doelings were placed in 2.4 x 2.4 m pens without forage. Pens had 3 metal panel sides and 1 side with 5 strands of barb wire 30.5, 55.9, 81.3, 106.7, and 132.1 cm from the ground adjacent to a pasture with forage and browse. Intervals between periods of 2-3 d and 1 wk were assigned to the two squares. Electric fence treatments in each square were 4 strands 15.2, 27.9, 43.2, and 58.4 cm from the ground at low voltage of 4-4.5 kV (4S-LV); 2 strands at 15.2 and 43.2 cm and high voltage of 8.5-9 kV (2S-HV); 2 strands at 15.2 and 43.2 cm and low voltage (2S-LV); 1 strand at low height of 15.2 cm and low voltage (1S-LH-LV); 1 strand at 43.2 cm and low voltage (1S-HH-LV); and 1 strand at 22.9 cm and high voltage (1S-MH-HV). The percentage of doelings exiting after 2 (during continuous visual observation) and 6 h was similar between intervals (6.3 and 4.2% at 2 h (SE=2.49) and 9.7 and 6.3% at 6 h (SE=3.23)) for long and short intervals, respectively). Doelings receiving a first shock in 2 h did not differ between intervals (16.7 and 19.4% for long and short intervals, respectively; SE=3.20). The percentage of doelings exiting at 2 and 6 h was not affected by fencing treatment. Period of the squares affected (P < 0.05) the percentage of doelings shocked in 2 h (62.5, 29.2, 6.3, 6.3, 0, and 4.2%; SE = 4.92) and exiting pens after 2 (20.8, 8.3, 2.1, 0, 0, and 0%; SE=3.24) and 6 h (27.1, 10.4, 6.3, 4.2, 0, and 0% for 4S-LV, 2S-HV, 2S-LV, 1S-LH-LV, 1S-HH-LV, and 1S-MH-HV, respectively; SE=3.44). Low pen exit, particularly in latter periods, suggests desirability of more thorough prior training to electric fence. Memory of previous exposure to electric fence appeared substantial, implying need to evaluate longer intervals. The overnight fasting period may not have created an adequate impetus to test electric fence for pen exit.

Effects of shearing on energy use by growing Angora goats


1American Institute for Goat Research, Langston University, Langston, OK
2Animal & Poultry Production Division, Desert Research Center, Matariya, Cairo, Egypt

Eight Angora wethers (initial BW 19.0 ± 1.14 kg) and 8 doelings (initial BW 16.3 ± 1.15 kg), approximately 17 mo of age, were used to assess effects of shearing on energy expenditure (EE) and heart rate (HR). Animals were fed a pelleted diet at 1100 h to achieve 12.5 g/d tissue gain and 7.5 g/d mohair fiber growth. Animals were placed in an indirect, open-circuit respiration calorimetry system in 4-animal sets (2 wethers and 2 doelings) for gas exchange measurement 1 d before (d 0) and for 3 d after shearing (d 1, 2, 3). Temperature and relative humidity were controlled at 20°C and 50%, respectively. Shearing was at 0900 h. To avoid effects of feeding on HR and EE, data collected during the daytime (0800 to 1900 h) were omitted. Energy expenditure was greater (P < 0.05) after than before shearing (3.48, 4.30, 4.01, and 3.82 MJ/d on d 0, 1, 2, and 3, respectively; SEM = 0.142). Similarly, HR (92.6, 104.8 97.5, and 100.0 beats/min; SEM = 3.02) and EE relative to metabolic size (405, 503, 468, and 448 kJ/kg BW0.75 on d 0, 1, 2, and 3, respectively; SEM = 10.8) were affected (P < 0.05) by shearing. The ratio of EE to HR was similar among days after shearing (4.45, 4.87, 4.87, and 4.52 kJ/kg body weight0.75 per heart beat on d 0, 1, 2, and 3, respectively; SEM = 0.151). A decline (P < 0.05) in respiratory quotient after shearing (1.049, 1.034, 1.016, and 1.015 on d 0, 1, 2, and 3, respectively; SEM = 0.0079) suggests increased body fat catabolism. Regression analysis indicated that more than 4 d would be required for EE and HR to return to pre-shearing levels. In conclusion, even with non-stressful environmental conditions, shearing Angora goats increases energy consumption.
Effects of level of feeding on energy utilization by Angora goats

I. Tovar-Luna,¹ ² R. Puchala,¹ T. Sahlu,¹ H. C. Freethy,¹ and A. L. Goetsch¹

¹American Institute for Goat Research, Langston University, Langston, OK
²Universidad Autónoma Chapingo, Unidad Regional Universitaria de Zonas Aridas, Bermejillo, Durango, México
³USDA, Agricultural Research Service, US Meat Animal Research Center, Clay Center, NE

Twelve mature Angora does were used in a replicated 3 × 3 Latin square to determine effects of feeding level on energy utilization. Fiber growth was measured in the first 4 wk of 6-wk periods, preceded by 2 wk of adaptation. Metabolizability and gas exchange measures occurred in wk 4, followed by feeding near maintenance then fasting in wk 5 and 6 to determine the ME requirement for maintenance (ME_m). A 60% concentrate diet was fed at levels to approximate 100, 125, and 150% of assumed ME_m. Digestibility and metabolizability were not affected by treatment with different levels of offered feed and subsequent intake near ME_m. Energy expenditure (EE) during fasting (261, 241, and 259 kJ/kg BW⁰.⁷⁵), efficiency of ME use for maintenance (71.6, 69.6, and 69.2%), and ME_m (365, 344, and 377 kJ/kg BW⁰.⁷⁵ for 100, 125, and 150%, respectively) were similar among treatments. Tissue (non-fiber) gain was lowest among treatments (P < 0.05) for 100% (-0.6, 23.7, and 29.8 g/d), although clean fiber growth only tended to increase with increasing level of feeding (5.60, 6.57, and 7.36 g/d for 100, 125, and 150%, respectively). Intake of ME was greater (P < 0.05) for 125 and 150 than for 100% (6.87, 8.22, and 8.41 MJ/d for 100, 125, and 150%, respectively). Total EE was greater for 150 vs. 100 (P < 0.05) and 125% (P < 0.07; 6.03, 6.31, and 6.77 MJ/d), and mobilized tissue energy was low but greater (P < 0.05) for 100 vs. 125 (P < 0.07; 0.16, 0.01, and 0.04 MJ/d for 100, 125, and 150%, respectively). Efficiency of ME use for fiber growth was similar among treatments (17.2, 16.3, and 17.7% for 100, 125, and 150%, respectively; SEM = 1.61). In conclusion, efficiency of ME use for fiber growth was similar to the NRC recommendation regardless of feeding level, although ME_m was lower perhaps because of experimental conditions employed. Energy appeared partitioned to fiber growth, although preferential usage was not complete possibly because energy metabolism for tissue and fiber accretion reached a plateau eliciting increased feed refusal.

Effects of garlic supplementation on nematode parasite infection in grazing goats


American Institute for Goat Research, Langston University, Langston, OK

Feeding garlic to goats infected with *Haemonchus contortus* reduced fecal worm-egg count (FEC) in a 4-wk indoor trial (J. Anim. Sci. 87(E-Suppl. 2):T354, 2009). The study reported here investigated effects of garlic supplementation of lactating meat goat does on infection with nematode parasites, mainly *H. contortus*, in summer grazing conditions. Forty multiparous Boer does (2 to 5 yr of age), naturally infected with nematode parasites, and their single- or twin-kids (1 to 4 mo old initially) were used in an 84-d experiment. Five does with their kids were allocated to each of 8 0.4-ha mixed grass-forb pastures. Treatments were control and garlic, with 4 pastures per treatment. The control group received 80 g/d of a 25% molasses and 75% corn mixture per doe. The garlic group received 20 g/d of garlic powder plus 80 g/d of the molasses-corn mixture per doe. A loose mineral-vitamin supplement was available free-choice. Initial mean FEC was 448/g (range of 0 to 1,450/g) for the control and 500/g (range of 0 to 2,450/g) for the garlic treatment (SEM = 119; P > 0.05). Forty-two days after the experiment started, the garlic treatment resulted in a lower (P < 0.06) FEC compared with the control (2,837/g for garlic and 6,105/g for control, respectively; SEM = 927), and some goats in the control group had to be treated with the anthelmintic (Levasole®, Schering-Plough Animal Health Corp, Union, NJ). Thereafter, the FEC of the garlic treatment remained steady and tended to be lower compared with the control (1,739, 1,689, and 1,303/g for garlic and 1,532, 2,340, and 1,967/g for control at d 56, 70, and 84, respectively; SEM = 280, 517, and 340, respectively). The BW of goats was not affected by garlic supplementation (P > 0.05). These data suggest that supplementing lactating meat goats with garlic can lessen the level of nematode parasitism.
Optimum duration of performance testing growing Boer bucks for growth rate, feed intake, and feed efficiency


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Central performance testing of meat goats has increased in popularity recently, but minimum test length has not been ascertained. This study was conducted to determine the minimum length of time required for accurate evaluation of growing Boer bucks for ADG, feed intake, and feed efficiency as assessed by ADG:feed intake and residual feed intake. Data were collected from 425 bucks in Langston University tests from 2000 to 2009. Bucks averaged 111 ± 25 d of age and 27 ± kg BW at the beginning of the test, consumed a pelleted 50% concentrate diet ad libitum, and were weighed weekly. Daily feed intake was determined with Calan feeding gates (American Calan, Inc., Northwood, NH) and automated feeding units (MK3 FIRE, Osborne Industries Inc., Osborne, KS). Weekly data of four performance traits were analyzed using the MIXED procedure of SAS with a repeated-measures model. The first-order ante dependence [ANTE(1)] structure type was selected as the appropriate covariance structure based on goodness-of-fit criteria. Variation relative to that at 84 d (%) was 337, 275, 225, 188, 153, 129, 118, and 107% for ADG, 171, 161, 150, 141, 131, 120, 112, and 106% for feed intake, 415, 303, 223, 165, 135, 122, 111, and 105% for gain:feed intake (g/d), and 154, 138, 129, 116, 106, 101, 101, and 101% for residual feed intake at 28, 35, 42, 49, 56, 63, 70, and 77 d, respectively. Grafted polynomial break-points determined by nonlinear regression indicated that residual variance had stabilized at 64, 64, and 56 d for ADG, ADG:feed intake, and residual feed intake, respectively. A break-point for feed intake was not estimable, although the correlation between ADG at 63 and 84 d was 0.99 (P < 0.01) compared with r of 0.95, 0.96, and 0.97 (P < 0.01) for ADG, ADG:feed intake, and residual feed intake, respectively. In conclusion, the duration of Boer buck performance tests could be decreased from 84 to 63 d with little loss in accuracy.

Accuracy of calculated distances between consecutive fixes of GPS collars worn by goats

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Small ruminants have been fitted with GPS collars to estimate distance traveled in grazing studies; however, accuracy has not been assessed. To do so, a mobile stand was developed to hold 21 Lotek 3300 GPS collars (Lotek Wireless, Newmarket, Ontario, Canada) and was moved a prescribed distance between fixes on four azimuthally different courses (NE at 45°, S at 180°, W at 270°, and NW at 315°). Fixes were scheduled at 5-min intervals. Distances traveled on a course were 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 m. Distances were replicated three times for each course and the order of the distances was randomized within each replicate. Two courses were run per day and each course was paired with every other course, for a total of six different dates. Fixes were downloaded and distances between fixes were calculated using spherical geometry. The BIAS was estimated as distance calculated from collars minus true distance and was analyzed using a repeated measures design (PROC MIXED; SAS). Dependent fixed effects included true distance (0 to 100 m), course (NE, NW, S, W), and the two-way interactions. Collars and dates were considered random effects. There was no effect (P > 0.10) of course on BIAS. For true distance, BIAS was greatest for 0 m (7.6 m ± 0.36) and least for 60 m (0.5 m). Other estimates of BIAS were intermediate at 10 (2.9 m), 20 (1.6 m), 30 (0.9 m), 40 (1.7 m), 50 (1.4 m), 70 (0.6 m), 80 (0.8 m), 90 (1.2 m), and 100 m (1.3 m). There were linear and quadratic (P < 0.01) effects on BIAS when all distances were analyzed. However, if 0 and 10 m distances were eliminated, the linear effect disappeared (P > 0.10) but the quadratic remained (P < 0.05). The ability of GPS collars to differentiate between when an animal is stationary or moving only a short distance between fixes appears very limited; however, if an animal is moving more than 20 m between GPS fixes, collar estimates are within 1.6 m of actual distance traveled.
Using FAMACHA and alternative dewormers to manage gastrointestinal nematodes in a dairy goat herd

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Gastrointestinal nematodes (GIN) are the greatest health problem in goat production. FAMACHA eye color scores have been developed for selective treatment of animals to reduce the rate of development of anthelmintic resistance. Alternative anthelmintics generally are only moderately effective (40-60% fecal egg count reduction; FECR), which may not be adequate for use with FAMACHA. The purpose of this study was to test the use of alternative anthelmintics in a FAMACHA program. Does were FAMACHA scored on May 25 and does with scores of 3 or greater were dewormed with levamisole HCl at 12 mg/kg BW (L). Lactating Alpine dairy goats (n = 91) were FAMACHA scored at 2 wk intervals from June 10 to October 15. Does with FAMACHA scores of 4 were administered one of three alternative anthelmintics and those with FAMACHA score of 5 were treated with L. Animals that were administered an anthelmintic were also given an oral supplement of iron, copper and vitamin B₁₂. Fecal samples were taken for fecal egg counts (FEC) and blood samples were taken for packed cell volume (PCV) and serum total protein (TP). The three alternative anthelmintics were: 1) 2.0 g of copper oxide wires in a gelatin capsule (W), 2) 2.0 mL of a 4% solution of copper sulfate per 4.5 kg of BW as an oral drench (S), and 3) 4.0 g of cayenne pepper in a gelatin capsule (P). At least three animals in each period that had FAMACHA score of 3 were used as controls. FECR was low and not significantly different (P > 0.10) among anthelmintics (35, 52, 3, 1, and -11% for L, W, P, S, and C, respectively). FAMACHA score was improved (P < 0.05; except for treatment P) by administering an anthelmintic (-0.48, -0.41, -0.16, -0.37, and +0.67, for L, W, P, S, and C, respectively). TP was improved (P < 0.01) by administering an anthelmintic (0.45, 0.10, 0.08, 1.20, and -0.96 for L, W, P, S, and C respectively). PCV was improved (P < 0.05) by administering an anthelmintic (-1.2, 1.0, 0.3, 1.6, and -2.4% for L, W, P, S, and C, respectively. Most anthelmintics improved physiological values above the control, but W appeared superior to other alternative anthelmintics and comparable to L and would be the alternative anthelmintic of choice to use with a FAMACHA program.
Summaries of Recent Journal Articles
**Effects of acclimatization on energy expenditure by meat goats**


Small Ruminant Research 81:42-54. 2009

Eight Spanish and eight Boer yearling doelings were used to assess relationships between energy expenditure (EE) and ambient temperature (Ta), relative humidity (RH), and temperature-humidity index (THI). Four doelings of each genotype were housed in two 5.6 x 3.1 m pens of an enclosed facility with a concrete floor without cooling and with heat provided only to prevent damage to waterers and water lines from freezing. EE was determined over 2 day periods 13 times during a 1 yr period based on EE:heart rate (HR) of each doeling. Climate variables were averaged over 2, 4, 6, and 8 wk preceding EE measurement. Doelings were fed to meet the maintenance energy requirement (ME\textsubscript{m}). Average mean, low, and high values during the 2 wk preceding EE determination were 19.9, 7.9, and 31.8°C for Ta and 53.6, 36.1, and 62.5% for RH, respectively. Neither Ta nor THI were correlated with or had significant effects in regressions to predict the difference between EE at particular measurement times and the 1 yr mean (EEdiff). Conversely, RH was correlated (P < 0.01) with EEdiff. When the 13 HR measurement times were assigned to cool and warm seasonal periods, EEdiff was affected (P < 0.01) by a genotype x period interaction. Nonetheless, the effect of RH in models including genotype, period, and genotype x period was significant for 2, 4, 6, and 8 wk (P < 0.01). The R\textsuperscript{2} of linear regressions of EEdiff against RH was slightly greater for 2 and 4 vs. 6 and 8 wk (0.11, 0.10, 0.08, and 0.07, respectively); regression coefficients for 2 and 4 wk were 1.265 and 1.163 kJ/kg BW\textsuperscript{0.75} per 1% RH, respectively. With RH of 50%, regression coefficient of 1.214 kJ/kg BW\textsuperscript{0.75} per 1% RH, and ME\textsubscript{m} of 390 kJ/kg BW\textsuperscript{0.75}, predicted ME\textsubscript{m} is 372 and 408 kJ/kg BW\textsuperscript{0.75} at 35 and 65% RH, respectively. In conclusion, without extremes eliciting cold or heat stresses, RH appears to have a slight effect on ME\textsubscript{m} of meat goats by acclimatization in both cool and warm periods of the year.

**The relationship between heart rate and energy expenditure in growing crossbred Boer and Spanish wethers**

*Puchala, R., I. Tovar-Luna, T. Sahlu, H. C. Freely, and A. L. Goetsch*


Eight Boer (75%) x Spanish (BS) and 8 Spanish (S) wethers (155 ± 8 d of age and 19.2 ± 2.3 kg BW, initial) were used in a replicated crossover design with a 2 x 2 factorial arrangement of treatments to determine effects of genotype, diet quality, and time of the day on energy expenditure (EE), heart rate (HR), and EE:HR with ad libitum, near maintenance, and fasting levels of feed intake. Diets were 65% concentrate and coarsely ground alfalfa hay. Energy expenditure ranked (P < 0.05) ad libitum > maintenance > fasting (500, 390, and 270 kJ/kg BW\textsuperscript{0.75}). Heart rate did not differ between genotypes when fasting and with maintenance intake, but was greater (P < 0.05) for S vs BS when intake was ad libitum (BS: 55, 71, and 92; S: 52, 72, and 100 beats/min for fasting, maintenance, and ad libitum, respectively (SE = 2.0)). There was an interaction in EE:HR (P < 0.05) between level of feed intake and genotype (BS: 5.31, 5.59, and 5.00; S: 5.07, 5.57, and 5.22 kJ/kg BW\textsuperscript{0.75}:beats/min for ad libitum, maintenance, and fasting, respectively (SE = 0.13)), without an effect of diet. The effect of time on EE, HR, and EE:HR differed among levels of intake (P < 0.05). General patterns of change in EE and HR as time of day advanced did not differ, but increases near meals followed by decreases were of slightly greater magnitude for maintenance vs ad libitum intake. The ratio of EE:HR was greater for the maintenance level of feed intake than for ad libitum intake at most times. These results indicate similar potential for use of HR to predict EE of different genotypes of growing meat goats and that establishing EE:HR with different diets or levels of intake may not be crucial. Magnitudes of difference among hours suggest that when EE:HR is used to predict EE of confined goats from full-day measurement of HR, EE:HR should be determined over an extended period of time, such as 24 h.
Impact of animal science research on U.S. goat production and predictions for the future


Goat research in the U.S. has increased but at a rate less than that in production. Research on goat meat includes nutritional quality, packaging, color, sensory characteristics, and preharvest management. Goat skins have value for leather, yet quality of goat leather has not been extensively studied. Research in the production, quality, antibiotic residues, and sensory characteristics of goat milk and its products has aided development of the U.S. dairy goat industry. Limited progress has been made in genetic improvement of milk or meat production. There is need to explore applications of genomics and proteomics and improve consistency in texture and functionality of goat cheeses. New goat meat and milk products are needed to increase demand and meet the diverse tastes of the American public. Despite research progress in control of mohair and cashmere growth, erratic prices and sale of raw materials have contributed to further declines in U.S. production. Innovative and cooperative ventures are needed for profit sharing up to the consumer level. Internal parasites pose the greatest challenge to goat production in humid areas largely because of anthelmintic resistance. Study of alternative controls is required, including immunity enhancement via nutrition, vaccination, pasture management such as co-grazing with cattle, and genetic resistance. Similarly, the importance of health management is increasing related in part to a lack of effective vaccines for many diseases. Nutrition research should address requirements for vitamins and minerals, efficiencies of protein utilization, adjusting energy requirements for nutritional plane, acclimatization, and grazing conditions, feed intake prediction, and management practices for rapid-growth production systems. Moreover, efficient technology transfer methods are needed to disseminate current knowledge and that gained in future research.

Effects of small ruminant species and origin in Ethiopia (Highland vs Lowland areas) and lengths of rest and feeding on harvest measures

Abebe, G., G. Kannan, and A. L. Goetsch


Yearling goats (G) and sheep (S) from Highland (H) and Lowland (L) areas of Ethiopia were used to determine effects of species and origin and lengths of rest and feeding on harvest measures, particularly carcass surface lightness. The H goat used was Arsi-Bale, and the L goat was Somali. The fat-tail indigenous H sheep is thought to be an Arsi-Bale genotype, and the fat-rump indigenous L sheep genotype was the Black Head Ogaden. There were two experiments (each a 2 x 2 x 3 factorial), one with rest for 0, 1, and 2 d before slaughter (R0, R1, and R2, respectively) and the second with feeding 0, 2, and 4 wk (0 wk=2 d rest; 0F, 2F, and 4F, respectively). There were 10 animals per treatment. In the rest experiment, the instrumental color measure L* (indicating lightness) for the hind leg surface 3 d PS was lower (P<0.05) for H than for L (34.8, 36.3, 37.4, and 38.9 for G-H, G-L, S-H, and S-L, respectively). Surface L* on d 3 was increased (P<0.05) by 1 and 2 d of rest compared with 0 d for goats regardless of origin, but was not affected for sheep (33.2, 36.3, 37.2, 38.5, 37.8, and 38.2 for G-R0, G-R1, G-R2, S-R0, S-R1, and S-R2, respectively). In the feeding experiment, surface L* on d 3 was lower (P<0.05) for H vs L (36.5, 39.0, 36.2, and 39.8 for G-H, G-L, S-H, and S-L, respectively). Feeding 4 wk increased (P<0.05) surface L* on d 3 regardless of species and origin (37.7, 36.8, and 39.2 for F0, F2, and F4, respectively). In summary, goat and sheep carcasses from Highland areas of Ethiopia may darken more quickly compared with Lowland areas, and 1 or 2 d of rest before slaughter can increase lightness of the surface of goat carcasses.
Effects of breed and diet on growth and body composition of crossbred Boer and Spanish wether goats


Sixty growing 3/4 Boer x 1/4 Spanish (BS) and Spanish (SP) wethers were used to determine influences of diet and breed on growth and body composition. A 50% concentrate pelleted diet (CON) and one based on grass hay (HAY) were fed free-choice. Six wethers of each breed were harvested at 0 wk (total of 12) and 6 of each diet-breed combination were harvested at 14 and 28 wk (24 per time). Initial BW of fed wethers was 21.6 and 18.8 kg for BS and SP, respectively (SEM = 0.67). Average daily gain during the entire experiment was influenced by an interaction (P < 0.05) between breed and diet (199, 142, 44, and 50 g for BS:CON, SP:CON, BS:HAY, and SP:HAY, respectively). Carcass mass was greater (P < 0.05) for CON vs. HAY (56.2, 56.2, 53.2, and 54.0% empty BW for BS:CON, SP:CON, BS:HAY, and SP:HAY, respectively). Mass of the liver (2.11, 1.92, 2.00, and 1.98% empty BW; SEM = 0.048) and gastrointestinal tract (5.50, 4.83, 8.43, and 8.36% empty BW for BS:CON, SP:CON, BS:HAY, and SP:HAY, respectively; SEM = 0.158) tended (P < 0.07) to be influenced by an interaction between breed and diet. Mass of internal fat (12.2, 12.1, 3.4, and 3.4% empty BW for BS:CON, SP:CON, BS:HAY, and SP: HAY, respectively; SEM = 0.28) differed (P < 0.05) between diets. Energy in the carcass (320, 236, 87, and 79 MJ), noncarcass tissues (318, 237, 77, and 72 MJ), and empty body (638, 472, 164, and 150 MJ) ranked (P < 0.05) BS:CON > SP:CON > BS:HAY and SP:HAY. Energy concentration in accreted tissue was 17.0, 18.7, 16.3, and 6.4 MJ/kg for CON:wk 1-14, CON:wk 15-28, HAY:wk 1-14, and HAY:wk 15-28, respectively (SEM = 1.39). In conclusion, relatively high growth potential of growing Boer goats with a moderate to high nutritional plane does not entail a penalty in realized growth when the nutritional plane is low. Body composition of growing Boer and Spanish goats is fairly similar regardless of growth rate. For growing meat goats other than with a prolonged limited nutritional plane, an average energy concentration in accreted tissue is 17.3 MJ/kg.

Effects of stage of lactation and dietary concentrate level on body composition of Alpine dairy goats


Multiparous Alpine does (42) were used to determine how stage of lactation and dietary forage level affect body composition. Initial measures were made with six does a few days after kidding (0 mo). Before parturition does were fed a 50% concentrate diet free-choice. Eighteen does were fed a 40% forage diet (40F) and 18 received a diet with 60% forage (60F) for approximately 2, 4, or 6 mo of lactation. The 60F diet had 20% more dehydrated alfalfa pellets than the 40F diet, with higher levels of corn and soybean meal and inclusion of supplemental fat in the 40F diet. Intake of dry matter was greater for 60F vs. 40F, average daily gain tended to be affected by an interaction between diet and month (0, 24, 121, -61, 46, and 73 g), and 4% fat-corrected milk was less in mo 5-6 than earlier. Internal fat mass was greatest among times at 6 mo and greater for 40F vs. 60F. Mass of the gastrointestinal tract was less for 40F than for 60F and decreased with increasing time in lactation. Concentrations of fat in the carcass (13.8, 13.1, 16.5, 11.2, 11.5, and 14.4%), noncarcass tissues (18.6, 24.2, 33.3, 14.3, 16.5, and 24.5%), and empty body (16.5, 18.7, 25.2, 12.9, 14.1, and 19.5% for 40F:2 mo, 40F:4 mo, 40F:6 mo, 60F:2 mo, 60F:4 mo, and 60F:6 mo, respectively) were affected by stage of lactation and diet. Based on daily change in tissue mass and energy, energy concentration in tissue mobilized or accreted was 16, 20, and 32 MJ/kg in 1-2, 3-4, and 5-6 mo of lactation, respectively. In conclusion, based on tissue mass more energy was expended by the GIT with 60F vs. 40F. Considerable internal fat is mobilized in early lactation particularly with diets moderate to high in forage, with more rapid and a greater magnitude of repletion by does consuming diets lower in forage. The concentration of energy in tissue mobilized or accreted may vary with stage of lactation.
Goat nutrition and feeding

Goetsch, A. L. and R. C. Merkel


Goats have been selected for different purposes, such as milk production, mohair or cashmere fiber yield, and average daily gain or meat production, resulting in different physiological conditions that affect nutrient requirements and most appropriate feeding methods. Nutrient requirements and dietary management practices are also unique for indigenous or local genotypes of goats that may not have been intensively selected by many for a particular type of production, but that have adapted to survive under specific and often harsh environmental conditions. Goats differ from other domesticated ruminant livestock species, namely beef and dairy cattle and sheep, in numerous ways; however, most notable are unique feeding behaviors. Goats generally consume a wider variety of plants when available, especially browse and foliage of woody plant species. Moreover, because of factors including mobile lips and precise tongue actions, goats exert considerable selection in the particular plant fragments and feed particles consumed. Another difference between goats vs cattle and sheep is the ingestion of relatively greater levels of many plants containing 'anti-nutritional factors' such as tannins that can influence nutrient absorption and utilization. In addition to effects of selection on nutrient requirements and desired feeding management practices, previous plane of nutrition has impact. This can be assessed by body condition score as practiced with other ruminant species. Knowledge of body condition score and other factors influencing nutrient requirements, such as breed, gender, desired levels of production including pregnancy status, and grazing and environmental conditions, are necessary to assess specific needs for energy, protein, minerals, and vitamins. Then dietary means of meeting these requirements can be devised. For animals in confinement this might be considered a bit easier than for grazing goats, since all nutrients are provided by feedstuffs offered. Although, many times in confinement forage is fed free-choice as the basal diet, similar to forage consumed when grazing. In both cases nutrients provided by the basal diet must be projected in order to formulate a supplement to satisfy any nutrient deficits at the lowest cost. Total mixed rations are frequently used as well, particularly for dairy goats, in which case least-cost formulation procedures considering different available forage and concentrate feedstuffs will yield greatest profitability.

Effects of milk fat depression induced by a dietary supplement containing Trans-10, Cis-12 conjugated linoleic acid on properties of semi-hard goat cheese


Dietary supplements of conjugated linoleic acid (CLA) containing trans-10, cis-12 CLA reduce milk fat synthesis in lactating goats. This study investigated effects of milk fat depression induced by dietary CLA supplements on the properties of semi-hard goat cheese. Thirty Alpine does were randomly assigned to three groups and fed diets with lipid-encapsulated CLA that provided trans-10, cis-12 CLA at 0 (control), 3 (CLA-1) or 6 g/d (CLA-2). The experiment was a 3x3 Latin square design. Periods were 2 wk in length, each separated by 2-wk periods without CLA supplements. Bulk milk was collected on d 3 and 13 of each of three periods for cheese manufacture. The largest decrease (23.2%) in milk fat content induced by the high dosage (6 g/d per doe) of trans-10, cis-12 CLA supplementation at d 13 of treatment resulted in the decreases of cheese yield and moisture by 10.2 and 10.0%, respectively. Although CLA supplementation increased the hardness, springiness and chewiness and decreased the cohesiveness and adhesiveness of cheeses, no obvious defects were detected and no significant differences were found in sensory scores among cheeses. In conclusion, milk fat depression induced by a dietary CLA supplement containing trans-10, cis-12 CLA resulted in changes of fat-to-protein ratio in cheese milk and consequently affected properties of semi-hard goat cheese.
Current status of composition and somatic cell count in milk of goats enrolled in Dairy Herd Improvement Program in the United States

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The effects of breed, parity, stage of lactation (month), herd size, and regions/states on fat and protein content, somatic cell count (SCC) and production of milk from dairy goats enrolled in the Dairy Herd Improvement (DHI) program in the United States (U.S.) in 2007 were investigated to monitor the current status of composition and SCC and to help goat producers improve their herd management and receive premiums for high quality goat milk. Statistical analysis of composite DHI data indicated that composition, SCC and production of goat milk were affected by many non-infectious factors. Marked variations (P < 0.05) in fat and protein content and milk production were found among goat breeds, particularly among those non-registered goats. In the first five parities, milk fat and protein content was relatively constant, however, a sharp decline (P < 0.05) was observed in parity 6. As parities increased, SCC in milk increased steadily (P < 0.05). Significant differences (P < 0.05) in all variables were discovered among regions. Large herds of goats tended to have lower milk fat and protein content but higher milk production and SCC than the small herds (P < 0.05). The above findings suggest that it be economically imperative to consider culling goats after their fifth lactation and that year-round breeding and lactation programs be practiced, if dairy goat producers in the U.S. are to meet the Grade “A” goat milk requirements. All factors that contributed to variations in fat, protein, SCC and production of goat milk should be taken into consideration when establishing price incentive systems for goat milk.

Effect of somatic cell count in goat milk on yield, sensory quality, and fatty acid profile of semi-hard cheese


This study investigated the effect of somatic cell count (SCC) in goat milk on yield, free fatty acid (FFA) profile, and sensory quality of semi-soft cheese. Sixty Alpine goats without evidence of clinical mastitis were assigned to three groups with milk SCC level of <500,000 (Low), 500,000-1,000,000 (Medium), and 1,000,000-1,500,000 (High) cells/mL. Thirty kilograms of goat milk with mean SCC levels of 410,000 (Low), 770,000 (Medium), and 1,250,000 cells/mL (High) was obtained for the manufacture of semi-soft cheese for two consecutive weeks in three lactation stages. The composition of milk was analyzed and cheese yield was recorded on day 1. Cheese samples on day 1, 60, and 120 were analyzed for scores of total sensory, flavor, body/texture by a panel of three expert judges, and FFA. Results indicated that the milk composition did not change when milk SCC varied from 214,000 to 1,450,000 cells/mL. Milk with higher SCC had a lower standard plate count while Coliform count and psychrotrophic bacteria count were not affected. However, milk components (fat, protein, lactose, casein and total solid) among three groups were similar. As a result, no significant differences in the yield of semi-soft goat cheeses were detected. However, scores of total sensory and body/texture for cheeses made from the high SCC milk were lower than those from the low and medium SCC milk. The difference in milk SCC levels also resulted in diverse changes in cheese texture (hardness, springiness, etc.) and FFA profiles. Individual and total FFA increased significantly during the ripening, regardless the SCC levels. It is concluded that SCC in goat milk did not affect the yield of semi-soft cheese, but resulted in inferior sensory quality of aged cheeses.
Effects of stocking rate, breed, and stage of production on energy expenditure and activity of meat goat does on pasture

Beker, A., T. A. Gipson, R. Puchala, A. Askar, K. Tesfai, G. D. Detweiler, A. Asmare, and A. L. Goetsch


Sixteen Boer and 16 Spanish multiparous does were used to determine how stocking rate (SR), breed, and stage of production influence energy expenditure and behavioral activities on pasture and to develop a simple method of predicting energy used for activity. The experiment began in late spring at an average of 24 days after kidding. Litter size was two and kids were Boer and Spanish. Two does of each breed resided in eight 0.5-ha grass/forb pastures. There were five periods, 56, 60, 63, 64, and 73 days in length, corresponding to mid-lactation, early post-weaning, the late dry period, early gestation, and mid-gestation. During period 1 and the first part of period 2, two additional does with kids of each breed grazed in four High SR pastures, with other pastures designated as Low SR. Because of low available forage mass in period 3, grass hay was offered for ad libitum consumption in periods 3-5 and a concentrate supplement was provided in periods 4 and 5. Energy expenditure (EE) was estimated from heart rate (HR) on pasture and EE:HR for each doe determined in a calorimetry system. A leg position/movement monitoring system and a GPS collar with position and movement sensors were used to estimate distance traveled and time spent grazing/eating, resting while lying, resting while standing, and walking without grazing/eating. EE attributable to activity (EE\textsubscript{a} %), expressed as a percentage of the ME requirement for maintenance plus activity in confinement, was determined based on total EE, estimated milk production, and doe BW and ADG. Forage DM mass in the middle of periods was 696, 246, 125, and 196 kg/ha for the High SR and 1362, 967, 479, and 610 kg/ha for the Low SR in periods 1, 2, 3, and 4, respectively. Kid ADG at weaning after 73 days was lower (P < 0.05) for the High vs. Low SR (87 vs. 112 g). Distance traveled was not influenced by SR or breed but varied among periods (3.54, 3.76, 3.09, 3.08, and 4.10 km/day in periods 1, 2, 3, and 5, respectively; SE = 0.193). Time spent grazing/eating tended (P < 0.07) to be greater for Boer vs. Spanish does (7.9 vs. 7.7 h/day) and differed among periods (8.0, 7.8, 7.6, 5.3, and 8.0 h/day in periods 1, 2, 3, and 5, respectively; SE = 0.72). Total EE was greater (P < 0.05) for Boer than for Spanish does (13.4 vs. 11.4 MJ/day) and differed among periods (13.5, 11.6, 11.7, 11.8, and 13.4 MJ/day in periods 1, 2, 3, 4, and 5, respectively; SE = 0.41). Likewise, predicted ME intake was greater (P < 0.05) for Boer vs. Spanish does (14.2 vs. 12.2 MJ/day) and varied with period (16.1, 10.6, 12.8, 12.6, and 14.0 MJ/day in periods 1, 2, 3, 4, and 5, respectively; SE = 0.47). EE \textsubscript{a} % was not influenced by SR, breed, or period, averaging 49%. Behavioral activities were not highly related to EE \textsubscript{a} %, although no-intercept regressions against time spent grazing/eating and grazing/eating plus walking indicated an increase in EE \textsubscript{a} % of 5.79 and 5.05%/h, respectively. In conclusion, although EE \textsubscript{a} % was not affected by treatments of this experiment or highly related to behavioral activities monitored, it represents a sizeable cost of energy deserved of further study.
Energy expenditure and activity of different types of small ruminants grazing varying pastures in the summer

Beker, A., T. A. Gipson, R. Puchala, A. Askar, K. Tesfai, G. D. Detweiler, A. Asmare, and A. L. Goetsch


Objectives were to determine the activity energy cost for different types of goats as well as a breed of sheep and to evaluate methods of prediction. Thirty-two animals were used, with eight of four different types. Animal types were yearling Angora doeling goats, yearling Boer wether goats, yearling Spanish wether goats, and Rambouillet wether sheep slightly more than 2 yr of age. Two animals of each type were randomly allocated to one of four pastures 9.3, 12.3, 4.6, and 1.2 ha in area. Forage conditions varied markedly among pastures. The experiment was conducted in the summer with three periods, 30, 26, and 26 days in length. Energy expenditure (EE) was estimated from heart rate (HR) on pasture and EE:HR for each animal determined in a calorimetry system. A leg position/movement monitoring system and a GPS collar with position and movement sensors were used to estimate distance traveled and time spent grazing/eating, resting while lying, resting while standing, and walking without grazing/eating. EE attributable to activity (EEₐ%), expressed as a percentage of the ME requirement for maintenance plus activity in confinement, was determined based on total EE, BW, and ADG. Forage mass in the different pastures and periods ranged from 2801 to 8672 kg/h. ADG was similar among animal types (-4, 30, -1, and 8 g for Angora goats, Boer goats, Spanish goats, and sheep, respectively; SE = 8.2). Distance traveled was affected by an interaction (P < 0.05) between animal type and period (Angora goats: 2.98, 2.33, and 2.47; Boer goats: 3.17, 3.46, and 2.68; Spanish goats: 2.85, 5.28, and 3.30; sheep: 3.04, 3.43, and 2.25 km in periods 1, 2, and 3, respectively (SE = 0.423)). Time spent grazing was lowest among animal types (P < 0.05) for Angora goats (4.3, 8.4, 7.8, and 6.8 h/day) and time spent walking without grazing was lower (P < 0.05) for Angora goats and sheep than for Boer goats (1.7, 2.4, 2.1, and 1.2 h/day for Angora goats, Boer goats, Spanish goats, and sheep, respectively). Total EE was affected by an interaction (P < 0.05) between animal type and period (Angora goats: 5.89, 5.55, and 5.16; Boer goats: 9.63, 10.92, and 8.55; Spanish goats: 6.73, 8.17, and 7.02; sheep: 12.54, 11.84, and 12.93 MJ/day in periods 1, 2, and 3, respectively (SE = 0.442)). EEₐ% was affected by an interaction (P < 0.05) between animal type and period (Angora goats: 15.7, 17.4, and 15.1; Boer goats: 59.7, 67.4, and 34.4; Spanish goats: 46.2, 61.7, and 41.6; sheep: 22.3, 11.8, and 21.9% in periods 1, 2, and 3, respectively (SE = 6.07)). EEₐ% of goats was predicted with moderate accuracy (R² = 0.40-0.41) and without bias from estimates of 5.79 and 5.05%/h spent grazing/eating and grazing/eating plus walking, respectively, determined in a companion experiment; however, these methods were not suitable for sheep.
Feeding behavior of goats


Factors influencing feeding behavior of goats include grazing management practices, type of vegetation and season, breed and stage of production, group size, and properties of diets fed in confinement. Considerable information has been gathered from visual observation during daylight. However, there are now tools available to characterize feeding behavior of goats while grazing and in confinement throughout the day. Global positioning system collars can be used to assess horizontal and vertical distances traveled, up or down position of the head, and movement within pasture or rangeland areas. A commercially available leg activity monitor allows estimation of the number of steps and time spent standing, lying, and moving rapidly without grazing. However, these measurements do not directly determine grazing. Therefore, prediction equations based on visual observation must be developed. Classification tree analysis is a robust method in developing these equations because the decision tree can be pruned or expanded to provide the best fit. Another equipment system determines time spent eating, ruminating, and idle from pattern of jaw movement. In addition to use of $n$-alkanes as internal markers to estimate digestibility, their profile can provide an indication of botanical composition of the selected diet. Automated feeding systems for confined goats permit determinations such as number of feeder visits and meals, eating time, and rate and pattern of feed intake. Heart rate measured while goats are in normal production settings can be used to predict total energy expenditure through multiplication by energy expenditure per heart beat of individual animals. To partition the activity energy cost, an estimate of ME intake or measures of change in body energy status and milk energy yield are needed to determine other sources of heat to be subtracted from total energy expenditure. These methods create opportunity to gain a fuller understanding of factors influencing feeding behavior of goats and relationships with levels and efficiencies of production.

Effects and interactions of origin of sheep in Ethiopia (Highland vs Lowland areas), feeding, and lengths of rest and feeding on harvest measures

Merera, C., G. Abebe, A. Sebsibe, and A. L. Goetsch


Yearling sheep from Highland (H) and Lowland (L) areas of Ethiopia were used to determine effects and interactions of animal origin, feeding, and lengths of rest and feeding on harvest measures. The fat-tail indigenous H sheep used is thought to be an Arsi-Bale genotype, and the fat-rump indigenous L sheep genotype was the Black Head Ogaden. Ten sheep of each origin were rested for 1, 2, or 3 days (R1, R2, and R3, respectively) after arrival at the abattoir and before slaughter, with ad libitum availability of grass hay and water and an overnight fast preceding slaughter. Eighteen to 20 sheep of each origin were subjected to feeding periods 2, 4, or 6 wk in length (F2, F4, and F6, respectively), during which time grass hay was consumed ad libitum and a concentrate supplement was provided at 200 g/day per animal (dry matter basis). There was an interaction (P<0.05) between origin and the linear effect of feeding period length in average daily gain, with a much greater value for H-F2 compared with other treatments (209, 120, 125, 118, 90, and 113 g/day for H-F2, H-F4, H-F6, L-F2, L-F4, and L-F6, respectively). Hot carcass weight increased linearly with increasing length of rest (P<0.05), with a tendency (P<0.09) for greater change for H vs L animals, and the effect (P<0.05) of feeding vs rest tended (P<0.16) to be greater for H sheep (8.09, 8.34, 8.73, 7.88, 8.19, 8.02, 9.08, 8.54, 9.13, 8.17, 8.03, and 8.57 kg for H-R1, H-R2, H-R3, L-R1, L-R2, L-R3, H-F2, H-F4, H-F6, L-F2, L-F4, and L-F6, respectively). There were no appreciable treatment effects on carcass pH or instrumental color measures. In conclusion, there is considerable opportunity to increase carcass weight of H by use of periods of rest after arrival at the abattoir and before slaughter longer than 1 day. Moreover, a short period of feeding, such as 2 wk, can be employed with H to markedly increase carcass weight.
Effects of acclimatization on energy expenditure by different goat genotypes


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Five Balady and five Shami (Damascus) intact male goats, approximately 1.5 yr of age, were individually housed and used to determine effects of ambient temperature (Ta), relative humidity, and temperature-humidity index on energy expenditure (EE). Average mean, low, and high values in 2-wk periods throughout the year were 22.5, 14.9, and 28.5°C for Ta and 61.0, 49.6, and 68.5% for RH, respectively. Animal measurements occurred monthly from December, 2006 through October, 2007. Animals were fed alfalfa hay to meet the maintenance energy requirement. Because BW was relatively constant throughout the experiment, EE was considered equal to metabolizable energy (ME) intake. In January, April, July, and October, the day of measuring heart rate (HR) occurred within a 7 day period when bucks were housed in metabolism crates for total collection of feces and urine. Individual EE to HR ratio was estimated at those times and used to predict EE throughout the year based on HR. EE in kJ/kg BW\(^{0.75}\) was greater for Shami than for Balady goats in January, July, and October (P < 0.05), for Balady ranked (P < 0.05) July and October < January and April, and for Shami ranked (P < 0.05) January, April, and July > October. EE:HR was greatest among times (P < 0.05) in April and greater (P < 0.05) for Shami vs. Balady. Digestibilities of DM and energy were slightly greater for Shami than for Balady (P < 0.05). For monthly measures, rectal temperature, blood hemoglobin oxygen saturation, and HR were similar between breeds. HR differed among months, with means ranging from 57.0 to 77.6 beats/min. There were large differences among months in the difference between EE at particular measurement daily times and the average (EEdiff). No climate measure in the preceding 2 or 4 wk was correlated with EE or EEdiff (P > 0.10). The same was true for correlations based on all data of EEdiff and the full-day measurement of climate conditions in the month preceding HR measurement. However, when correlations were conducted separately for each genotype, some relationships for Balady goats were significant while those for Shami goats were nonsignificant. A regression of EEdiff of Balady goats against mean Ta and THI on the preceding HR measurement day revealed a coefficient of 4.17 or 2.78 kJ/kg BW\(^{0.75}\) per 1°C or THI unit, respectively. In conclusion, EE of Balady goats appears sensitive to climate conditions, whereas that of Shami goats is not or at least is relatively less impacted. With hot conditions, Balady goats have an advantage in a decreased ME requirement for maintenance and with low Ta, Balady goats have an increased requirement.

Grazing management systems: creep grazing for suckling goat kids

Yiakoulaki, M. D., A. L. Goetsch, and T. Sahlu


Creep grazing is a management system designed to match particular pasture forages and(or) grazing areas with specific nutritional requirements of different classes of grazing animals. It allows access of young nursing animals to forage of high quality and palatability (creep area) while excluding mature animals. The young animals through special openings (creep gates) are able to graze the creep area and return for suckling, thus possibly increasing weight gain and weaning weight without concentrate supplementation. In this paper, creep grazing by goats is described, with special attention given to considerations of the location of the creep area, creep gates and forage species. Kids’ foraging behavior and relevant management practices, with highlighting of areas deserved of future research attention, were also discussed.
Gender differences in an on-line certification program for goat producers

_Merkel, R. C., T. A. Gipson, and T. Sahlu_

Tropical and Subtropical Agroecosystems 11:145-149. 2009

In 2006, a Langston University unveiled an on-line training and certification program for meat goat producers consisting of 22 learning modules. Participants take pre- and post-tests and must record a minimum score of 85% to pass the 16 required and a minimum of 3 elective modules for certification. As of May 31, 2008, 638 participants had registered for the program and 64 had completed the requirements for certification. An equal proportion of males (335) and females (303) have registered for the certification program ($P^2 = 1.61; P = 0.21$). The same nearly-equal gender frequency of registered participants also existed for those becoming certified, 39 males vs. 25 females, ($P^2 = 3.06; P = 0.08$). A higher proportion of registered females ($P^2 = 17.38; P < 0.01$) and certified females ($P^2 = 11.52; P < 0.01$) were engaged in full- vs. part-time farming than registered and certified males. There were no gender differences for farm size ($P^2 = 7.98; P = 0.33$) or for herd size ($P^2 = 2.89; P = 0.58$). For all participants over all tests, there were no differences in pre- or post-test scores between genders ($P = 0.23$). For those participants required to take post-tests for the 16 required modules, females scored higher on pre-tests than males (66.8 vs. 62.1%, $P < 0.05$). For the 6 elective modules, there were no gender differences in pre-test or post-test scores. Results show that both women and men goat farmers will equally access and use an on-line certification program. Pre- and post-test scores show equivalent knowledge of goat production for female and male goat producers. The greater proportion of females than males who characterize themselves as full-time farmers illustrates the importance of women in the goat industry.

Considerations for on-farm research and demonstration of useful feeding/nutrition practices for small ruminants in Ethiopia

_Goetsch, A. L., and G. Abebe_


Many funding organizations view on-farm research as having greater impact than ‘on-station’ trials, a feeling shared by farmers and pastoralists because of the opportunity to see and evaluate findings first-hand. Langston University provides technical assistance in a 5-year project supported by the U.S. Agency for International Development, entitled Ethiopia Sheep and Goat Productivity Improvement Program (ESGPIP), which includes on-farm research and demonstrations of useful feeding/nutrition practices. The ESGPIP partners with research and extension entities throughout Ethiopia in implementing specific activities. One effective strategy in on-farm research and demonstrations used by some partners involves group management of animals by Farmer Research Groups (FRG) situated in different villages. Four or five FRG have been used by ESGPIP implementing partners, with each consisting of 9 or 10 farmers contributing 3 or 6 animals. Funds were provided to construct a simple barn with three pens (10 animals per pen) at each FRG for group housing and feeding at night. One or two animals per farmer were subjected to each of three feeding treatments. Conversely, in other settings treatment imposition on individual farmers and their animals in multiple communities was most suitable. Both approaches allow for statistical analysis of data, desirable for publication of the findings and, perhaps more importantly, true value or meaning of any differences noted. With use of farmer-owned animals in some instances it may not be feasible to impose negative control treatments, but an appropriate common or standard supplemental feedstuff treatment allows for an adequate basis of comparison. For sustainability, on-farm research should include input by and intimate involvement of producers and participation of local technology transfer personnel.
Visiting Scholars (2009/2010)

Dr. Ahmed Helal
Native of Egypt
Research Project: Effects of nutritional plane on the maintenance energy requirement of goats
Experiment: AH-09-05

Dr. Wenping Hu
Native of China
Research Project: Boer Goat Selection for Residual Feed Intake
Experiment: WH-09-06

Dr. Abdelhafid Keli
Native of Morocco
Research Project: Management of lactating Alpine goats to minimize internal parasitism and the activity energy cost
Experiment: AG-09-11

Ms. Rulan Shangguan
Native of China
Experiment: RS-09-04

Dr. Ignacio Tovar-Luna
Native of Mexico
Research Project: The Grazing Activity Energy Cost of Goats (BIO11-001-005)
Experiments: AA-07-02, ITL-08-01

Dr. Yoko Tsukahara
Native of Japan
Training Focus: Goat Research and Production and the Importance of Goats in Development Projects

Dr. Lynn Wang
Native of China
Experiments: LW-08-03, LW-09-02, LW-09-02