Research Accomplishments and Impacts

1.1 Contributions to Research Areas

Priority Area 1: Design innovative, cost-competitive, non-human edible roughage feed ingredients

- Created four new livestock feed ingredients from encroaching woody plants (ground *Juniperus ashei*, *J. pinchotii*, *J. monosperma*, and *J. virginiana*) and expanded our knowledge related to the use of *Prosopis glandulosa* in livestock diets.
  - Discovered that these ingredients have unique characteristics not shared by any other feed ingredient in existence:
    - require no inputs by man to grow; e.g., land cultivation, planting, irrigated water, fertilizer, pesticides, or herbicides;
    - when harvested, can concurrently enhance natural resources, increase forage production, enhance land value; increase water availability; and reduce the risk of wildfires;
    - available year-around, thus not subjected to seasonal pricing characteristics or availability.
  - Enhanced the value of these ingredients by discovering and summarizing an extensive 100-year history of using multiple woody plant species in livestock diets.
    - This review revealed that ground aspen wood is currently a commercially-approved feed ingredient. During this review, I was able to summarize the extensive literature related to the nutritional and feeding value of ground aspen.
  - Established the nutritional value for these ingredients through *in vitro* and *in vivo* digestibility and rumen microbial gas production studies.
    - Discovered that these ingredients have nutrient and digestive characteristics similar to or better than, some traditional roughage ingredients.
  - Established the feeding value for these ingredients, through studies with growing ruminant sheep, goats, and cattle.
  - Brought together multiple commercial juniper wood fiber companies, numerous ranchers, and feedmill representatives. A commercialized “Wood to Feed” industry will be initiated as soon as juniper is approved as a livestock feed ingredient.
- Discovered that ground woody products can be sustainable sold year-round for a profit, at $80/ton (FOB).
- Considering that ground woody products are cost-competitive feed ingredients and available year-around, they have potential to reduce the extreme cyclic pricing nature of all traditional roughage ingredients, especially during drought.
- A landowner can completely offset the land clearing (brush management) cost by selling the derived tree chips for around $30/ton to a commercial feed processor.
- The social, environmental, and economic impacts of creating an $80/ton value for the ground wood is enormous and difficult to accurately predict.
  - Texas has over 77 million tons of juniper biomass, which continues to rapidly increase. If valued at $80/ton, this equals $6.2 billion in gross potential revenue.
• Scenario 1: One hundred acres of land; 100 juniper trees/acre; 250 lb/tree on a dry matter (DM) basis:
  - removing the juniper trees from the rangeland has the potential to increase forage production by at least 500 lb/acre. If so, the additional forage value would be worth approximately $160 to $320 (assuming a value of $10 to $20/animal unit month and assuming that 25% of total forage is available to the animal).
  - removing and processing these trees would result in 1,250 tons of juniper. When CSH are priced at $100/ton, the feed ingredient savings would = $25,000. When CSH are priced at $160/ton, the feed ingredient savings would = $100,000.
• Scenario 2: [2.45 million head of feeder cattle in TX × 365 d × 16 lb mixed feed/d × 10% juniper in diet]/2000 = 715,400 tons of juniper needed
  - if the feedlot saved only $10/ton (difference between CSH vs. juniper), savings = 7.15 million/yr
  - if the juniper processor realizes a net profit of only $10/ton, net profit for their operation = 7.15 million/yr
  - To supply the needed 715,400 tons of juniper material, 57,200 acres would need to be harvested; potentially for free.
  - If the increase in forage production (by removing juniper trees) is 500 lb/acre, then an extra 5,720 tons of forage is produced. Equates to approximately 1,430 tons of available forage (25% of total) for the animal, which equates to approximately 2,860 bales of hay/yr, which equates to approximately $114,400/yr (assuming $40/bale).
• Land value can increase by at least $200/acre after juniper trees are strategically removed.
• Studies have reported that ground water and stream flow can increase after juniper trees are removed; however, establishing economic and social values is currently impossible due to the accuracy of the models used to estimate water availability parameters.

Priority Area 2: Reduce feedlot costs
  o Enhanced the feeding value of dried distillers grains (DDG; corn brewers industry) and dried distillers grains with solubles DDGS (corn ethanol industry).
  o Discovered that DDG can economically replace all the CSM in lamb feedlot diets.
    • Reduced diet cost by $8/metric ton without negatively affecting ADG, G:F, or wool or carcass characteristics.
    • Enhanced juiciness, tenderness, and flavor of lamb meat.
  o Discovered that using 30% vs. 10% or 20% CSH in lamb feedlot diets containing 40% DDGS enhanced ADG and reduced diet cost by $25.5/metric ton and cost/kg of BW gain by $0.08.
  o Discovered that using a combination of ground juniper and oat hay during the growing and finishing periods enhanced ADG and final BW, reduced feed costs by $14/metric ton, and reduced total feedlot costs by $1.93/lamb.
  o Discovered that replacing 33% of the ground alfalfa with ground juniper in beef cattle feedlot diets, reduced the feed cost by $5/metric ton, without negatively affecting growth or health.

Priority Area 3: Reduce livestock production costs through designing innovative supplementation and grazing strategies
  o Discovered that supplements containing DDGS and cottonseed meal (CSM) increased consumption of juniper leaves by goats, by 188%.
- Discovered that supplements containing up to 54% mature ground juniper trees can be used in a pregnant ewe supplement without negatively affecting ewe health, lamb birth weight, or lamb weaning weight.
  - Compared to a traditional supplement, a savings of approximately $60/ton was realized.

**Priority Area 4: Exploiting the beneficial attributes of plant secondary compounds in ground juniper to enhance animal health and end product quality.**

- Discovered that redberry juniper material can reduce internal parasite (*Haemonchus contortus*) motility by 44% and fecal egg shedding by 69%.
- Discovered that redberry juniper material can increase ivermectin efficacy by 66%.
  - Economic impact has not been assessed; however, internal parasites drastically increase production costs and no new synthetic anthelmintics are being developed to assist with the resistance problem. If plant secondary compounds can increase synthetic anthelmintic efficacy enough to be biologically relevant, then the savings to the manufactures and livestock producers will be substantial and realized world-wide.
- Discovered that *Desmodium paniculatum* can reduce fecal egg shedding by 44%.
- Discovered that using ground juniper can, at times, increase meat conjugated linoleic acid (CLA), reduce saturated fatty acids, and enhance carcass and lamb sensory characteristics.

**Priority Area 5: Enhance end product quality and animal health with various feed ingredients and feeding strategies**

- Discovered that replacing all of the CSM with DDG in lamb feedlot diets enhanced juiciness, tenderness, and flavor intensity without affecting off-flavor of lamb meat.
- Discovered that using 30% vs. 20% or 10% CSH in lamb feedlot diets containing 40% DDGS increased meat CLA.
- Determined that a higher quality diet fed to early-weaned steers enhanced ADG, G:F, and the febrile response to an infectious bovine herpes virus-1 respiratory challenge.

**Priority Area 6: Evaluate ground woody products in white-tailed deer supplements to reduce consumption by feral hogs**

- A white-tailed deer supplement has been designed, which eliminated non-target species consumption, e.g., feral hogs, raccoons, and turkeys.
- Due to the ever-increasing populations of hogs, raccoons, and turkeys, all of which consume white-tailed deer supplements, the economic impact would be substantial.

**Priority Area 7: Increase the research capacity and effectiveness of the Texas A&M AgriLife Research Nutrition Program, San Angelo**

- Refurbished the Texas A&M AgriLife Research feedmill, feeding facilities, and Nutrition Laboratory, which developed the capacity to:
  - feed 108 sheep or goats in individual, covered pens;
  - grind hay and woody plant material, store multiple bulk feed ingredients, and mix larger quantities of feed with greater accuracy and personal safety;
  - (1) analyze multiple nutrient and fiber characteristics, *in vitro* and *in situ* digestibility, microbial gas production, and terpene oil; (2) separate particle-associated bacteria; (3) analyze various blood serum and rumen fluid parameters; (4) evaluate internal parasite infections such as *Eimeria* spp.
and *H. contortus* in fecal material; and (5) evaluate treatment effects on internal parasite larvae development and *in vitro* motility.

- Established collaborations with multiple laboratories across the U.S., which allows Dr. Whitney to cost-effectively analyze various serum and rumen fluid parameters, microbial species diversity, carcass characteristics, meat fatty acid profiles, and plant secondary compounds.

### 1.2 Contributions to Discipline, Industry, or Society

- Created four new livestock feed ingredients from encroaching woody plants (ground *Juniperus ashei*, *J. pinchotii*, *J. monosperma*, and *J. virginiana*) and expanded our existing knowledge related to feeding *Prosopis glandulosa*.
  - This effort will not only reduce feed costs, but will potentially increase rangeland ecosystem health and water availability and provide the livestock industry with the most natural “green” feed ingredient known to man.
  - Creates an opportunity to increase the scope and effectiveness of the Natural Resource Conservation Service’s Environmental Quality Incentives Program (EQIP).
  - Creates an avenue for a commercialized “Wood to Feed” program to become a reality.
  - Creates opportunities to enhance public perception of the livestock feed and feeding industries through rangeland restoration.
- Renewed interest in the use of ground aspen fiber in livestock diets and research studies.
- Enhanced the feeding value of urea, DDG, and DDGS for small ruminants.
- Discovered that *Juniperus* spp. and *Prosopis* spp. contain beneficial concentrations of terpenes and CT and have unique fiber characteristics that can enhance rumen function.
- Discovered through research trials and an extensive literature review that “research bias” has resulted in juniper terpene oils being mislabeled as being “toxic” to ruminant livestock.
- Enhanced the Penn State Particle Separator method by using it to evaluate feed ingredient sorting by livestock.
- Developed a modified larvae migration inhibition (LMI) assay procedure to incorporate the use of ruminal fluid.
- Trained 11 graduate students and 18 undergraduate students.

### 1.3 Professional Improvement and Activities and Research Service

**2002 – present**
- Member, American Society of Animal Science (ASAS)
  - Chair of Small Ruminant session (2016)
  - ASAS Beef Species Section Committee (2017)
    - Chair of “Ruminant Nutrition IV: Feed Intake Level” session (2018)
- Member, Western Section of the American Society of Animal Science
  - Chair, Beef Cattle Extension Committee (2012 - 2013)
  - Chair, Sheep and Goat Committee (2015)
  - Member, Graduate Student Competition Committee (2018)
- Member, American Registry of Professional Animal Scientists (ARPAS)
- Member, Society for Range Management: National and Texas Chapter
  - Member, Western Extension, Research, and Academic Coordinating Committee-039 (WERA-039); *Coordination of Sheep and Goat Research and Education Programs for the Western States*
    - Secretary (2010 - 2011)
• Chair (2011 - 2012; 2014 - 2015)

2005 – 2007 Supervised and assisted in the remodeling of the Texas A&M AgriLife (San Angelo) feedmill, feedlot pens, nutrition barn, and pasture fencing

2005 – present Planning committees for San Angelo Research Center Field Days

2006 – present Search committees for the San Angelo Research Center
   o Assistant Professor, Rangeland Scientist
   o Research Technicians

2006 – present Member, Tom Green County Goat Show

2006 – present Member, Southern Section of ASAS (SASAS)
   o Small Ruminant Production Committee (2013 - 2016)
     ▪ Chair (2015 - 2016)
   o Resolutions Committee (2018-2020)

2007 – present Developed and maintain the Texas A&M AgriLife Research Livestock Nutrition Program’s web site, Facebook page, and YouTube videos

2007 – 2015 Member, Western Extension, Research, and Academic Coordinating Committee- W1012 (previously WERA-110); Improving Ruminant use of forages in sustainable production systems for the Western U.S.

2007 – present Member, Texas Sheep and Goat Raisers’ Association

2007 – present Member, International Goat Association

2010 – present Member, State Forage and Beef Workers’ group

2011 – 2013 Member, Forage and Livestock Internship Program in Texas: The Brazilian Connection to the Texas A&M University System.

2011 – 2014 Member, Texas A&M AgriLife Council of Principal Investigators

2012 – present Member, Texas A&M AgriLife Agriculture Animal Care and Use Committee

2017 – present Member, Multistate Research and Coordinating Committee and Information Exchange Group NCERA-214; Increased efficiency of sheep production
   o Secretary (2017 - 2018)
   o Chair (2018-2019)

2017 – present Member, American Sheep Industry Association, Producer Education and Research Council Board

2017 – present Member, Texas A&M Department of Animal Science Facility and Animal Review Committee

2017 – present Member, Texas and Southwestern Cattle Raisers Association
   o Agricultural Research and Education Committee (2018 to present)

2. Activity as a Reviewer


3. Extension and Other Services

2005 – present Delivered 37 oral presentations and presented 18 abstracts to date, to livestock producers and other industry representatives
2005 – present Provide support to specialists, county agents, and livestock producers: via phone and email consultations, ranch visits, and meetings at the San Angelo Research Center
2005 – present Assist with Texas A&M AgriLife Extension Youth Veterinary Science Workshops
2006 – present Created and maintain the Texas A&M AgriLife Research Livestock Nutrition website, Facebook page, and videos
2006 – 2007 Participated in Texas A&M AgriLife Extension Agent workshops
2012 – 2013 Chair, Western Section of ASAS Extension Committee
2015 Developed, hosted, and chaired a Sheep and Goat Symposium for the Western Section of the American Society of Animal Science (WASAS).
2017 Developed and hosted Texas A&M AgriLife Research conference, “Strategic Supplementation Strategies to Enhance Texas Rangelands and Reduce Livestock Production Costs”

Collaborations:

- Colleges and Universities:
  - New Mexico State University
  - Montana State University
  - Virginia Tech
  - Virginia State University
  - Louisiana State University
  - University of Missouri
  - University of Georgia
  - University of Wyoming
  - Langston University
  - University of Arizona
  - Animal Production Research Institute, Agriculture Research Center, Giza, Egypt
  - Ain Shams University, Cairo, Egypt
  - Universidad Autónoma del Estado de México, Toluca, México
  - São Paulo State University, São Paulo, Brazil

- Industry and Government:
  - Noble Research Institute
  - USDA-Agricultural Research Service, Poisonous Plant Research Laboratory
  - USDA-Agricultural Research Service, Range Management Research Laboratory
  - Agricultural Research Organization, Israel
  - TAMU-Consejo Nacional de Ciencia y Tecnología program (CONACYT), Yucatan, MX