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# **U.S. SHEEP INDUSTRY RESEACH, DEVELOPMENT, AND EDUCATION PRIORITIES**

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American Sheep Industry Association, Inc.

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## EXECUTIVE SUMMARY

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### **Objective**

The sheep industry in the U.S. is a complex industry facing many complex issues and challenges. The sheep industry is a diverse industry producing quality meat, milk, and wool products under a variety of management and environmental conditions. Identifying and understanding the key issues and challenges facing the sheep industry today is important to help establish the industry's research, development, and education priorities and to help guide resource allocation - both public and private.

The overarching objective of this report is to identify research, development, and education priorities for the U.S. sheep industry that: 1) result in products from sheep that are of the highest possible quality, 2) are safe and wholesome, 3) are produced in a sustainable and environmentally responsible manner, 4) contribute to the nation's food and fiber security, 5) recognize the ethical responsibility to provide for the humane care and welfare of sheep, and 6) create opportunities for increased profitability, competitiveness in the world market, and industry growth.

In a 2015 National Research Council report titled, *Critical Role of Animal Science Research in Food Security and Sustainability*, the committee stated that sustainably meeting the nutritional needs of a growing population and its demand for animal products will require significant investment in research and development.<sup>1</sup> However, public funding for animal agriculture in general, and for sheep research, development, and education in particular, is on the decline. It is within this context of complex issues and challenges, industry diversity, and reduced funding that a comprehensive needs assessment for the U.S. sheep industry was undertaken.

### **Methodology Overview**

A multi-faceted approach was used to identify research, development, and education priorities for the sheep industry. The approach included:

- 1) A review of published sheep research across a range of topics and disciplines, with particular emphasis placed on the National Research Council report, *Changes in the Sheep Industry in the United States, Making the Transition from Tradition* (2008), the American Sheep Industry Association Producer Survey, *Compendium of Research Results & Analysis by Producer Region and Flock Size* (2010), the USDA, APHIS, Veterinary Services, National Animal Health Monitoring System *Sheep 2011 Study* (2012), the ASI Sheep Production Handbook, and the Sheep and Goat Research Journal.
- 2) On-line surveys were developed for each of the major industry sectors/stakeholders - including producers, feeders, lamb packers/processors, and wool buyers/processors. Results of the stakeholder surveys provided a summary listing of current industry needs and challenges. Demographic differences and/or similarities of key producer challenges were analyzed by type of operation (commercial lamb, wool, dairy, seedstock, etc.), location of operation, type of

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<sup>1</sup> National Research Council. *Critical Role of Animal Science Research in Food Security and Sustainability*. Washington, DC: The National Academies Press, 2015. Web.

management (herded/open range, fenced range, pasture, etc.), size of operation, breed(s) of sheep, years of experience raising sheep, expansion/contraction over the past five years, expansion/contraction plans over the next five years, as well as the use and effectiveness of various management practices and technologies.

3) Focus groups representing research and education across a range of disciplines, including genetics, reproduction, nutrition, range science, veterinary medicine, marketing, and meat, wool, and dairy sciences, were asked to categorize each of the top industry issues and challenges identified as primarily a research, development, and/or education need. That is, to weigh-in on the most effective way to address a particular issue or challenge - through basic and/or applied research, through the development of specific management tools, products, etc., or via political advocacy and regulatory development, and through educational outreach and technology transfer. The focus groups provided both context and specific/targeted recommendations.

The research, development, and education priorities summarized in this report reflect significant industry input and are a composite of those identified through the literature review and industry-wide surveys. Producer challenges were generally summarized by both percent breeding ewes and percent operations. Percent breeding ewes highlights those challenges affecting the greatest number of sheep and are critical to maintaining the commercial infrastructure of the industry. Percent operations highlights those challenges impacting the greatest number of sheep producers and are important to meeting the diverse needs of U.S. lamb, wool, and dairy consumers – particularly those of the nontraditional and niche markets. There is, of course, significant overlap. Rankings and emphasis differ primarily reflecting operation size and management system (range-based versus pasture-based).

The top ***producer sector challenges ranked by percent breeding ewes:***

- 1) Labor/labor management
- 2) Predator management
- 3) Government regulations and compliance
- 4) Marketing
- 5) Flock health
- 6) Grazing and forage management
- 7) Facilities and Fencing
- 8) Estate planning and generational transfer

The top ***producer sector challenges ranked by percent operations:***

- 1) Grazing and forage management
- 2) Marketing
- 3) Flock health
- 4) Labor/labor management
- 5) Facilities and fencing
- 6) Predator management
- 7) Genetics
- 8) Reproduction

The top ***feeder sector*** challenges:

- 1) Feeder lamb availability
- 2) Labor costs/availability

- 3) Processing contracts/kill slot availability
- 4) Price risk

The top ***lamb packer/processor*** challenges:

- 1) Labor availability/cost
- 2) Consumer demand
- 3) Government regulations and compliance
- 4) Seasonal supply and supply security
- 5) Quality and uniformity of slaughter lambs

The top ***wool buyer/processor*** challenges:

- 1) Contamination
- 2) Availability/supply of U.S. wool
- 3) Quality

Clearly, the challenges identified point to many common stakeholder concerns. Labor challenges, for example, were common across sectors. However, other challenges, including genetics and animal health and welfare, identified by the producer sector, and demand, identified by the packer/processor sector, are also fundamentally industry-wide concerns and challenges - impacting the entire U.S. sheep industry.

The research, development, and education priorities summarized here are presented topically by discipline, in no particular order of importance. Greater detail and specific recommendations are provided in the main body of this report. The priorities are broadly classified as research, development, or educational needs based on focus group assessment. Although, in nearly all cases, some element of each - research, development, and education – is required to adequately address specific challenge areas.

## **RESEARCH, DEVELOPMENT, AND EDUCATION PRIORITIES FOR THE U.S. SHEEP INDUSTRY**

### ***Institutional framework recommendations for basic and applied research***

- Continued support for centers for sheep research
- Targeted collaborative efforts between the industry, universities, and the U.S. Department of Agriculture's Agricultural Research Service
- Public and private partnering to leverage resources for increased efficiency and effectiveness
- Continued support and utilization of existing private and public research and education infrastructure
- Increased checkoff assessments toward expanding the scope of the checkoff program to include production research and education

### ***Genetics and Breeding***

- Value of EBVs generated by NSIP
- Genetic parameters and selection criteria for new and/or complex traits
- Genomic information

- Economic selection indices
- Genomic breeding values
- Strategic crossbreeding systems
- Simple goal-based production records for commercial flocks

#### **Flock Health**

- Parasite control and vaccine development
- Lamb starvation
- Lamb respiratory disease
- Mastitis control
- Footrot and scald control
- Coccidia control
- Alternatives to antimicrobials
- Scrapie transmission and live animal tests
- Q-fever mitigation and control
- Increased adoption of existing health technologies
- Accurate flock health information

#### **Reproductive Performance and Efficiency**

- Out-of-season breeding programs and technology uptake
- Genetic potential scoring
- Ultrasound-assisted selection for litter size
- Ewe/lamb bonding behavior
- Commercial availability of reproductive intervention products
- Increased adoption of existing reproductive technologies
- Online resources

#### **Grazing and Forage Management & Nutrition**

- Ecosystem management and enhancement
- Multi-species grazing
- Sustainability indicators
- Matching breed type, production goals, and forage resources
- Alternative feeds and forages
- Strategic parasite control
- Online resources
- Train-the-Trainer programs
- Web- and workshop-based programs
- Risk Management Insurance education

#### **Public Interest and Social Issues**

- Properly trained and affordable labor
- H-2A shepherders/guest worker program
- Socially acceptable methods of waste handling and removal, and carcass disposal
- Enhancement of Clean Water Act provisions
- Animal welfare and humane handling educational tools for all sectors
- Food and fiber security, continuity of business, and supply chain management under adverse conditions and circumstances

- Bighorn sheep and species separation policies
- Enhancement of sage grouse habitat

#### **Predator Management**

- Lethal predator control technologies
- Non-lethal preventative and corrective technologies
- Discriminant predator management
- Increased producer awareness of animal damage control resources and of state and federal regulations
- Education and training on the effectiveness and use of existing predator management tools
- Increased public awareness and development of public/private partnerships aimed at reducing depredation by wildlife and domestic dogs

#### **Lamb Processing and Marketing**

- New and innovative methods of managing supplies
- Market information and price signals
- Price volatility and risk management
- Demand index and demand drivers
- Processing opportunities
- Local market development
- Value-based pricing
- Objective measures and predictors of meat quality and eating satisfaction
- Packaging technologies

#### **Wool Production and Marketing**

- Price signals and value-based pricing
- Wool quality and preparation
- Wool grower education aimed at improving wool quality and reducing contaminants
- Demonstrate/estimate return on investment in wool preparation
- Marketing campaign to expand demand for domestic wool
- New product/market development and improved packaging
- Military apparel
- Dye-resistant fibers
- Rapid, reliable, objective measurement equipment and technologies
- Development of a rapid mechanical method to detect defects in raw pelts

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# Introduction

## *Objective and Background*

The objective of this study is to identify research, development, and education needs for the U.S. sheep industry. The study was designed to provide information that can be used by decision-makers to help guide resource allocation for sheep research, development, and education. The study provides industry-wide input for USDA intramural and extramural research planning as well as for allied industries and businesses that develop and provide many of the products and services used by the sheep industry. The study was prompted, in part, by a declining trend in public funding and resource allocation for sheep research and education and by the need for more precise direction from stakeholders to help affect both public and private investments.

The U.S. sheep industry has experienced declines in total inventory of 30 to 40 percent since the early 1990s - similar to those of major sheep producing countries around the world. Steep contractions in inventory appear to have halted, and even reversed, with the national inventory experiencing gains over the past two years. Tapping into those gains and addressing industry needs through a better understanding of the challenges faced by producers, feeders, packers, and wool businesses, can help promote and sustain industry growth. Developing an effective, demand-driven set of priority research, development, and education goals will help keep the industry moving forward.

## *Method*

A multi-faceted approach was used to identify the industry's research, development, and education priorities.

First, a review of published sheep research across a range of topics and disciplines was conducted. In developing a research plan, survey instruments, and recommendations, the study drew from previous sheep industry analyses, surveys, and resources, including:

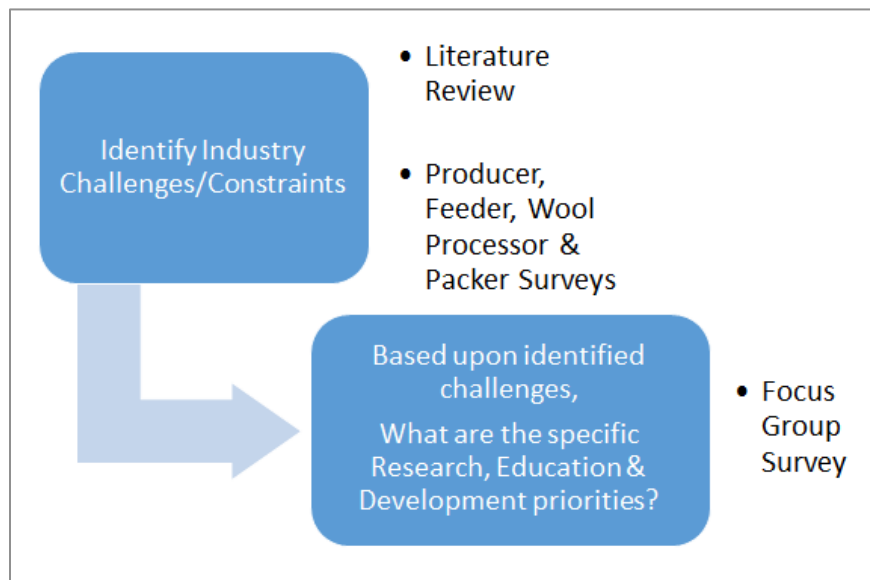
- The 2008 National Research Council's (NRC), *Changes in the Sheep Industry in the United States: Making the Transition from Tradition*;
- The American Sheep Industry Association's (ASI), *Producer Survey-2010: Compendium of Research Results & Analysis by Producer Region and Flock Size*;
- The USDA, APHIS, Veterinary Services, National Animal Health Monitoring System (NAHMS), *Sheep 2011 Needs Assessment* and *Sheep 2011* final reports, including Sheep 2011: Part I: Reference of Sheep Management Practices, Part II: Reference of Marketing and Death Loss, Part III: Health and Management Practices, and Part IV: Changes in Health and Production Practices, as well as various "Info Sheets" developed from the Sheep 2011 study;
- ASI publications including symposiums, conference and convention proceedings, Sheep Safety and Quality Assurance Program (SSQA), Sheep Care Guide, and Nontraditional Markets, Targeted Grazing, Livestock Guardian Dogs, and Predation publications;

- The ASI Sheep Production Handbook--a reference guide covering a wide variety of topics pertaining to sheep production-- and various issues and special editions of the Sheep & Goat Research Journal;
- The American Lamb Board Roadmap and value-based pricing reports; and
- Other information sources, including numerous online resources and delivery formats.

The bibliography provides a more complete listing of the supporting literature reviewed and information resources consulted.

Following the literature review, online surveys of producers, feeders, lamb packers/processors, and wool businesses were developed and implemented. The surveys were developed to ensure that the priorities identified were demand-driven, reflecting the priority needs and challenges of each of the major industry sectors and of the industry at large.

Finally, a focus group representing research and education across a range of academic disciplines was also surveyed. This was followed by two rounds of focus group conference calls, and a final set of questions directed to advisory teams with expertise in specific priority areas.



**Figure 1** Research Method

Focus Group members with professional knowledge of the sheep industry were selected to represent research and education across several disciplines and levels of experience, as well as geographic areas. Expertise and experience related to nutrition, grazing, genetics/breeding, reproductive physiology, veterinary science, range science, meat, wool, and dairy science, marketing, and sheep management were represented. In addition, some members were administrators responsible for research and/or educational resources traversing several disciplines, multiple species, and an array of programs supported by state, federal and/or private sources of funding.

The objective of the focus group was to analyze and interpret the priority challenges to help guide the allocation of scarce resources to areas of greatest need. The focus group was asked to classify the major challenges identified by producers as research, development, and/or educational needs. The focus group provided context and specific, targeted recommendations (e.g., researchable topics, development recommendations, educational approaches/deficiencies, etc.).

The focus group responded to three types of survey questions: 1) research, development, and educational needs, 2) educational resources for information delivery or technology adoption, and 3) changes and recommendations related to the research and extension/education infrastructure. Specifically, the focus group was asked to:

1. Evaluate the important producer challenges, needs or constraints across the research, development and education continuum. The continuum included: a) new research information, b) interpretation of existing research results, c) acceptance/adoption at the producer level, d) technology development (e.g., products, information systems, pharmaceuticals), and e) educational resources.
2. Describe the current status of educational programs for each of the top producer priorities/challenges: a) currently available, b) easily accessible, c) readily used, d) contains up to date information, and e) new or revised programs needed.
3. Identify changes that have impacted the research and extension/education infrastructure and enhancements for the creation and delivery of technology for the U.S. sheep industry.

### *Organization and Presentation of Findings*

The body of this report deals primarily with the industry stakeholder survey results, analyses and findings. The research, development, and education priorities summarized at the end of each chapter are a composite of those identified through the literature review, stakeholder surveys, and include specific focus group recommendations.

Priorities are presented topically by discipline, in no particular order of importance, and are broadly classified as research, development, or education priorities based on focus group input. Clearly, there is overlap and synergy between a number of the top industry challenges, as well as between some of the research, development, and education priorities aimed at addressing those challenges. In nearly all cases, more than one element or approach - research, development, and education - is needed to effectively address the industry's priority challenges.

The report and supporting materials are organized as follows:

- I. Chapter one provides background information and introduces the greatest challenges identified by producers.
- II. Chapters two through eight focus on the major challenges by topic - in no particular order of importance. The research, development, and education priorities for each topic area are detailed at the end of each chapter.
- III. Chapter nine discusses resource allocation for research and education trends in public funding.
- IV. The Appendices offer more detailed information and summaries of selected survey results and demographics, and public funding information.

# Chapter 1 Survey Results: Background and Greatest Producer Challenges

## *Introduction*

Research, development, and educational needs defined in this study are demand driven. The greatest producer challenges were first identified based on results from a nation-wide survey of sheep producers that included commercial lamb, seedstock, 4-H/club-lamb, wool, dairy, and sustainable land management/grazing services. Sheep producers in 46 states and all eight of ASI's representative regions participated in the survey, providing a broad cross-sectional sampling of the industry. Separate surveys of other marketing chain participants, including feeders, packers/processors, and wool buyers/processors, were also conducted. The focus groups and priority teams were then engaged to provide insight, input, and recommendations.

The research priorities identified in this report are taken to include basic through applied research, and can also include technology transfer. Development priorities include local, state, and national statutory and regulatory enhancements, and advocacy, as well as investments in product and process development, manufacturing, and delivery. Education priorities are broadly defined as information dissemination - education and outreach that utilize both traditional and innovative new methods and systems of delivery.

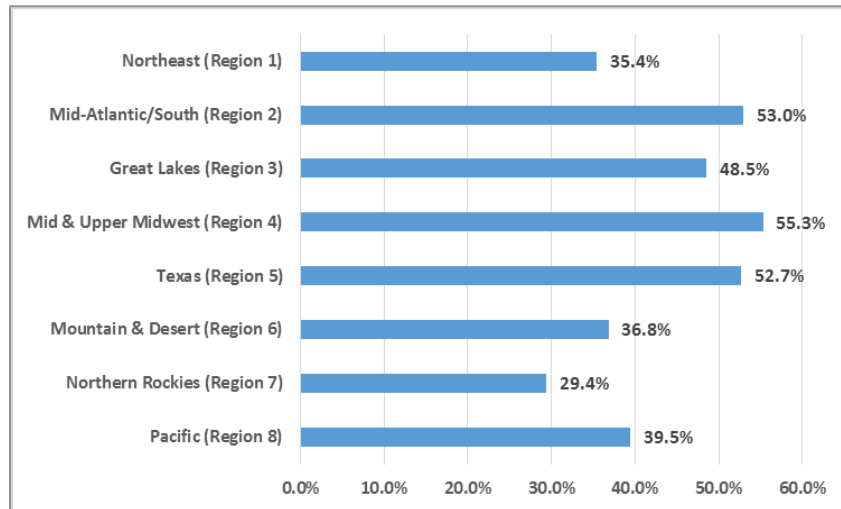
## *Expansion Plans*

Identifying research, development, and educational needs is particularly important to support those operations that are expanding (or plan to expand) and to understand the constraints faced by those operations that do not plan to expand, or plan to reduce flock size in the near future. Among producers responding to a survey question about expansion plans, 47 percent plan to increase the number of breeding ewes on their operations over the next five years. ASI's "Let's Grow" campaign supports this growth by promoting the development of innovative and sustainable initiatives.

Over half of survey respondents in ASI's Regions 2 (Mid-Atlantic/South), 4 (Mid & Upper Midwest), and 5 (Texas) plan to increase breeding ewe numbers over the next five years. Region 7 (Northern Rockies) has the largest breeding ewe population among survey respondents, but the smallest percentage of operations planning to increase breeding ewe numbers.

Across all flocks, land availability (44 percent), satisfied with current size of operation (41 percent), working part-time/off farm (32 percent), and retirement (24 percent) were the top four reasons cited for not expanding. Feed resources/availability ranked fifth at 21 percent with other reasons ranking much lower.

Fifty-five percent of operations in Region 4 (Mid & Upper Midwest) plan on expanding in the next five years. Regions 2 (Mid-Atlantic/South) and 5 (Texas) also reported over 50 percent of operations planning to expand. Region 7 (Northern Rockies) reported the lowest rate at 29 percent. Region 6 (Mountain & Desert) was at 37 percent, Region 1 (Northeast) was at 35 percent, and Region 8 (Pacific) was at 39 percent.



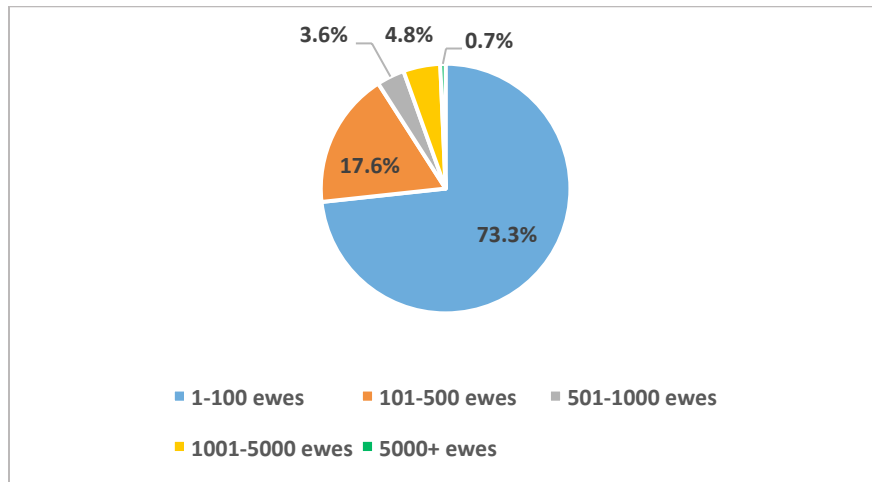
**Figure 1-1** Percent of Operations by Region that Plan on Increasing Breeding Ewe Numbers over the Next Five Years

### *Greatest Challenges Identified by Producers*

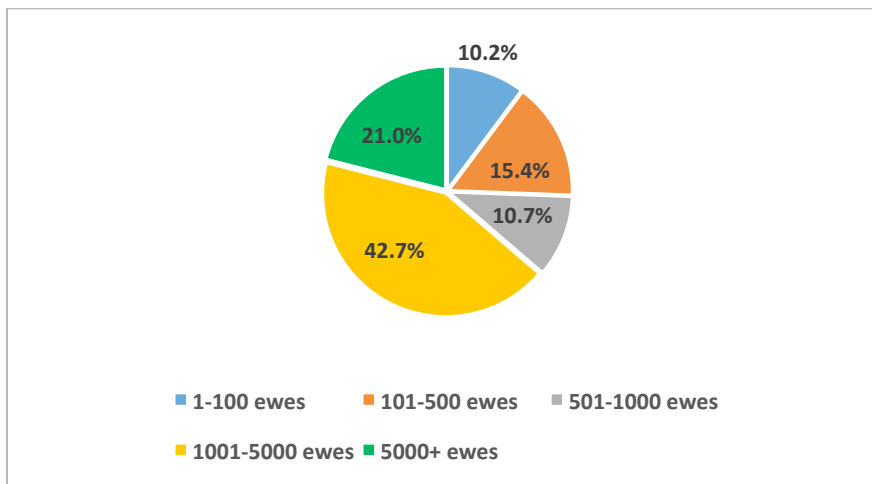
The survey asked producers to identify their three greatest challenges, then asked producers to identify the challenge with the greatest impact on profitability. Challenges ranged from flock health, grazing and forage management, and nutrition, to predation, labor/labor management, marketing, and current policy and other issues.

The greatest challenges were defined by percent operations and by percent breeding ewes. The U.S. sheep industry is characterized by many relatively small operations, and a few very large operations that manage a large percentage of the ewes in the U.S. flock. Nationally, approximately 20 percent of operations represent approximately 80 percent of the total breeding ewe population.

Of all operations reporting current number of breeding ewes, 73 percent had 100 ewes and fewer. Over half, 55 percent, reported fifty head or fewer and nearly a third, 32 percent, reported 25 head or fewer. In contrast, operations with over 5,000 ewes comprised 21 percent of all ewes and operations with 1001-5000 ewes comprise 43 percent of all ewes. Thus, 73 percent of operations represented only 10 percent of the total number of breeding ewes captured by the survey. By contrast, only 9 percent of operations represented 74 percent of total breeding ewes.



**Figure 1-2** Percent Operations by Flock Size

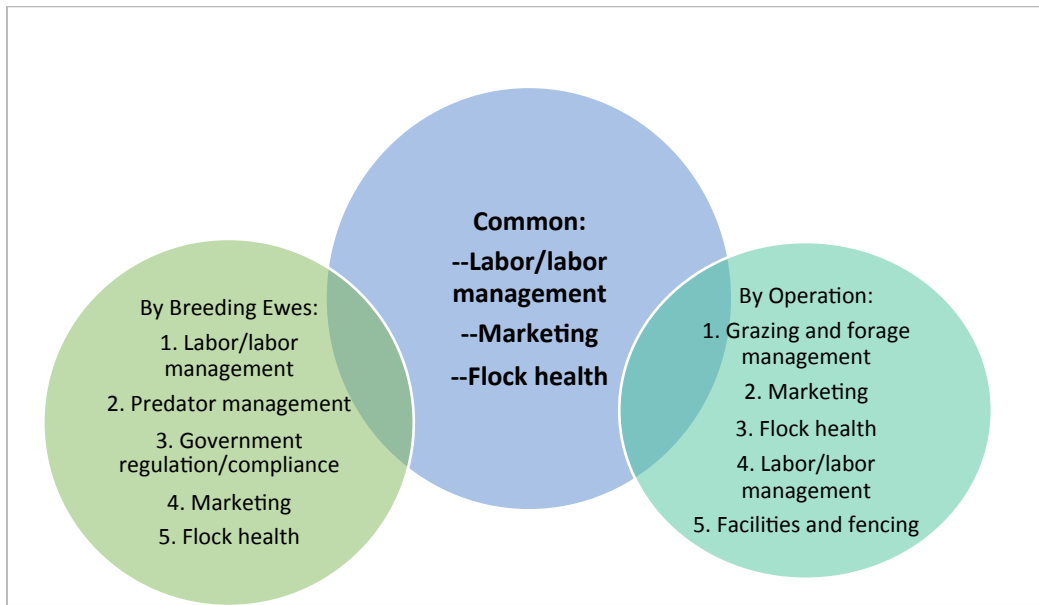


**Figure 1-3** Percent Breeding Ewes by Flock Size

Calculating producer challenges by the percent of operations identifies challenges affecting the greatest number of sheep producers, whereas weighting the greatest producer challenges by the number of breeding ewes identifies challenges affecting the greatest number of sheep.

The greatest producer challenge identified by percent of operations was grazing and forage management. This was not unexpected, as the greatest number of operations are small and mid-sized operations in pasture and pasture/dry lot flock management systems. The second-highest ranking challenge by percent operations is marketing, followed by flock health.

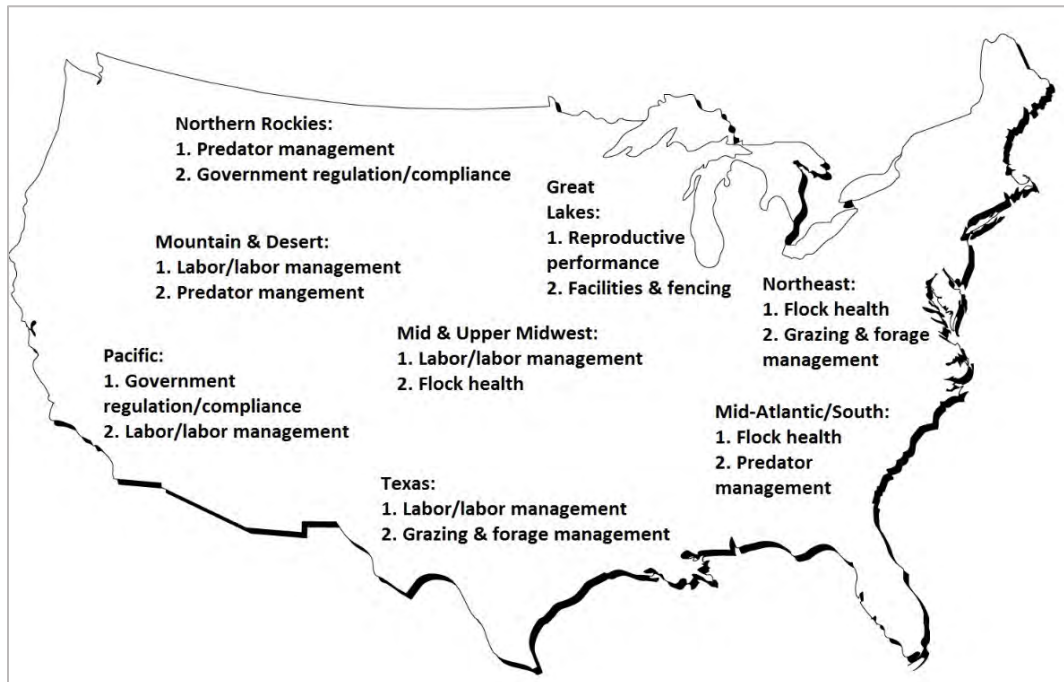
Labor/labor management and predator management surfaced as more important priorities when survey results were summarized by percent of breeding ewes--influenced by larger flocks especially in the western regions. Government regulations and compliance ranked third by percent breeding ewes.



**Figure 1-4** Greatest Producer Challenges by Percent Breeding Ewes and Percent Operations

In the ASI 2010 survey, grazing and pasture management ranked third in seven areas of possible technology improvements. Technology investments reflect areas of producer concern. In the 2010 survey, breeding and selection was ranked highest followed by nutrition management.

Regional differences emerged in ranking producer challenge priorities. Based on percent breeding ewes, in the Northeast and Mid-Atlantic/South flock health was the top-ranking challenge. In the Great Lakes, reproductive performance and facilities and fencing ranked first and second. In the Mid & Upper Midwest, Texas and Mountain & Desert regions, labor/labor management was the number one challenge. In the Northern Rockies and Pacific, government regulation/compliance was high ranking.

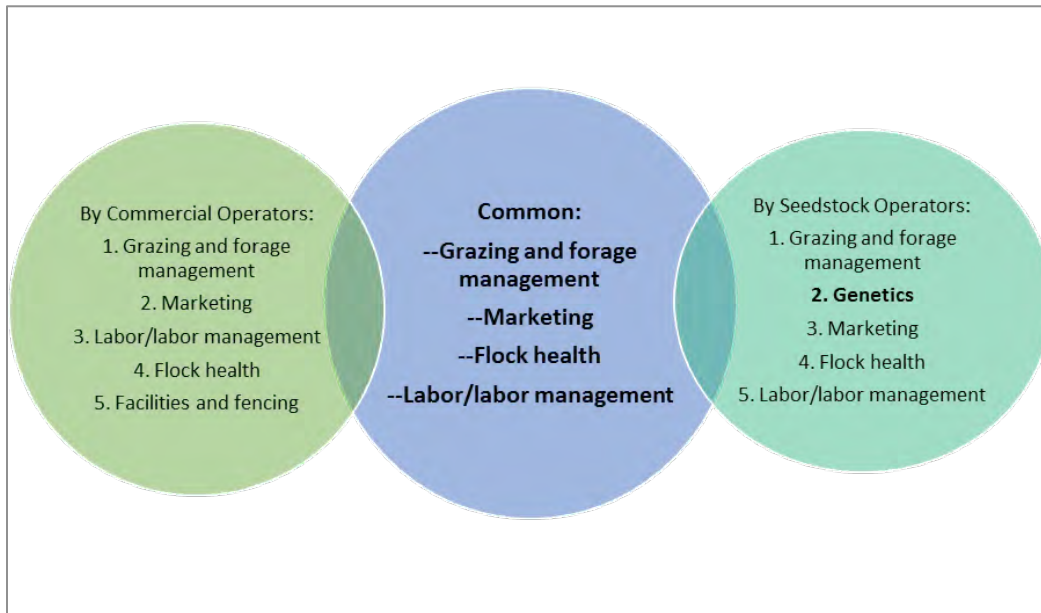


**Figure 1-5** Greatest Producer Challenges by Percent Breeding Ewes and by Region

The producer survey helped define greatest challenges for commercial and seedstock operations. Commercial flocks included commercial lamb, wool, dairy, and sustainable land management flocks. Seedstock flocks included seedstock flocks and show and 4-H/club lamb flocks.

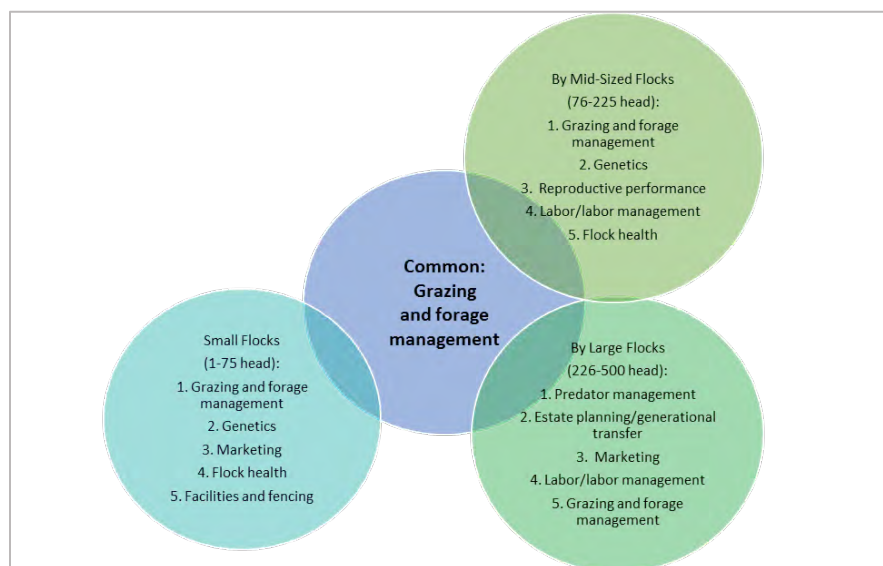
There are cross-cutting producer challenges across commercial and seedstock operations. Grazing and forage management is thus a far reaching, broad research priority affecting many across the sheep industry. As measured by percent operations, grazing and forage management was the top-ranking priority for both commercial and seedstock operations. Marketing, flock health, and labor/labor management were also common concerns.

Not surprisingly, genetics received a higher ranking among seedstock flocks than among commercial flocks. Genetics ranked second after grazing and forage management for seedstock operators. The percent of seedstock producers identifying genetics as one of their top three challenges is double that of other commercial operations.



**Figure 1-6** Greatest Producer Challenges for Commercial and Seedstock Operations

Grazing and forage management is the one common producer challenge that emerges when seedstock producers are defined by size of breeding flocks. Genetics is the second-highest ranking challenge among the small and mid-sized flocks, but is overshadowed by predator management and estate planning/generational transfer by large seedstock operations.



**Figure 1-7** Greatest Producer Challenges by Size of Seedstock Operation

Flock health, marketing, and labor/labor management are three challenges that are common when commercial flocks are defined by size of breeding flocks. Government regulations/compliance, labor/labor management and predator management are the top three producer challenges facing the largest commercial operations.

Aside from genetics, size of operation tends to have a greater influence than type of operation when comparing the greatest producer challenges among commercial and seedstock operations.



**Figure 1-8** Greatest Producer Challenges by Size of Commercial Operation

The 2010 ASI survey produced similar findings. In the 2010 ASI survey, producers were asked to rank in order of importance all the new technologies they had adopted to improve production efficiency. The largest operations placed highest priority on predator control, followed by nutrition management, and breeding and selection.

## Chapter 2 Sheep Genetics and Breeding

Genetics was identified as a high priority producer challenge by seedstock flocks and was ranked second to the challenge of forage and grazing management. However, 12 percent and 15 percent of medium- and small-sized commercial flocks, respectively, also ranked genetics as a high priority challenge indicating a reasonable amount of interest among many commercial flocks for genetic issues.

Estimated Breeding Values (EBVs) are science-based measurements of heritable traits that provide an estimate of the genetic potential of an individual animal relative to the breed average. One of the priority technology constraints identified through the survey was the limited use of EBVs by the sheep industry due to a lack of familiarity with EBVs. The producer respondents viewed educational material for EBVs as not being readily used or easily accessible. Focus group respondents reinforced that educational material for genetic improvement is often not readily used and/or not easily accessible. However, the use of EBVs is actually increasing, reflecting a renewed emphasis by the National Sheep Improvement Program (NSIP) on educational outreach.

The volume of new genomic and genetic information over the past several years has created a challenge to harness, interpret, and utilize the information. Genomic information is particularly valuable for managing the expression of simply inherited genes; however, application to traits such as disease resistance and meat quality is more complex. The interpretation and use of genomic information draws upon many disciplines including genetics, computer science/data management, statistics, animal breeding, economics, and biology.

### *Estimated Breeding Values Assessment*

Animal scientists have developed a method that provides the estimated breeding value of an animal for a particular trait based on the animal's performance data, its genetic history, and the environment in which it was reared. This is the best method to predict progeny performance, and its efficacy has been clearly demonstrated in other livestock species.<sup>2</sup>

Among those seedstock producers that responded to a question about use of EBVs, 41 percent reported using EBVs in their selection and breeding decisions.

Of those seedstock/show producers that identified genetics among their top three challenges, 38 percent reported using EBVs in their selection and breeding decisions – not substantially different from that of all seedstock producers.

Of those seedstock/show producers reporting that they do not use EBVs in their selection and breeding decisions, “Need more information on how to use EBVs” was the most common reason given, followed by “No interest or other” and “Difficulty finding rams or ewes with EBVs”, respectively.

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<sup>2</sup> Redden, Reid. *Understand Sheep Estimated Breeding Values*. NDSU Extension Service. October 2012.

## **Genetics and Breeding Research and Development Priorities**

- ***Verify the value of EBVs generated by NSIP*** - Applied studies of performance-recorded flocks are needed to demonstrate the usefulness of EBVs with a concomitant emphasis on producer education to encourage greater uptake of genetic technologies.

The focus group respondents recommended that the priorities for future genomics studies focused on genetic markers for application by the sheep industry should be parasite resistance, specific diseases, milk production, production traits and carcass traits - in that order. The focus group affirmed that each of these priority areas require not only new information from research but also the interpretation of research results for application by the industry.

Applied research studies need to be conducted in performance-recorded flocks to demonstrate the usefulness of EBVs. This applied research can add credence to educational programs for producers on the value of EBVs generated by the NSIP. Some examples of such studies include:

Specific research studies could be focused on large research or commercial flocks, where progeny testing would be done on a large number of rams with high and low EBVs or, alternatively, high and low index scores, in order to demonstrate the response to such selection. In addition, research flocks at university or USDA Agricultural Research Service stations enrolled in NSIP could use retrospective selection to compare performance of adults if different selection criteria had been applied. For example, adult ewes could be divided into two or more groups based on their birth type, the lifetime average litter sizes produced by their dams, the lifetime average litter sizes produced by their dams but adjusted for age of dam, the EBV of the dam for prolificacy, the EBV of the sire for prolificacy, the EBV of the ewe as a lamb, or the EBV of the ewe after her first parity and prolificacy of the adult ewes in each group compared. The adult ewes in the group with the highest EBVs as lambs or as young ewes should have the highest lifetime prolificacy.

The 2008 National Research Council report included recommendations to continue improvements in productivity through further advances in genetics (including gene biotechnology), nutrition, health, and management programs.<sup>3</sup> The report stated that the sheep industry continues to lag behind other livestock industries in the adoption of genetic improvement technology resulting in a competitive disadvantage of sheep with respect to other livestock species.

The American Lamb Board Roadmap Project also stressed the importance of expanded use of EBVs.<sup>4</sup> The Roadmap project recommended that NSIP should launch an assessment of how to reintroduce genetic selection to the U.S. industry. It also recommended re-introduction of NSIP to commercial and purebred producers.

- ***Identify genetic parameters and selection criteria for new and/or complex traits*** - Identify major genes and mutations associated with economically important production traits and disease conditions and develop selection criteria for difficult to measure new and/or complex traits.

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<sup>3</sup> National Research Council. Changes in the Sheep Industry in the United States, Making the Transition from Tradition, 2008.

<sup>4</sup> Hale Group. The American Lamb Industry Roadmap Project--Final Presentation, December 10, 2013.

Effective genetic improvement programs are based upon knowledge of the heritability of traits and the genetic correlations among traits. These genetic parameters are well known for many common production traits such as litter size, weaning and post-weaning weights, fleece weight, fiber diameter, and commercial milk production traits. However, the genetic parameters for traits such as parasite and disease resistance, feed efficiency and residual feed intake of growing lambs, and meat quality and eating satisfaction are not as well known. The few large sheep research flocks still present at universities and USDA Agricultural Research Service stations should be utilized to estimate the genetic parameters for difficult to measure economically important traits and to identify genetically correlated traits that are more easily measured.

- **Develop economic selection indices** - *Develop improved selection indexes to increase the rate of genetic improvement of net profit under different production environments.*

Knowledge of genetic and phenotypic parameters for economically important traits, and their economic values, can lead to the development of site-specific “net profit” or “net merit” economic selection indices that can increase the rate of genetic improvement and result in increased profitability.

- **Genomic information** - *Identify major genes and mutations associated with economically important production traits and disease conditions.*

Single nucleotide polymorphism (SNP) “chips” are available that can identify the particular component of an individual animal’s DNA at 50,000 or more locations throughout a sheep’s genome. Genome wide association studies (GWAS) can be used to associate SNP differences among animals with certain genetic defects or production traits. DNA tests can then be developed to identify animals that are carriers of genetic defects or genes that are expected to result in increased performance for production traits. Some currently identified genes are the recessive spider syndrome, scrapie susceptibility/resistance, the partially dominant Booroola gene for increased ovulation rate, the Callipyge gene for muscling, and the recessive 1 haplotype for decreased susceptibility to ovine progressive pneumonia. There are likely many more single genes and genetic mutations to be identified that have a major effect on a performance trait.

- **Genomic breeding values** - *Develop genomic breeding values.*

Another future use of SNP “chips” will be to identify many locations in the sheep genome that have both small and large effects on performance traits, with opportunity to use this information to select sheep at very young ages and, in particular, select for traits that are difficult-to-measure (e.g., disease resistance/tolerance; reproductive fitness; longevity).

Ideally, the genomic information is combined with performance records of the individual and/or relatives to produce a genomic estimated breeding value (GEBV). Such GEBVs are routinely being used to accelerate the rate of genetic improvement in the U.S. dairy cattle industry. In order to determine the relationship between the SNP data and performance traits, both genomic and performance data on a very large number of individuals are required.

While the genomic data can be obtained at a cost by submitting DNA samples of individuals to a commercial laboratory, the weak link in researching this technology in the U.S. sheep industry is the lack of phenotypic performance information on a large number of animals. There is a current research initiative to collect both genomic and performance data on Katahdin, Suffolk, and Rambouillet sheep.

While sheep producers are anxious to harness the possibilities of genomics, there is a crucial need for the recording of phenotypic performance records on many sheep before genomics can be utilized for improvement in most traits.

### ***Education Priorities for Genetics and Breeding***

- ***Strategic crossbreeding systems*** - Educators should continue to emphasize organized crossbreeding systems that are suited to local climatic and market environments and that optimize both breed complementarity and hybrid vigor.

The 60+ breeds of sheep in the U.S. represent a genetic reservoir that allows a producer to target their desired level of production for any economic production trait by using a single breed or combining two or more breeds. If two or more breeds can be used to meet target production levels, advantages resulting from hybrid vigor also can be realized. Educators should continue efforts to inform producers about organized crossbreeding systems that are suited to local climatic and market environments and that optimize both breed complementarity and hybrid vigor.

- ***EBVs to improve flock performance*** – Educators should continue to promote the positive benefits of NSIP in order to recruit and retain seedstock flocks into the program and to increase the number of commercial flocks purchasing rams with EBVs from seedstock flocks enrolled in NSIP.

The National Sheep Improvement Program is the core entity for the genetic improvement of the national flock. However, the number of seedstock flocks enrolled in NSIP is still too small. Continued educational activities are required to promote the positive benefits of NSIP in order to recruit and retain seedstock flocks into the program and to increase the number of commercial flocks purchasing rams with EBVs from seedstock flocks enrolled in NSIP.

- ***Goal-based production records for commercial flocks*** – For commercial flocks, production records used to make selection and culling decisions should be simple and based on selection criteria that have a high probability of resulting in true genetic improvement.

While the vast majority of genetic improvement in commercial flocks will come through the purchase of rams with desired EBVs from seedstock flocks enrolled in NSIP, some additional genetic progress can come from within-flock selection of replacement ewe lambs and culling of ewes. Production records to make these selection and culling decisions should be simple and based on selection criteria that have a high probability of resulting in true genetic improvement.

The National Research Council reported that key opportunities for enhanced industry efficiency and competitiveness is continued improvements in productivity through further advances in genetics (including gene biotechnology), nutrition, health, and management programs.<sup>5</sup> NRC also reported that the genetic potential exists to further increase productivity within the various production systems.<sup>6</sup>

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<sup>5</sup> National Research Council 2008. *Changes in the Sheep Industry in the United States, Making the Transition from Tradition*. 2008:5.

<sup>6</sup> Ibid.

## Chapter 3 Flock Health

Flock health ranked among the top five producer challenges when analyzed by both percent breeding ewes and percent operations.

Producers were asked to further define their flock health concerns through questions about lamb and breeding stock diseases and disease conditions.

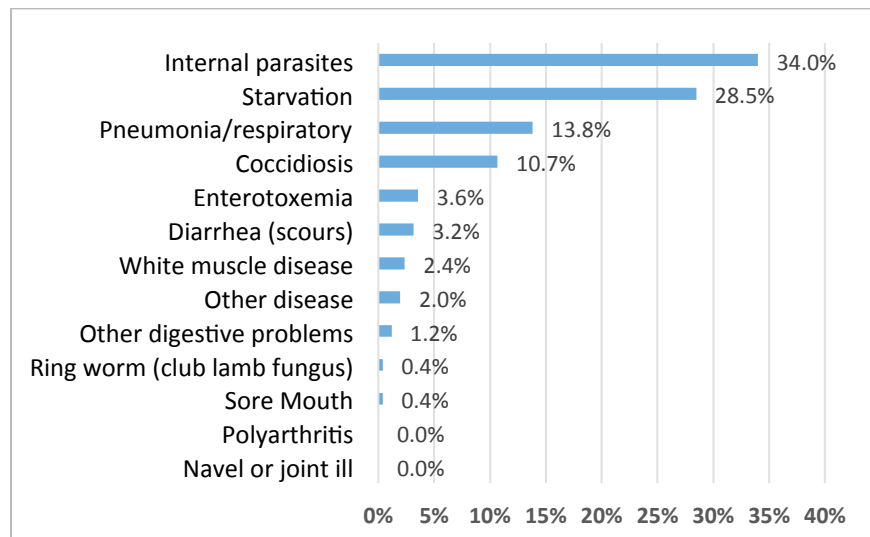
### *Producer Survey Results*

When producers were asked which diseases or disease conditions in lambs are most difficult to manage, the most common concerns across all flocks, regardless of type of operation, size of operation, management system, or years of experience raising sheep, were internal parasites, starvation, pneumonia and other respiratory diseases, and coccidiosis. The only exception being that internal parasites dropped out of the top four diseases/disease conditions for operations with 1500 or more breeding ewes. These larger operations tend to be located in the western and intermountain states (areas with limited rainfall) and managed on open range where ground contamination is minimized.

Mountain & Desert (Region 6) and Northern Rockies (Region 7) were the only two regions where internal parasites were not ranked among the top three most difficult diseases/disease conditions to manage in lambs. Again, management system and annual rainfall contribute to these regional differences.

Starvation and pneumonia and other respiratory disease conditions ranked first and second in the Mountain & Desert and Northern Rockies regions. These two regions-accounted for 37 percent of the total number of breeding ewes captured by the survey and 10 percent of operations.

Once producers identified the diseases in lambs that were most difficult to manage, they were asked to identify the diseases and disease conditions in lambs with the greatest economic impact. For all flocks, internal parasites was the highest-ranking concern affecting lambs, with starvation a close second.

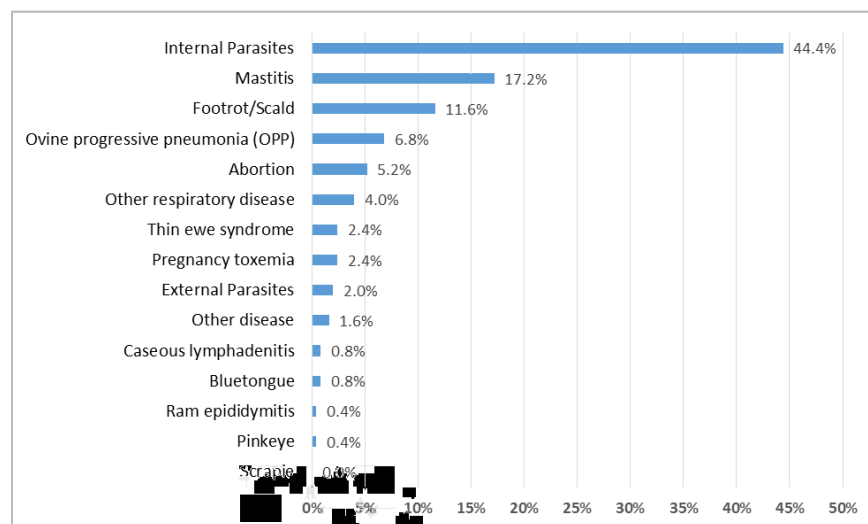


**Figure 3-1** Disease/Disease Condition in Lambs with Greatest Economic Impact (All Flocks)

Producers were also asked to identify the diseases/disease conditions in breeding stock that are the most difficult to manage. Across flocks, internal parasites, mastitis, and hoof conditions (footrot/scald) ranked as the most difficult diseases/disease conditions to manage in breeding ewes and/or rams. Abortion, pregnancy toxemia, other respiratory diseases, ovine progressive pneumonia (OPP), and caseous lymphadenitis were the next highest ranking disease management challenges.

Very small (1-99 breeding ewes) and small (100-499 breeding ewes) operations ranked internal parasites as the most difficult disease/disease condition to manage in breeding stock for 55 percent and 56 percent of operations, respectively. Mid-sized (500-1499 breeding ewes) and large (1500 or more breeding ewes) operations ranked mastitis as the top priority, at 57 percent and 45 percent of operations, respectively.

Once producers identified the diseases in breeding ewes/rams that were most difficult to manage, they were asked to identify the diseases and disease conditions in breeding stock with the greatest economic impact. Across all flocks, internal parasites was the highest-ranked disease/disease condition by a wide margin. Mastitis and footrot/scald were a distant second and third in ranking.



**Figure 3-2** Disease/Disease Condition in Breeding Ewes/Rams with Greatest Economic Impact (All Flocks)

In summary, across all flocks, internal parasites have the greatest economic impact in both lambs and breeding ewes/rams at 34 percent and 44 percent, respectively. Across all flocks, starvation in lambs and mastitis in breeding ewes ranked second in terms of economic impact.

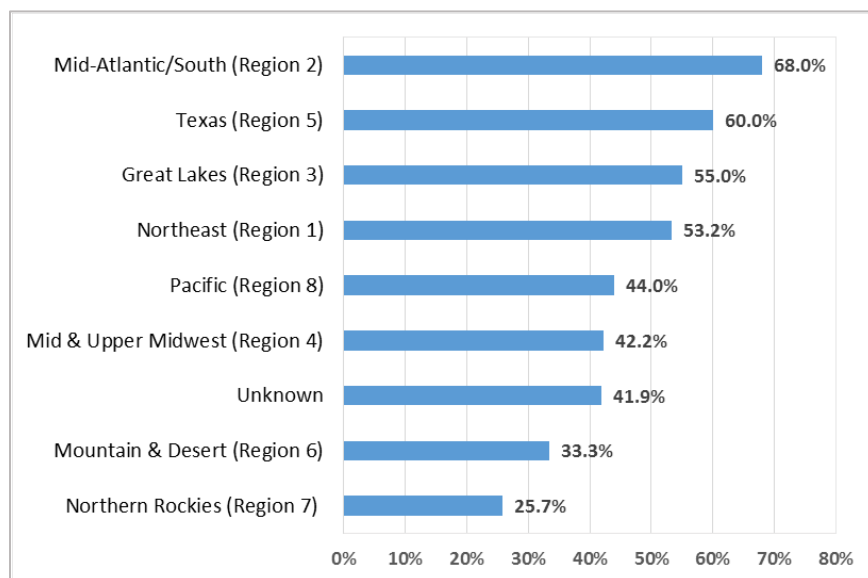
Mastitis and lamb starvation are among the clinical signs of OPP infection in ewes. Of commercial operations identifying “starvation” as one of the three most difficult diseases/disease conditions to manage in their lambs, 40 percent also identified “mastitis” as one of their three most difficult diseases/disease conditions to manage in their breeding ewes and 20 percent identified OPP. OPP ranked fourth in terms of economic impact for breeding ewes.

Among flock health issues, the USDA/APHIS/Vs NAHMS Sheep 2011 study reported ewe health/management-related issues were the most important management issue for respondents, with respondents ranking this as their first, second, or third most important issue. Infectious disease was the second most important management issue (30 percent), followed closely by disease prevention (29.5 percent), predator control (22 percent), lamb health/management (21 percent), and death loss (20 percent).<sup>7</sup>

### *Greatest Challenge: Internal Parasites*

Regions 2 and 5 (Mid-Atlantic/South and Texas, respectively) had the highest percentage of producers within those regions identifying internal parasites as one of their three most difficult diseases/disease conditions to manage in lambs and/or breeding sheep, followed by Regions 1 and 3 (Northeast and Great Lakes, respectively).

Not surprisingly Regions 6 and 7 (Mountain & Desert and Northern Rockies, respectively) had the lowest percentages of producers within those regions identifying internal parasites as one of their most difficult disease conditions to manage. Climate (annual rainfall) and management system impact potential parasite challenges.



**Figure 3-3** Percent of Operations within a Region Identifying Internal Parasites as a Difficult Disease Condition among Lambs and/or Breeding Stock

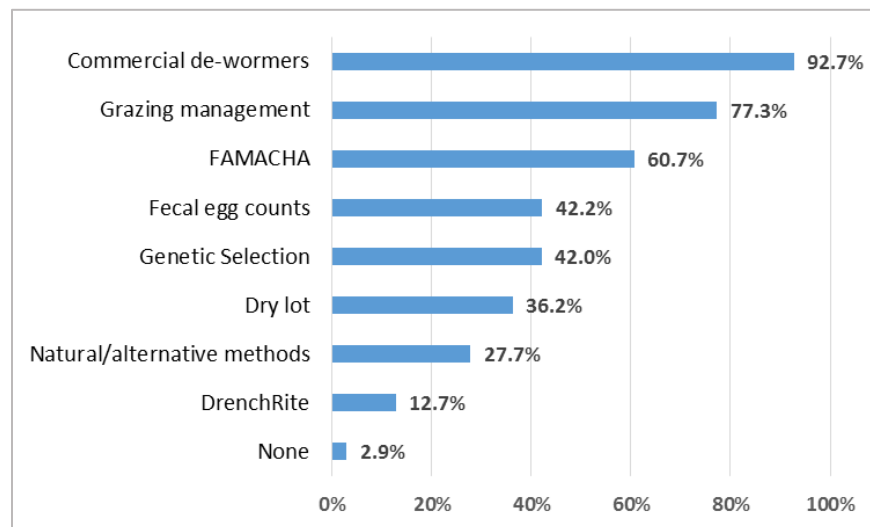
Producers were asked to characterize the effectiveness of specific parasite treatment practices/technologies. Overall, 93 percent of producers responding to a question about the use of

<sup>7</sup>USDA/APHIS, NAHMS, NAHMS Sheep Needs Assessment Findings. 2015.

parasite management technologies, have used commercial de-wormers on their operations.<sup>8</sup> This was followed by grazing management practices aimed specifically at parasite control and the FAMACHA<sup>®</sup> eyelid color test as an indicator of anemia in individual animals, at 77 percent and 61 percent of operations, respectively. Of operations identifying parasite management as a major challenge, 73 percent have used the FAMACHA<sup>®</sup> test, compared to 43 percent of operations that did not identify parasite management as a major challenge.

Of producers reporting the use of genetic selection as a parasite management strategy, 33 percent report raising a “Hair Sheep” breed. Note that NSIP calculates EBVs for parasite resistance in the Katahdin breed of hair sheep.

Across all operations that have used genetic selection as a parasite management strategy, the percentages of those that considered genetic selection somewhat to very effective relative to those that considered genetic selection somewhat ineffective to ineffective was not substantially different across all breeds compared to hair sheep breeds, at 43 percent and 57 percent, respectively. Note that not all hair sheep breeds (or individuals within a breed) are considered parasite resistant/tolerant.



**Figure 3-4** Use of Parasite Management Technologies

Once producers were asked whether they used certain parasite management technologies, they were asked to rate the effectiveness of different technologies. Across all operations, only the DrenchRite<sup>®</sup> resistance assay and natural/alternative methods of parasite management were rated by producers as somewhat to very effective. Only 13 percent of producers reported using the DrenchRite<sup>®</sup> assay, and 28 percent reported using natural/alternative parasite management technologies.

<sup>8</sup>This is consistent with findings from the USDA/APHIS/VS NAHMS Sheep 2011 study which also reported that internal parasites were a major concern among operators. The study reported de-wormer use as a preventative measure for 87 percent and 79 percent of ewes and lambs, respectively, (USDA/APHIS, NAHMS, *Sheep 2011 Part III: Health and Management Practices on U.S. Sheep Operations*, 2011. September 2013).

Natural/alternative parasite management technologies were not enumerated in the survey, but could include such things as the use of copper oxide wire particles, diatomaceous earth, botanicals, herbs, etc. The use of high tannin concentrate forages (e.g. *Sericea lespedeza*) could be included under either natural/alternative or grazing management technologies.

Flock sizes for those reporting the use of natural/alternative parasite management technologies ranged from two to 6,000 breeding ewes--with 76 percent of those reporting 100 or fewer breeding ewes.

Responses to the question regarding use of parasite management technologies were subdivided into those producers identifying internal parasites as one of the three most difficult disease conditions to manage on their operations versus those that did not identify internal parasites as a top disease management concern. A larger percentage of those producers that considered parasite management a major disease challenge, reported using each of the parasite management interventions listed. Again, with the exception of the DrenchRite® resistance assay and natural/alternative methods, producers considering parasite management a major disease challenge rated all other management intervention strategies relatively more ineffective than effective. Conversely, producers that did not identify internal parasites as a major disease condition challenge, rated all intervention strategies as relatively more effective than ineffective.

### ***Research Priorities for Flock Health***

Some disease research, development, and education needs can be site and region specific. Flock health ranked relatively higher in pasture-based and pasture/dry lot management systems than in herded open- and fenced-range systems. In general, internal parasites ranks as one of the most important disease challenges in both lambs and breeding stock.

Internal parasites, starvation, pneumonia/respiratory conditions, mastitis and footrot/scald are all conditions identified for further research.

- ***Parasite control*** – Both basic and applied research addressing parasitism in sheep, including genetic markers for parasite resistance, development of vaccines, more effective anthelmintics, and improved management practices are critically needed by the industry.
- ***Lamb starvation*** - Examine the risk of starvation from a genomic approach of ewe influence to gain a better understanding of the genetic influences associated with lamb survival.

Starvation ranked first in Regions 6 (Mountain & Desert) and 7 (Northern Rockies) accounting for 37 percent of breeding ewes and 10 percent of operations. Some data suggest that OPP may be a contributing factor.

- ***Lamb respiratory disease*** – Conduct region-specific research that targets pneumonia and other respiratory conditions in lambs.

Pneumonia/respiratory conditions ranked second in Regions 6 (Mountain & Desert) and 7 (Northern Rockies). Regions 6 and 7 accounted for 37 percent of the total number of breeding ewes captured by the survey and 10 percent of operations.

- **Mastitis control** – *Mastitis in sheep is not well characterized. Etiological studies and information, genomics, and biologicals are needed by the industry to assist with mastitis control.*

Mastitis ranked highest among disease management challenges in mid-size to large flocks. This condition often affects the heaviest milking ewes and there is a need to better understand the development of mastitis and its control. Mastitis can be linked to OPP as well as to bacterial infections and trauma. The industry needs a better understanding of mastitis in ewes and genomics and biologicals to assist with prevention and control.

- **Footrot and scald control** - *A significant tool for the control of footrot is no longer available in the U.S. More effective control tools are needed to assist flock owners with the prevention, treatment and elimination of footrot and scald, including genomics and biologicals.*

Footrot/scald received a high ranking among disease management challenges in breeding stock. Lambs perform at subpar levels and are a welfare concern. Prolonged periods of wet, moist conditions and crowding can increase the incidence of both footrot and scald.

- **Alternatives to antimicrobials** - *As the sub-therapeutic use of antibiotics in animal agriculture is phased out, research is needed to explore alternatives that provide the same or greater benefits in terms of improved feed efficiency, disease prevention, and overall animal health.*
- **Scrapie transmission and live animal tests** – *Better knowledge of environmental contamination and reservoirs of the infective agent in the transmission of scrapie is needed, as well as the development of improved live animal tests.*

Scrapie eradication is a top priority for the U.S. sheep industry. Since 2002, the prevalence of scrapie has decreased significantly through existing eradication efforts, largely a result of effective slaughter surveillance. Since slaughter surveillance started in FY 2003, the percent of cull sheep found positive at slaughter (once adjusted for face color) has decreased 90 percent.<sup>9</sup> The industry's goal is to eradicate scrapie from the U.S. by 2017 and to achieve "Scrapie Free" status in accordance with World Organization for Animal Health (OIE) standards.

### **Development Priorities for Flock Health**

- **Anti-parasitic pharmaceuticals** - *Develop new vaccines and more effective anthelmintics for treatment and control of parasites.*

The National Research Council reported a challenge to sheep health is the lack of availability of many critically needed drugs.<sup>10</sup>

- **Coccidia control tools** - *The industry needs a more complete set of coccidia-control tools.*

<sup>9</sup> USDA Animal and Plant Health Inspection Service, National Scrapie Eradication Program. Web. May 2016.

<sup>10</sup> National Research Council. Changes in the Sheep Industry in the United States, Making the Transition from Traditional, 2008.

Coccidiosis continues to be a challenge primarily in grass reared lambs where coccidiostats are difficult to provide in adequate doses or aren't permissible due to market specifications. In confinement reared lambs, these same market challenges exist. Technology transfer and education with respect to existing control measures also need to be supported.

- **Lamb respiratory disease** - *There have been no new adoptable tools to assist the U.S. sheep industry with lamb respiratory disease. Such tools are needed by the industry.*
- **Footrot vaccine** - *Develop and license an effective footrot vaccine for U.S. sheep industry use.*
- **Q fever mitigation and control** - *Coxiella burnetii research is needed to further elucidate transmission between sheep, other animals, and humans and mitigation and control strategies are needed that include management systems and vaccine development.*

Q fever is a zoonotic disease that has long been considered an occupational disease associated with exposure to livestock by farmers, veterinarians, slaughter facility workers, and animal researchers. Q fever is an acute/chronic zoonotic illness caused by the bacterium *Coxiella burnetii*. The disease is a major cause of abortion in sheep and goats, which can result in significant economic losses to producers, and in significant risk of transmission to humans. Evidence from other countries suggests that use of a *Coxiella* vaccine in livestock is an effective means of minimizing disease transmission. At present, there are at least two commercially available *C. burnetii* vaccines in other parts of the world, but none commercially available in the U.S.<sup>11</sup>

### ***Education Priorities for Flock Health***

- **Adoption of existing technologies** – *Educators should promote the adoption of existing parasite control technologies, including selection and culling, until more effective research solutions can be identified.*

The survey indicated that the most commonly used parasite control technology was deworming. Grazing management and the use of the FAMACHA<sup>®</sup> test were the second and third most commonly used tools. A key part of worm control involves determining which dewormer works in a population of animals (flock) either by performing a Fecal Egg Count Reductions test (FECRT) or, alternatively, a DrenchRite assay. Only 13 percent of the respondents indicated that they used the DrenchRite assay as a parasite management tool. There is a need to understand why available tools (such as FECRT) are not seeing higher adoption rates by sheep operations.

Anthelmintic-resistant nematode infections significantly hamper the survivability of U.S. lambs in parts of the country where climate sustains nematode larval development on grass. Even in the West, there have been recent rainfall events that have promoted nematode infections in lambs where typically not experienced.

For lambs and breeding ewes, Regions 2 and 5 (Mid-Atlantic/South and Texas, respectively) had the highest percentage of producers within those regions identifying internal parasites as one of their three

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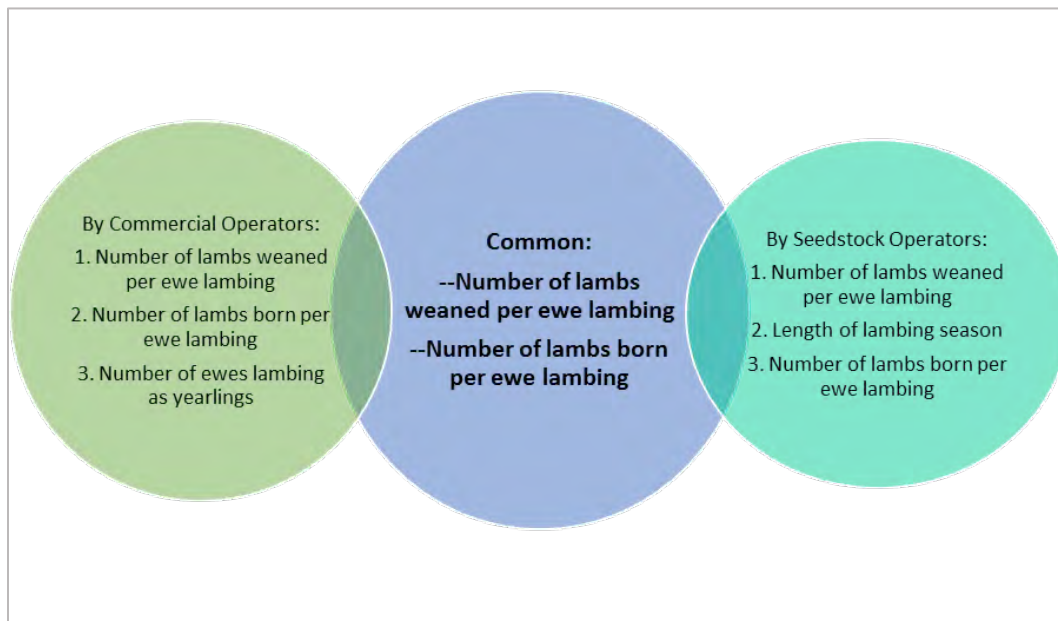
<sup>11</sup> Proceedings of the One Hundred and Seventeenth Annual Meeting United States Animal Health Association. San Diego, CA. 17-23 October 2013.

most difficult diseases/disease conditions to manage, followed by Regions 1 and 3 (Northeast and Great Lakes, respectively). Regions 6 and 7 (Mountain & Desert and Northern Rockies, respectively) had the lowest percentages of producers within those regions identifying internal parasites as one of their most difficult disease conditions to manage. Internal parasites had the greatest economic impact across all operations.

- **Accurate information** – *Educators should direct producers to accurate parasite management materials, including internet sources and the Sheep Production Handbook.*

## Chapter 4 Reproductive Performance

Reproductive performance is directly tied to profitability. Commercial and seedstock operators were asked to assess how satisfied they are with the reproductive performance of their flock. The common concerns among both commercial and seedstock operators were number of lambs weaned per ewe lambing and number of lambs born per ewe. The number of lambs weaned per ewe has been cited as the trait with the greatest financial impact on sheep production.<sup>12</sup> Number of ewes lambing as yearlings and length of lambing season completed the top three reproductive performance concerns for commercial and seedstock operations, respectively.



**Figure 4-1** Least Satisfied Areas of Reproductive Flock Performance

### *Assessment of Out-of-Season Breeding Use*

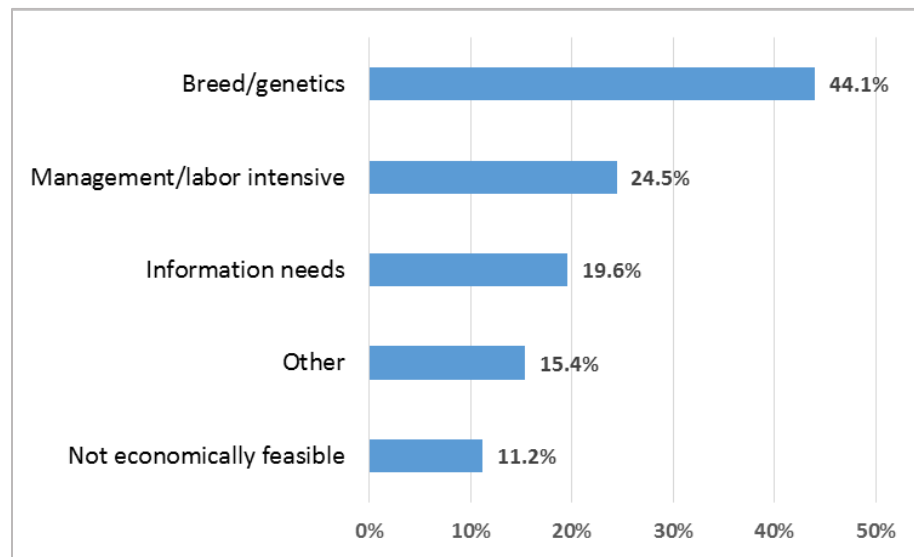
In the U.S., the lamb feeding industry developed, in part, to help address asymmetries of seasonal lamb production and seasonal lamb consumption. Out-of-season breeding protocols and products have also been developed to help smooth seasonal production patterns and address seasonal supply.

When asked: *In the past three years, were any of your ewes exposed for out-of-season breeding?* 45 percent of respondents reported that they had exposed ewes for out-of-season breeding during the past three years.

Of those respondents that reported ewes exposed for out-of-season breeding, 97 percent answered *How satisfied are you with the results of your out-of-season breeding program?* Of those that responded, 38 percent reported that they were very satisfied with the results of their out-of-season breeding program, 49 percent reported that they were somewhat satisfied, and only 13 percent reported that they were not satisfied with their results.

<sup>12</sup> Bradford G.E., Selection for reproductive efficiency, Sheep Goat Res. J. 17 (2002) 6–10.

Those producers responding that they were either “Somewhat satisfied” or “Not satisfied” with the results of their out-of-season breeding programs, were asked: *What factors have limited the success of your out-of-season breeding program?* Of those, 44 percent responded breed/genetics was a limiting factor, followed by management and labor requirements, and a need for more information on management practices, protocols and/or product availability, at 24 percent and 20 percent of respondents, respectively.



**Figure 4-2** Factors Limiting the Success of Out-of-Season Breeding Programs

### **Research Priorities for Reproductive Performance**

- **Reproductive efficiency** - Studies examining fecundity, survivability and out-of-season lamb production are important to increasing lifetime productivity per ewe.

Reproductive efficiency is important to the overall productivity and profitability of individual sheep operations, and of the sheep industry as a whole. With domestic production currently supplying less than half of the total annual disappearance of lamb meat in the U.S., improvements in reproductive efficiency are essential to the sustainability and competitiveness of the sheep industry.

- **Mastitis and internal parasites** - Mastitis and parasites can hinder optimal reproductive performance. Recent data indicate that resistance to parasites involves genetic differences in the immune system. Studies that examine methods to stimulate the immune system and the role of genetics in disease resistance and immune response can improve the health and welfare of ewes and while also contributing to improved reproductive performance.
- **Out-of-season breeding** – Out-of-season breeding as a means for increasing flock income and managing the seasonal supply of lambs remains underutilized by the industry.

Selection, hormone treatment, and ram introduction are proven practices. However, studies of factors that influence the component traits in relation to seasonal success are needed. For example, the neural factor kisspeptin, which varies seasonally, affects secretion of gonadotropin releasing hormone. A

better understanding of these influences may lead to increased ovulation rate or viability of oocytes shed in response to treatments with light, nutrition, melatonin, progestogen, or ram introduction.

- **Genetic potential scoring** - *Research is needed to develop a more precise method to assess the reproductive status of an individual animal or flock relative to its genetic potential.*

A Genetic Potential score, similar in principle to a FAMACHA® score used to assess parasite challenge or a Body Condition score used to assess nutritional status, would serve to gauge the amount of gain that could be anticipated in response to reproductive interventions in out-of-season breeding programs. If well below genetic potential, treatments are effective. If at potential, treatments have no further effect. Reproductive technologies could then be better directed to help animals/flocks achieve their genetic potential, not misdirected to where such technologies have a low probability of success, and yield disappointing outcomes for flock owners.

- **Ultra-sound assisted selection for litter size** - *Studies have shown that embryonic and fetal mortality in ewes occurs throughout pregnancy and that these losses can be substantial. Counts of corpora lutea and early embryos or fetuses with ultrasonography and of lambs born provide the opportunity to determine whether producers applying this technology can select for embryonic or fetal survival as a tool for increasing number of lambs born per ewe lambing.*

Ultrasound pregnancy diagnosis, staging pregnancy and fetal counts can also aid with the nutritional management of pregnant ewes and with lambing management.

- **Ewe/lamb bonding behavior** - *Bonding behavior is critical to early neonatal lamb survival. Investigations of factors affecting ewe/lamb bonding as a means to improve management for early lamb survival are needed.*

### ***Development Priorities for Reproductive Performance***

- **Commercial availability of reproductive intervention products** - *The commercialization of research outcomes that involve products used to enhance reproductive performance (e.g., commercial availability of hormonal treatments used in out-of-season breeding protocols) are essential for these technologies to be adopted and utilized by the industry.*

### ***Education Priorities for Reproductive Performance***

- **Online resources** - *Online resources specific to reproductive performance and reproductive efficiency should be expanded with emphasis on increasing the number of lambs weaned per ewe lambing, out-of-season breeding management, and mastitis prevention and treatment.*

Reproductive performance ranked 7<sup>th</sup> in importance among concerns of both seedstock and commercial flock operators. Number of lambs weaned per ewe lambing, a composite trait of reproductive performance, was the most important trait of concern. Number of lambs born per ewe lambing, length of lambing season and lifetime performance or longevity were identified as limiting factors in both seedstock and commercial flocks, with percentage of ewe lambs lambing as yearlings being somewhat more important to commercial producers than to seedstock operators.

## Chapter 5 Grazing and Forage Management & Nutrition

One of the more notable and advantageous characteristics of sheep is their versatility and ability to adapt and thrive under a wide variety of environmental conditions and management systems. Sheep are efficient converters of renewable forage to high-quality food and fiber. In many parts of the country, sheep provide residual economic benefit from crop production through the grazing of crop aftermath. Sheep are used to help control weeds on stream banks, croplands, and pastures, reducing the need for chemical herbicides. In rangeland areas, strategic sheep grazing can be an effective tool for controlling invasive plant species that can damage critical wildlife habitat and for suppressing brush for wildfire control.

Forty-two percent of producers identified grazing and forage management as one of the top challenges facing their operations. Among survey respondents, 85 percent reported managing flocks on pasture or a combination of pasture and some other type of system, with 11 percent managing flocks on either fenced or open range. Less than one percent of survey respondents reported dry lot-only management systems.

Nutritional management, on-the-other-hand, did not rank high among the top challenges, with only 14 percent of producers identifying nutritional management as one of their top three challenges. From a production standpoint, however, on most operations grazing and forage management and nutritional management are inextricably intertwined. Nutritional management is fundamental to reproductive performance and expression of genetic potential, animal health and welfare, lamb growth and efficiency, and overall flock productivity.

### *Grazing and Forage Management*

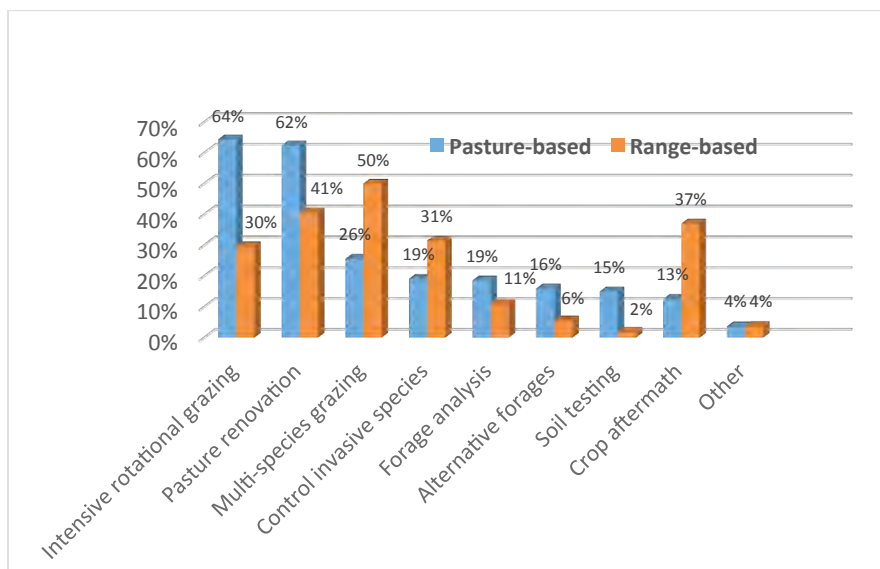
Rangelands in the U.S. are primarily located in the Regions 4, 5, 6, and 7 – the Upper Midwest, Texas, Mountain & Desert, and Northern Rockies, respectively. Sixty percent of the breeding ewes captured by the survey were managed under range conditions. The average flock size of range operations surveyed was just over 1500 breeding ewes. Pasture-based systems are located in all regions. The average flock size of pasture-based operations surveyed was around 100 breeding ewes.

The survey asked producers to identify their top three grazing and pasture management challenges and to indicate which of the three has the greatest potential for increasing the profitability of their operation.

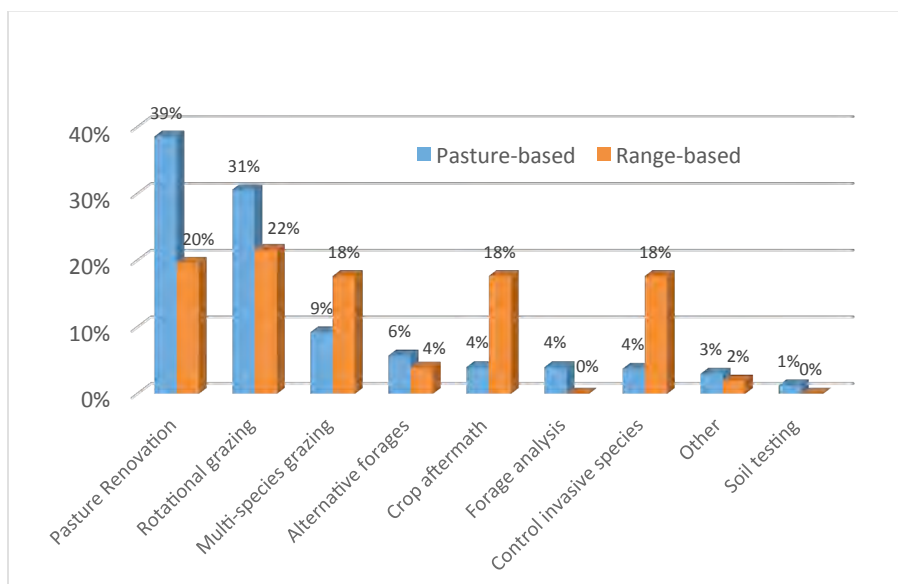
The top grazing and pasture management challenges identified by pasture-based operations were intensive rotational grazing and pasture renovation, at 64 percent and 62 percent of operations, respectively, followed by multi-species grazing at a distant 26 percent.

The top challenge identified by range-based management systems was multi-species grazing followed by pasture renovation (presumably rangeland ecology), grazing crop aftermath/crop residues, controlling invasive species, and intensive rotational grazing (presumably the ability, or lack thereof, to better manage and control grazing rotations on rangeland).

Pasture renovation and intensive rotational grazing were identified by both pasture-based and range-based systems as having the greatest potential for increasing the profitability of those operations. For range-based operations, these were followed equally by multi-species grazing, grazing crop aftermath/residues, and controlling invasive species.



**Figure 5-1** Grazing and Pasture Management Challenges



**Figure 5-2** Greatest Grazing/Pasture Management with Potential to Increase Profitability

Pasture renovation, rotational grazing, and multi-species grazing each entail a slightly different focus depending on whether an operation is pasture-based or range-based. Pasture renovation generally focuses on improving the mix and balance of introduced or improved plant species, whereas the focus of

rangeland renovation is typically on improving the production of native vegetation, controlling invasive species and may also include riparian area protection, erosion control, and fire control (suppression and recovery).

Many range operations graze sheep on public lands for all or part of the year. Rotational grazing practices and opportunities on these operations are generally limited by the conditions set forth in federal or state grazing permits. On public lands, government agencies, to a large extent, control many of the basic livestock grazing management practices, leaving the rancher with little flexibility. Grazing permits dictate when livestock are allowed to graze certain areas, stocking rates, mix of livestock, etc. Grazing periods, stocking rates and livestock mixes are based on the average time of range readiness and forage production, and may not match well with the actual condition and readiness of the range at any given time which can result in lower efficiency and poor utilization of forage resources.

There is a body of research to support the benefits of multi-species grazing – showing increases in both production and profitability, under both pasture and range conditions. The advantages of multi-species grazing are based on complementarity in forage selection and grazing habits.

### *Nutritional Management*

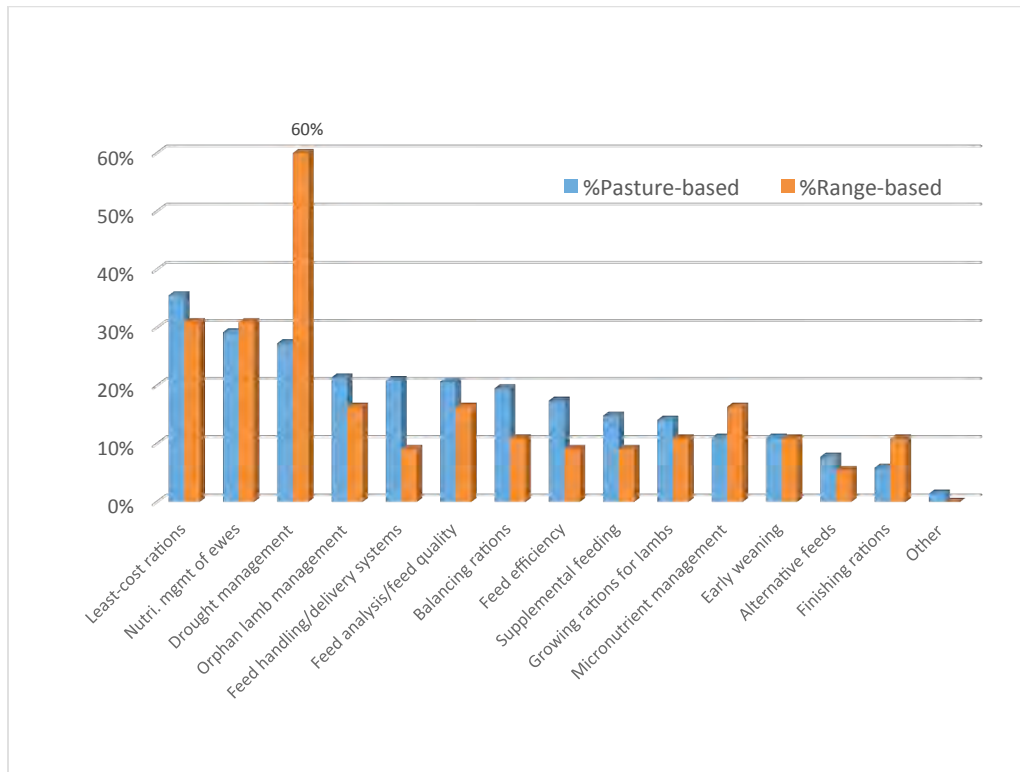
Sheep producers are constantly looking for feed and forage alternatives that supply the appropriate levels and balance of nutrients to optimize health, improve production efficiency, and reduce feed costs. In grazing systems, nutritional management is built around both the forage base and the production goals of the operation. The National Research Council (2015) notes that nutritional advancements in food animals are being made to enhance animal reproduction (e.g., long-chain polyunsaturated fatty acids, selenium, and vitamin E), improve the quality and nutritional value of animal products for the consumer (e.g., dietary vitamin E to extend meat shelf-life), and improve animal health (e.g., copper and gut health, selenium and vitamin E for improved oxidative stability).<sup>13</sup>

Overwhelmingly, the most significant nutritional challenge for range-based operations was drought management, identified by 60 percent of range operations. This was followed equally by nutritional management of ewes by production period and least-cost rations. Pasture-based operations identified these same top three challenges, although with different ordering and weights.

For range operations, drought management also showed the greatest potential to increase profitability among the nutritional challenges identified. For pasture operations, the top three nutritional challenges affecting profitability followed the same ordering as the top three nutritional management challenges, least-cost rations, nutritional management of ewes by production period, and drought management.

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<sup>13</sup> 3 Animal Agriculture Research Needs: U.S. Perspective." National Research Council. Critical Role of Animal Science Research in Food Security and Sustainability. Washington, DC: The National Academies Press, 2015. doi:10.17226/19000.



**Figure 5-3** Nutritional Management Challenges

### **Research Priorities for Grazing & Forage Management and Nutrition**

- **Production efficiency** - Develop integrated methods for increasing the efficiency of sheep production under both extensive rangeland conditions and intensive pasture-based systems as a responsible means of utilizing renewable forage resources while simultaneously improving the quality and value of the products produced.
- **Multi-purpose, multi-use public lands** - Science-based, economically viable solutions to the complex challenges that arise from multi-purpose, multi-use, public lands and competing interests are critical to the sheep industry. Management strategies and practices are needed that enhance and conserve rangeland ecosystems while providing multiple ecosystem services including forages for wildlife, sheep and other livestock, control of noxious weeds and invasive plant species, conservation of wildlife habitat, soil and water conservation, fire control, and recreational opportunities, under changing environmental conditions.
- **Multi-species grazing** - There is a need for both science-based information and “best practice” examples of the environmental and economic benefits of multi-species grazing. This includes co-grazing of rangelands by domestic and wildlife species and co-grazing by multiple domestic species (sheep, cattle, goats) of pasturelands.
- **Sustainability indicators** - A fundamental challenge to the issue of sustainability is measurement and determining key indicators or metrics of sustainability in rangeland management. The

development and application of new technologies for monitoring and predictive modeling that address climate change, livestock grazing, and wildlife management practices are critically needed to demonstrate sustainability and benefits to rangeland ecosystems under multi-use and multi-species grazing systems.

- **Matching stage of production, breed type, and forage resources** - New/updated information is needed to increase producer knowledge and skill in meeting the nutritional needs of ewes at critical production stages, as well as selecting the most appropriate maternal and terminal sire breed(s) to complement available forage resources, while improving the quality of lambs produced, and increasing profitability.
- **Alternative feeds and forages** – Research is needed to identify and incorporate the use of alternative feeds and forages to help meet nutritional requirements during different stages of production while reducing production costs.
- **Strategic Parasite control** – Continued research and development of strategic grazing systems aimed at parasite control and reducing parasite loads on pastures that are both effective and practical to implement are needed, including pasture rotation and rest protocols, multispecies grazing, and introduction of plant species with anti-parasitic properties.

#### **Development Priorities for Grazing & Forage Management and Nutrition**

- **Online information** – Improve the online availability of grazing and forage management, and nutritional management tools, products, and solutions.

#### **Education Priorities for Grazing & Forage Management and Nutrition**

- **Program topics** – Focused educational efforts on long-term cooperative strategies, cover-crop options, residue/aftermath nutritional value, feed supplements, and fencing and water source management are needed.
- **Updated literature** – Updated literature is needed to increase producer knowledge and skill of meeting nutritional needs of ewes during critical production stages and selecting the most appropriate maternal breed to match available nutritional resources in an area or region. Improving the nutrition of pregnant and lactating ewes can result in better lamb growth rates and survival to weaning.
- **Train-the-Trainer** – Provide Train-the-Trainer opportunities to educate extension personnel in grazing and forage management and nutritional management tools, products, and solutions.
- **Web- and workshop-based programs** -- Web- and workshop-based educational campaigns focused on selecting breeds that are most suited for the grazing environment, with particular attention to breeds appropriate for drought-prone environments.

- ***Risk management insurance education*** – Provide educational opportunities in the use of USDA-RMA Pasture Range and Forage rainfall insurance program as a risk management tool, particularly in drought-prone regions.

## Chapter 6 Public Interest and Social Issues

Many sheep operations face increased regulatory burden from federal agencies. Public policy concerns involve a number of complex issues, including:

- Wildlife habitat and livestock grazing
- Ecological stability and sustainability
- Watersheds, wetlands and riparian areas
- Potential for disease transmission between domestic and wildlife species
- Preservation of endangered species
- Predator control
- Immigration reform

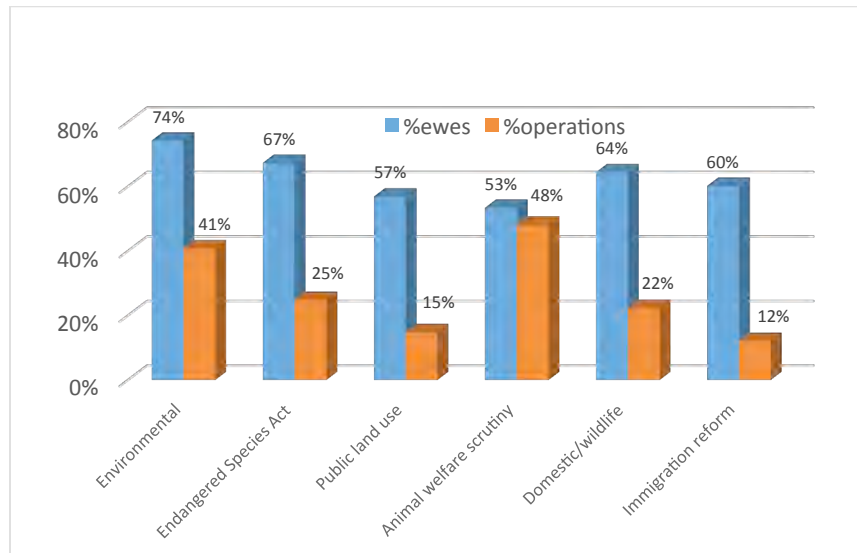
Commercial operations with 1500 or more breeding ewes identified government regulations and compliance, labor and labor management, and predator management as the top challenges currently facing their operations. These top challenges were identified by 65 percent, 61 percent, and 48 percent, of large commercial operations, respectively.

Producers were asked to rate the impact or potential impact on their operations of a number of current public policy issues as significant, moderate or minor. These issues included:

- 1) Environmental regulations (e.g., Clean Water Act)
- 2) The Endangered Species Act
- 3) Public land use (i.e., multiple-use: livestock grazing, recreation, timber, wildlife habitat, etc.)
- 4) Animal welfare scrutiny (e.g., docking, castrating, shearing, handling, humane slaughter)
- 5) Domestic/wildlife interfaces or conflicts (e.g., Bighorn sheep, sage grouse, wolves)
- 6) Immigration reform/H-2A workers

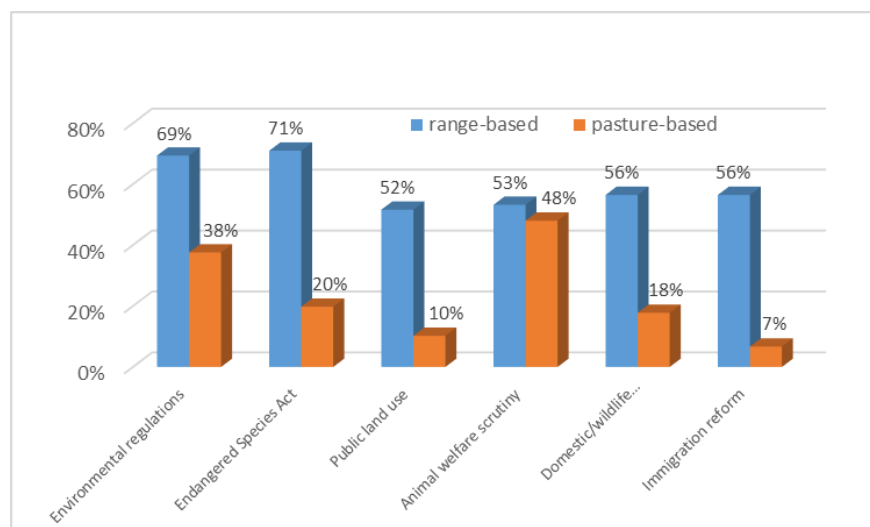
Among all survey respondents, animal welfare scrutiny and environmental regulations/compliance ranked first (48 percent) and second (41 percent), respectively, for operations indicating a moderate to significant impact.

Environmental regulations and compliance and animal welfare scrutiny are increasingly important to consumers and therefore have become part of the overall demand equation, compelling sheep producers to become more proactive and to demonstrate sustainable and humane on-farm practices.



**Figure 6-1** Moderate to Significant Current or Potential Impact on Operation by Percent Breeding Ewes and Percent Operations

Eighty percent of operations reporting 1500 or more breeding ewes were either open range or fenced range operations. For each of the public policy issues listed, over half of range operations reported that these issues have a moderate to significant current or potential impact on their operations. The Endangered Species Act and environmental regulations ranked at the top, identified by 71 percent and 69 percent of large commercial operations, respectively, followed by domestic/wildlife interface or conflicts and immigration reform at 56 percent each, and animal welfare scrutiny and public land use at 53 percent and 52 percent of range-based operations, respectively.



**Figure 6-2** Moderate to Significant Current or Potential Impact on Operation by Percent Range-based and Percent Pasture-based

Large expanses of the country's rangeland are located on public lands - with many of these areas designated for multiple-use. The Bureau of Land Management's (BLM) multiple-use mission is set forth in the Federal Land Policy and Management Act of 1976, which mandates that public land resources be managed for a variety of uses, including livestock grazing, recreation, timber harvesting, and energy development, while at the same time protecting a wide array of natural, cultural, and historical resources<sup>14</sup>. Public policy issues are increasingly brought to the forefront by special interest groups that target multiple-use public lands in particular.

Nearly one-third of the nation's entire sheep production is supplied by ranches that utilize sheepherders.<sup>15</sup> The herders' understanding and familiarity with large rangelands, location of water, and identification of noxious plants are keenly important, as is the knowledge of sheep care at shearing, lambing and shipping, and the use of livestock guardian dogs.

At the time the producer survey was administered, immigration reform and the status of H-2A herders was in question. The week following the survey, the U.S. Department of Labor announced the H-2A Herder Final Rule on the employment of foreign workers in jobs related to the herding of livestock on the range, including sheep and goats. As such, the timing of the survey may have contributed to the level of response to questions concerning labor and labor management issues and more particularly, immigration reform. Although, undoubtedly, labor and labor management issues would still have been identified as a top industry concern had the survey timing been otherwise.

Among survey respondents, immigration reform/H-2A workers has the greatest impact/potential impact in Regions 6 (Mountain & Desert), 7 (Northern Rockies), and 8 (Pacific), affecting 15 percent, 27 percent and 32 percent of operations in those regions, respectively. The average flock size for operations rating the impact/potential impact of immigration reform/H-2A workers as moderate to significant was around 1500 breeding ewes.

With respect to productivity and production efficiency, the National Research Council's 2015 report addressing animal agriculture research needs, stated that increasing production efficiency while reducing the environmental footprint and cost per unit of animal protein product is essential to achieving a sustainable, affordable, and secure animal protein supply.<sup>16</sup> Sustainability, as defined by the committee, encompasses economic, environmental, and social considerations. However, the committee also noted that sustainability is often assumed to address only environmental issues. As summarized in the report:

*Productivity is a key element in achieving food security, and production efficiency relates to sustainability through its effects on economics and environmental impacts. Increasing the productivity per animal unit and land unit while concomitantly decreasing negative impacts on the environment (sustainable intensification) can ultimately produce safe, affordable, and nutritious food to help meet overall global food and protein needs. Technological advancements, genetic improvement, better nutrition, husbandry, and advances in animal*

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<sup>14</sup> U.S. Department of the Interior, Bureau of Land Management: Mission Statement. Web. [http://www.blm.gov/wo/st/en/info/About\\_BLM.html](http://www.blm.gov/wo/st/en/info/About_BLM.html).

<sup>15</sup> American Sheep Industry Association, Issues & Programs: Sheepherders. Web. May 2016.

<sup>16</sup> "3 Animal Agriculture Research Needs: U.S. Perspective." National Research Council. Critical Role of Animal Science Research in Food Security and Sustainability. Washington, DC: The National Academies Press, 2015. doi:10.17226/19000.

*health and welfare in animal production have contributed to major productivity and efficiency gains in food animals.<sup>17</sup>*

### **Research Priorities for Public Interest and Social Issues**

- **Bighorn sheep: species separation** – *It is imperative that appropriate scientific studies determine the influence of domestic sheep on the health of bighorn sheep and that the concept of species separation is validated by research.*

A policy of spatial and/or temporal separation between domestic sheep and bighorn is being advanced as a means to protect and maintain bighorn sheep populations. Spatial separation threatens to displace large numbers of domestic sheep from historical grazing permits on public lands. The concept of species separation must be validated by appropriate scientific research.

- **Sage grouse habitat** – *Research is needed to fill in the gaps in range management and use practices aimed at ensuring resilient sagebrush steppe that is resistant to invasive annual plants, facilitates sustainable livestock grazing, and provides long-term quality habitat for sage grouse.*

The sagebrush steppe simultaneously provides a vital national food-security resource from livestock production as well as an important habitat for wildlife, such as sage grouse. Land-management agencies are modifying range and forest management plans with a primary goal of sustaining and increasing sage grouse populations to avoid future considerations to list sage grouse under the Endangered Species Act. These actions border on single-focus management, which places long-standing range use practices and ecosystem services at risk, including the use of rangelands as a food security resource.

### **Development and Education Priorities for Public Interest and Social Issues**

- **H-2A shepherders/guest worker program** – *Development of appropriate training materials for shepherders entering the U.S. under the H-2A guest worker program are needed, and should include relevant wildlife and environmental regulatory information. An objective, uniform, and feasible audit system to document efficacy and needs would also benefit and help maintain the integrity of the program.*

Despite industry recruiting efforts, a reliable domestic labor supply of shepherders, sheep shearers and livestock workers does not exist in some areas of the country. The H-2A guest worker program and accompanying Special Procedures regulations provide the sheep industry with trained employees, which results in proper animal care, more efficient livestock production, and stewardship of natural resources.

- **Waste, manure and carcass disposal** - *Socially acceptable methods of waste handling and removal and carcass disposal should be developed that are environmentally sound and respect the sensitivities of neighboring communities.*

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<sup>17</sup> Ibid.

- **Clean Water Act** – *Enhancement of Clean Water Act provisions to reduce the associated costs and regulatory burden while maintaining responsible environmental stewardship.*
- **Animal welfare and humane handling** - *Animal welfare and humane handling educational tools are needed for all industry sectors.*
- **Food and fiber security, continuity of business, and supply chain management under adverse conditions and circumstances** – *There is a critical need to develop and have in place plans that provide guidance and direction for supply chain management, including the movement of live animals and meat, milk, and fiber products. These plans are needed to ensure continuity of business and to maintain domestic food and fiber security under adverse conditions or circumstances that may arise including natural disaster, the threat or outbreak of a foreign animal disease, or an unanticipated event or threat to national security.*

### ***Predator Management***

USDA/APHIS/VS/NAHMS reported that in 2014, 585,000 sheep and lambs died of all causes, costing the industry about \$102 million.<sup>18</sup> NAHMS also reported that nearly three-fourths of adult sheep losses (72 percent) were attributed to nonpredator causes, while just over one-fourth of losses (28 percent) were attributed to predators. By comparison, nonpredator causes accounted for 64 percent of all lamb death losses in 2014. Predation and predator management issues have strong public policy underpinnings.

#### ***Producer Survey Results***

Among operations that reported the top three challenges facing their operation, 23 percent identified predator management as one of those top three challenges. Of the total number of breeding ewes on operations identifying predator management as one of their top three challenges, 75 percent were on operations with greater than 1,000 breeding ewes. Combined, this represents one-half of the total number of breeding ewes captured by the survey.

Of operations that identified predator management as a major challenge, 22 percent were located in Region 8 (Pacific) and 18 percent in Region 2 (Mid-Atlantic/South), followed equally by Regions 5 and 7 (Texas and Northern Rockies) at 13 percent. Region 7 (Northern Rockies) had the highest percentage of breeding ewes affected by predator management challenges (44 percent).

Of those producers that identified predator management as one of their top three challenges, 58 percent reported using livestock guardian dogs on their operations. Of those, 94 percent indicated that livestock guardian dogs are very important to their sheep operation. Among all operations, 48 percent reported using livestock guardian dogs on their operation.

Among 15 predator control options, guardian dogs were the second most common predator control measure used by survey participants. Woven wire or net fences were the most common. When asked to rate the effectiveness of those predator control measures used on their operation, livestock guardian dogs were rated as the most effective.

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<sup>18</sup> USDA/APHIS, Veterinary Services, National Animal Health Monitoring System (NAHMS), "Sheep and Lamb Predator and Nonpredator Death Loss in the United States, 2015," September, 2015.

Of those operations that identified predator management as one of their top three challenges and also rated the effectiveness of livestock guardian dogs in predator control, 57 percent rated livestock guardian dogs as extremely effective, and 92 percent rated guardian dogs as either extremely effective or somewhat effective. Only 8 percent rated guardian dogs as either not very effective or ineffective.

The most difficult predators to manage were coyotes (reported by 89 percent of operations), followed by dogs (51 percent) and fox as a distant third (15 percent). For producers reporting predator management as one of their top three challenges, the most difficult predator to manage across all regions was coyotes.

### ***Research Priorities for Predator Management***

- ***Predator control technologies*** – Continued research and development of technologies aimed at reducing depredation are essential to effective predator management. These technologies include alternative/new lethal toxicants, as well as corrective and preventative non-lethal control measures.
- ***Discriminant predator management*** - Research is needed to explore the avenues for more effective and discriminant (species-specific) predator management.

### ***Development Priorities for Predator Management***

- ***Public-private partnerships*** - Develop public-private partnerships that will engage the public sector to help reduce depredation by wildlife and domestic dogs.

The National Research Council reported that increasing predation problems in wildlife populations in many states indicate the need for sheep industry alliances to work closely with wildlife agencies and other interest groups and with those involved with threatened and endangered species management programs.<sup>19</sup>

### ***Education Priorities for Predator Management***

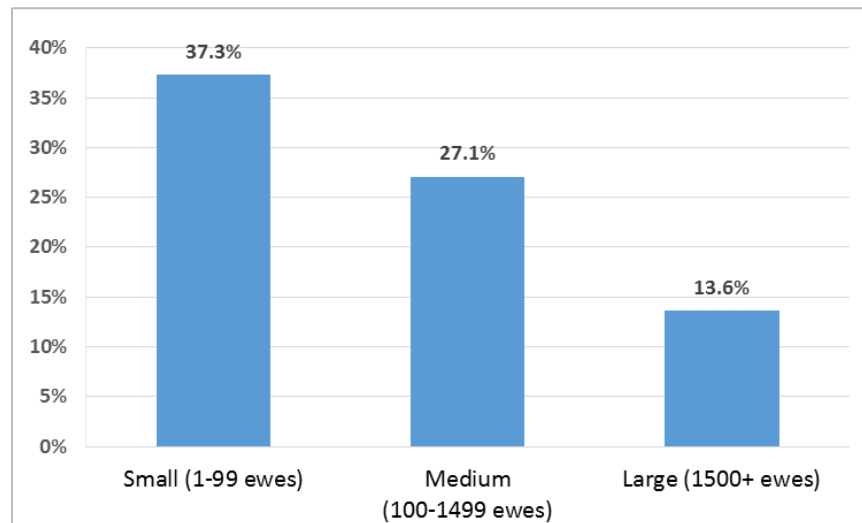
- ***Education and outreach*** – Improved education and outreach regarding the use and effectiveness of currently available predation management tools, including species-specific risk assessment and threshold use of lethal and non-lethal predator control tools.
- ***Increased awareness*** - Increased producer awareness of USDA, Animal and Plant Health Inspection Service Wildlife Services information and services and of state and federal regulations as they apply to animal damage control.

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<sup>19</sup> National Research Council. *Changes in the Sheep Industry in the United States, Making the Transition from Tradition*. 2008.

## Chapter 7 Lamb Marketing

Lamb marketing was identified as an important challenge facing many sheep producers. A panel of industry experts helped identify the marketing constraints facing producers and made recommendations of how best to ease marketing constraints based upon survey results.



**Figure 7-1** Percent of Commercial Lamb Operators Identifying Marketing as a Major Challenge by Flock Size

### *Producer Survey Results*

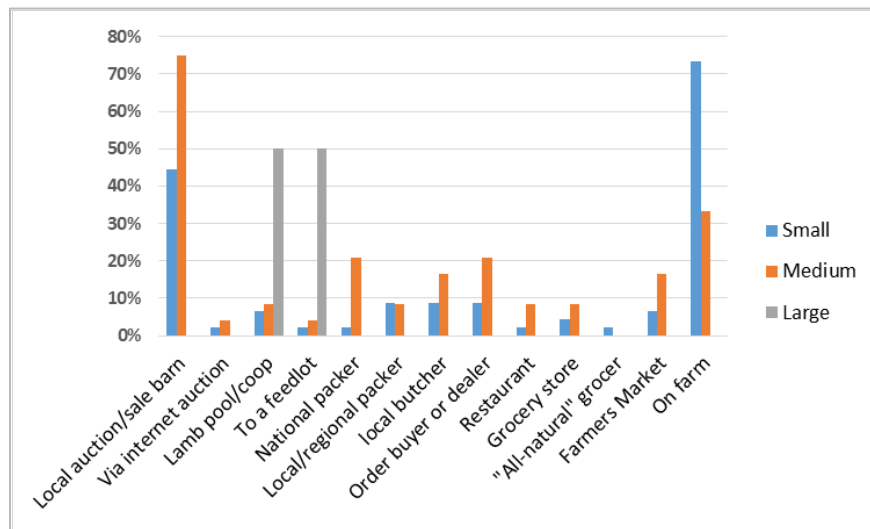
Thirty-four percent of commercial flock operations and 32 percent of seedstock operations reported marketing as a top producer challenge. Among commercial operations citing marketing as a challenge, 37 percent, 27 percent, and 14 percent were small, medium-size, and large operations, respectively.

Of commercial lamb producers identifying marketing as a major challenge, 22 percent of operations are located in Region 2 (Mid-Atlantic/South) and 22 percent in Region 3 (Great Lakes). One-third of seedstock producers identifying marketing as a major challenge are located in Region 4 (Mid & Upper Midwest).

Market weights of lambs sold during 2014 (feeder and slaughter) did not differ substantially for those operations identifying marketing as a major challenge and those operations that did not identify marketing as a major challenge.

A smaller percentage of small commercial lamb operations sold lambs in the heaviest weight classification (120+ lbs.) – generally describing traditional commercial slaughter lamb markets. Conversely, none of the large commercial lamb operations reported selling lambs in the lightest weight classification (<50 lbs.) – generally associated with nontraditional or ethnic markets. Most lambs sold weighed between 50-120 lbs. with large operations selling an equal percentage of lambs weighing 50-120 lbs. and lambs weighing over 120 lbs.

There is a wide range of marketing channels available to commercial operators. The largest percentage of large commercial lamb operations market lambs to feedlots, national packers, and through lamb pools and other cooperatives, respectively. The largest percentage of medium-size commercial lamb operations market lambs through local auction markets/sale barns, on-farm to individuals/families, and through order buyers/dealers, respectively. The largest percentage of small commercial lamb operations market lambs on-farm to individuals/families and through local auction markets/sale barns, respectively.



**Figure 7-2** Commercial Lamb Operations by Market Outlet and Flock Size

The USDA/AHPIS NAHMS sheep study had consistent findings. A much higher percentage of lambs were moved from herded/open range operations to feedlots (66 percent) than from smaller operations--fenced range (32 percent), pasture (19 percent), and dry lot/ feedlot operations (14 percent).<sup>20</sup> The NAHMS sheep study also found that 55 percent of small (20-99 head) and 52 percent of medium (100-499 head) operations sold to local auctions/sale barns, compared to a lower percent (30 percent) of large operations (500+ head).<sup>21</sup>

The nontraditional and ethnic markets are growing within the commercial lamb industry. There are a growing number of flocks with hair sheep and hair sheep crosses across the U.S. that are particularly well-matched to the ethnic market. Texas, the largest sheep state, has seen a growth in Dorper lamb flocks in recent years. The South and Southeast are also seeing increased hair sheep production—areas that traditionally have not seen sheep flocks. The NAHMS Sheep 2011 study reported that the percentage of operations that had hair breeds increased over fourfold from 2001 to 2011 (5 percent to 22 percent, respectively).<sup>22</sup>

<sup>20</sup> USDA/APHIS, Veterinary Services, National Animal Health Monitoring System (NAHMS), "Sheep 2011, Part II: Reference of Marketing and Death Loss on U.S. Sheep Operations," December 2012.

<sup>21</sup> Ibid.

<sup>22</sup> USDA/APHIS, Veterinary Services, National Animal Health Monitoring System, "Sheep 2011, Part 1: Reference of Sheep Management Practices in the United States, 2011," May 2012.

According to the National Research Council, “The emergence of new markets for lamb products presents arguably the best opportunity for growth of the lamb industry. The growth in the number of Muslims who reside in the United States is one example.”<sup>23</sup> The NRC continued: “Hair sheep lambs are well suited to the ethnic markets because of their smaller carcass size, presence of tail, and lower likelihood of feedlot finishing.”

Value-based pricing can reward investments in lamb production and better target quality attributes to meet consumer needs. Eighty-five percent of those that explained why they sold on a grid responded: “Receive higher prices/rewarded in higher prices for production efforts”.

Value-based pricing often is coupled with marketing agreements to sell lambs at a later date. Of commercial operations that sell on the rail, 36 percent have a contract in place (written or oral) to sell all or part of their 2016 lamb crop. This compares to 9 percent of commercial producers that do not sell on the rail, and 14 percent of all producers.

The 2008 National Research Council recommended adoption of electronic grading to improve the accuracy of value-based pricing.<sup>24</sup> However, the share of slaughter lambs harvested under formula/grid pricing has contracted over the past 13 years - declining from nearly half of all federally-inspected (FI) slaughter lambs in 2002, to 24 percent of FI slaughter lambs in 2015.<sup>25</sup> Packer-owned lambs, lambs procured at auction and live, and negotiated trades all trended upward during this same period.

Use of value-based pricing in the producer survey appeared to be related to size of flock, location and experience. Nearly three-quarters of flocks that used value-based pricing were in the medium-size range (100-1,499 head), 28 percent were large flocks (1,500 head +). Formula use was negligible among small producers (less than 99 head). The average number of ewes by the subset of operations that use formula/grid pricing is 1,200 head compared to 300 head for those that do not.

Proximity to a large national packer and/or lamb pool also appears to be related to value-based pricing adoption. One-quarter to 1/3 of those selling on a grid sold through a lamb pool or cooperative or to a national packer. Location is important for grid use.

Experience was also important for grid use. Seventy percent of those reporting formula/grid use had over 30 years of experience raising sheep and 55 percent of those reporting formula/grid use were from multi-generational operations.

Thirty-eight percent of those commercial operations not currently participating in formula/grid pricing would like to participate.

Livestock Risk Protection-Lamb (LRP-Lamb) price insurance is a risk management tool available to lamb producers and feeders. Lamb feeders are major participants in the LRP-Lamb program. In addition, 63 percent of large commercial operations captured by the survey have also purchased LRP-Lamb price insurance.

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<sup>23</sup> National Research Council. *Changes in the Sheep Industry in the United States, Making the Transition from Tradition*. 2008.

<sup>24</sup> Ibid.

<sup>25</sup> Estimate derived from USDA, Agricultural Marketing Service and ASI.

### *Lamb Feeder Survey Results*

A feeder survey was conducted to assess the constraints facing feedlot operators and to help define research, development, and educational needs in the producer/feeder complex.

The concerns facing feeding operations include feeder lamb availability, labor costs/availability, market prices for feeder and slaughter lambs, processing contracts/kill slot availability, and the risk associated with marketing lambs.

Thirty-three percent of feeders surveyed reported that they were either somewhat satisfied or not satisfied with the feed efficiency of feeder lambs on growing rations. A third were also somewhat satisfied or not satisfied with the feed efficiency of the lambs on finishing rations. The top three causes of death in feedlots include shipping fever/pneumonia, other respiratory disorders, and rectal prolapse. Overall, feeders are looking to develop options for reducing or eliminating use of antibiotics in feed and/or in water.

Feeder lambs are most often purchased on a live weight basis. In general, feeders do not offer premium pricing for preconditioned lambs. They also generally do not offer suppliers premium/discounted pricing for known genetics or reputation of lambs.

Many feeders sell slaughter lambs on a grid, with formula pricing based upon carcass characteristics. Among respondents, 43 percent reported that getting paid for the actual quality/value of lambs was the most important benefit of formula/grid pricing. Feeders routinely receive a kill sheet for lambs sold on a formula/grid. A kill sheet will often include the dressing percentage, number of respective yield grades, pelt credit, offal credit, and discounts. Feeders routinely receive feedback from packers on pelt quality, bruising, abscesses, and parasites. In turn, feeders will sometimes report to producers about how their lambs performed on feed and carcass quality.

Risk management practices in feedlots include forward pricing and raising some of their own feed. Feeders use Dried Distillers Grains (DDGs) in growing rations. Often up to 75 percent of lambs are committed to a packer upon arrival at the feedlot which reduces marketing risk. Feeders have—on average—purchased at least one 13-week Livestock Risk Protection price insurance contract for slaughter lambs (LRP-Lamb).

Feeders are somewhat familiar with, but many have not taken training in the Sheep Safety and Quality Assurance Program training course.

Environmental regulations specific to carcass disposal and water regulations and restrictions (Clean Water Act) were ranked as significant concerns among feeders.

### *Lamb Packer/Processor Survey Results*

Lamb packers and processors were also surveyed to gain a better understanding of the challenges they face. The survey asked for input and helped identify research, development, and education priorities for the packer/processing sector.

Twenty-three percent of packer/processor respondents reported that labor availability/cost is their top challenge, followed by consumer demand (15 percent) and government regulations/compliance (15 percent).

The most significant quality defects/deficiencies or attributes of domestic lambs needing the most improvement were size consistency and a year-round supply of grass-fed lambs. The most favorable quality attributes were freshness, the ability to source regionally, and grass-fed lamb. Halal, grass-fed and local were cited as the markets for domestic lamb that have the greatest growth potential over the next 5 years.

Packers/processors were asked to identify one change that has been made in any area of their operation that has produced the greatest benefit. Common responses were the increase in custom processing and improvement in size and breed consistency of fed lambs.

Packers were asked to identify area(s) of industry and/or public investment in research, development, and education that would provide the greatest benefit to their business. Commonly identified research needs/priorities were measures and predictors of eating satisfaction, packaging and shelf life. The development priority identified was supply security and the education priority was consumer education.

### ***Research Priorities for Lamb Marketing***

- ***Demand signals*** - Sustainable and profitable production systems must respond to market-driven consumer demand signals. It is critical that price and demand information be captured, reported, analyzed and communicated so that producers, feeders, packers and processors can make timely decisions and effectively respond to those market signals.
- ***Price volatility and risk management*** – Strategies and tools are needed for managing price volatility and market risk.

Market access is multifaceted, comprising physical access, access to value-based contracts and informational access. The extreme volatility in lamb prices during the last few years can help explain why marketing was a high-ranking challenge. Price volatility increases the cost of doing business, eroding profits and constraining investment. Related to that is the limited number of price risk management tools available to the sheep industry. The declining number of markets including auction markets and packer plants also creates a marketing challenge for many smaller producers.

- ***Demand index and demand drivers*** - Update the lamb demand index and maintain a current understanding of demand drivers.

The lamb industry is complex and dynamic, with an equally diverse lamb consumer base. Understanding consumer demand will allow the industry to improve its marketing efforts. The American Lamb Board (ALB) maintains a lamb demand index which tracks changes in lamb demand. The index should be updated quarterly or annually to reflect the current dynamics of the lamb industry.

## ***Development Priorities for Lamb Marketing***

- **Market information** - Work with USDA/AMS to improve the availability of lamb market information.

The sheep industry continues to struggle with a declining amount of public market information. From a research and development perspective, the industry needs to address the problem of how to deal with less and inconsistent market information. Limited availability of market information is one reason why marketing is a high-ranking industry challenge.

- It is recommended that the industry identify the costs of limited and inconsistent market data and work with USDA/AMS to improve market data access. Current price information is integral to the LRP-Lamb insurance program, needed to establish baseline formula and grid pricing and serves as a benchmark for countless other feeder and slaughter lamb trades. The injury to the industry resulting from a lack of transparency in market prices is unknown. However, given that prices are often only available for heavier, lower-valued lambs, this limited price information could potentially result in a serious undervaluing of the national flock.
- Separate marketing channels are thought to exist for hair breed lambs versus lambs from wool breeds. The U.S. Department of Agriculture should be urged to record and publish wool and hair breed inventories separately in its annual producer survey - both nationally and by state. When possible, USDA Agricultural Marketing Service market reports should provide a separate breakout of hair sheep/lamb prices. Exploring the feasibility of capturing better ethnic market demand and supply information can improve the industry's understanding of ethnic market trends, challenges, and opportunities.

From the National Academies *Report in Brief*: "The current foundation of the industry, lamb meat, is primarily marketed through a traditional channel, in which lambs move from pastures to higher-quality feeding systems to grow to harvest weight and then are commercially harvested. However, increasing numbers of lambs are being sold as early harvest lamb to meet the demand for better quality, lighter-weight lambs and/or are being sold directly from the farm gate to individual consumers. Official government data captures information about the traditional channel, but provides incomplete information about the other channels, (2008).<sup>26</sup>

- **Objective measures and predictors of meat quality and eating satisfaction** – Develop objective, consistent measures and predictors of meat quality and eating satisfaction.
- **Supply management** – New and innovative methods of managing slaughter lamb supplies are needed, including seasonal supply management and processing throughput scheduling.
- **Packaging Technologies** – Develop improved packaging technologies that will maintain product quality, freshness, appearance, and increase shelf-life
- **Processing opportunities** - Identify new and/or expanded processing and investment opportunities and develop vertically integrated producer-driven processing opportunities to address the needs of smaller operations with limited access to slaughter and processing plants.

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<sup>26</sup> National Research Council. "The National Academies: Changes in the Sheep Industry in the United States," 2008.

The reduced number of sheep auction houses and the consolidation of lamb processing plants reduces market access for many producers. Across many rural areas there is a dearth of livestock packing plants, particularly for sheep, and particularly of USDA-inspected facilities that are required of retail sales. Incentives for packing plant investments are needed, especially in underserved areas of the U.S.

- **Local markets** - *Develop direct, local lamb marketing and niche marketing opportunities.*

Some domestic consumers, largely in urban areas, want to know where their food comes from. They want to know if the animals were humanely raised, what they were fed, and where they were raised. Direct, local market opportunities should be explored and these opportunities shared with producers. Grass-fed production systems also play well into these types of niche marketing opportunities.

### ***Education Priorities for Lamb Marketing***

- **Value-based pricing** – *Expand the use of value-based pricing. Improvements in lamb quality and consistency can be supported by ensuring that lamb producers receive prices based upon measured quality attributes. Feedback on feedlot performance and carcass merit are integral to value-based pricing and quality improvement.*

Survey evidence revealed a relatively low level of participation in value-based pricing. Access and proximity to packers plays a role in producer participation and use of value-based pricing. The larger, national packers primarily offer value-based pricing and attract larger producers in their areas.

Increased utilization of value-based pricing can help raise the overall quality and consistency of U.S. lambs. Pricing based on quality, rather than live weight, rewards quality and therefore enables the industry to better serve consumers. A pricing structure that rewards quality attributes can improve consumer offerings and stimulate demand. The industry should encourage packers to utilize electronic grading equipment, offer value-based pricing for all lambs, and provide carcass quality feedback to producers and feeders.

The National Research Council recommended the adoption of a value-based grading system that accurately sorts carcasses based on quality and yield.<sup>27</sup> The American Lamb Board Roadmap Project also ranked the adoption of value-based pricing and electronic grading as a top priority requiring immediate action.<sup>28</sup>

- **Risk Management: LRP-Lamb price insurance education** – *Provide educational opportunities in the use of USDA-RMA Livestock Risk Protection-Lamb (LRP-Lamb) price insurance program as a risk management tool.*

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<sup>27</sup> National Research Council. *Changes in the Sheep Industry in the United States, Making the Transition from Tradition*. 2008.

<sup>28</sup> Hale Group. The American Lamb Industry Roadmap Project--Final Presentation, December 10, 2013.

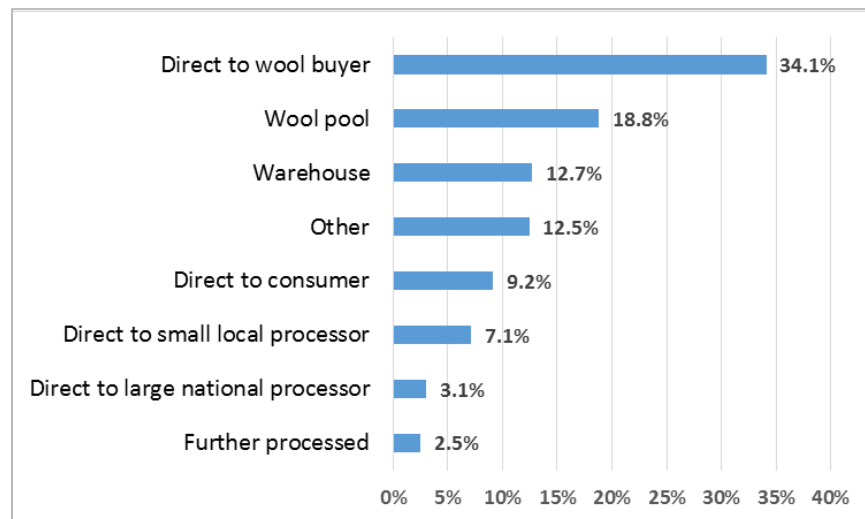
## Chapter 8 Wool Marketing

Wool is a significant joint-product of sheep and lamb production. Investments in wool production can serve as an important revenue stream for sheep flocks that can help an operation diversify and manage risk.

### *Producer Survey Results*

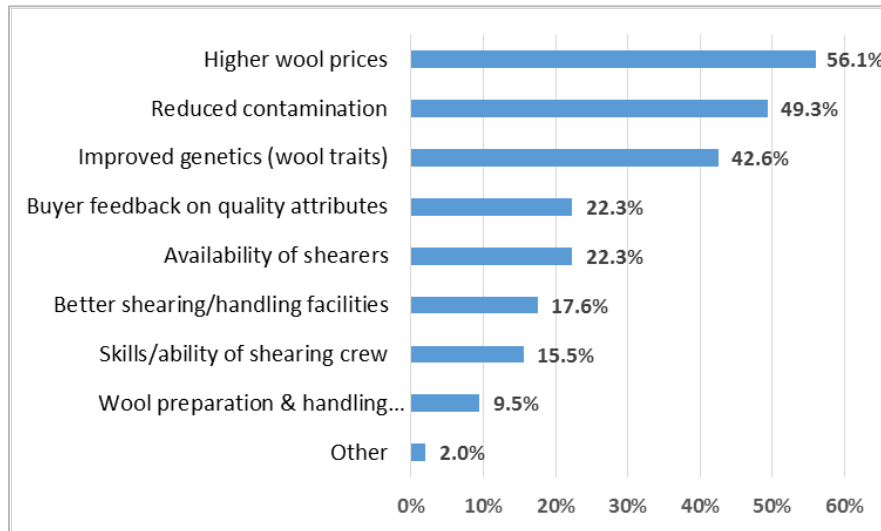
Twenty-five percent of survey respondents identified wool production as either their primary or secondary type of operation - 8 percent as their principal type of operation and 17 percent as their secondary type of operation.

Wool growers use a variety of marketing channels to market their wool as shown below. Wool was sold direct to a wool buyer (34 percent), a wool pool (19 percent), and a wool warehouse (13 percent). Other outlets included direct sales to consumers (9 percent), to small local processors (7 percent), to a large national processor (3 percent) and further processed (3 percent).



**Figure 8-1** Wool Sales by Marketing Outlet

Among those operators that responded to how satisfied they are with their wool clip, 28 percent were “very satisfied”, 40 percent “somewhat satisfied”, 7 percent “not satisfied” and 12 percent responded “not important”.



**Figure 8-2** Recommended Factors to Help Improve the Wool Clip

Those growers that receive feedback regarding wool quality appear to be more satisfied with their wool quality. A larger percentage of producers that are “very satisfied” with the quality of their wool clip receive feedback from their wool buyer (73 percent), compared to those that are “not satisfied” with the quality of their wool clip (32 percent). Similarly, a larger percentage of those producers that are “very satisfied” with the quality of their wool clip core test (37 percent), compared to those that are “not satisfied” with the quality of their wool clip (9 percent).

Of those producers that receive feedback from their wool buyer about the quality of their wool, 54 percent receive information about average fiber diameter, followed by 48 percent receiving information about contamination.

Among growers selling wool, 56 percent reported that higher wool prices would help improve the quality of their wool clip--presumably through increased investment in wool quality attributes. One-half of producers indicated that reduced contamination would improve the quality of their wool clip.

#### *Wool Buyer/Processor Survey*

The total sum of greasy wool handled by survey respondents is 20.185 million lbs., 76 percent of greasy wool production in 2014.

One-third of all wool survey respondents expect their business to expand over the next 5 years, 27 percent expect their business to contract and 40 percent reported little to no expected change. Of the respondents expecting to reduce the size of their business, 50 percent reported that reduced availability of wool was the reason for business contraction. Respondents also identified low margins (25 percent) and competition from other natural and/or synthetic fibers (25 percent). One-half of all survey respondents reported that the reason for business expansion was stronger domestic demand, 25 percent due to more military contracts, and 25 percent due to other increases in their customer base.

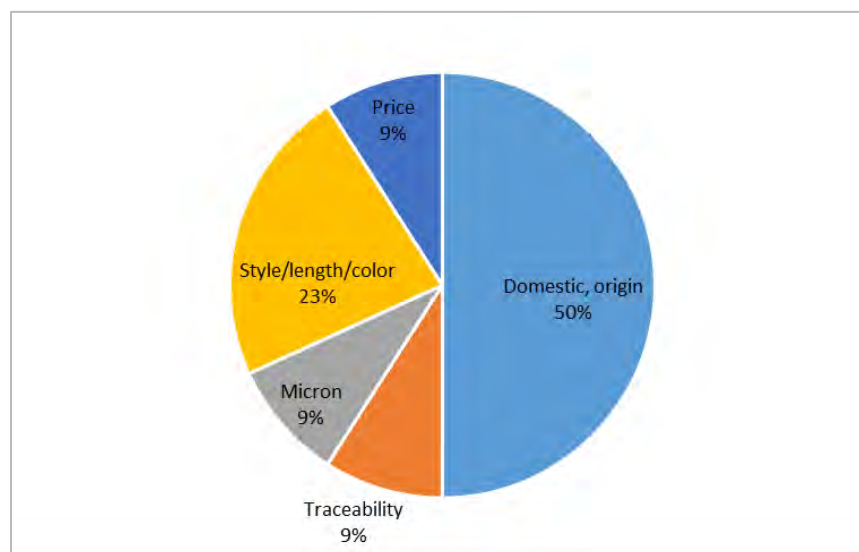
Sixty-three percent of respondents reported their business handles greasy wool, 44 percent handle clean wool, and 31 percent handle further processed wool. Sixty-seven percent of respondents processed wool, 50 percent produced yarn, 17 percent produced fabric, and 33 percent produced finished products.

Forty-seven percent of survey respondents identified their principal type of business as wool processor, 24 percent as wool buyer/broker, and 19 percent as wool warehouse. Wool processors also included a carpet manufacturing and knitted products

Nearly half of survey respondents purchased wool from warehouses with 18 percent buying wool directly from growers.

Half of wool buyers/processors reported that the fact that U.S. wool is local is the top-ranked quality/value of U.S. wool. Respondents reported that the origin of U.S. wool is its greatest attribute. Other positive attributes that also received high ranking included traceability, style, and micron.

Wool processors also mentioned specifically that the Berry Amendment is one of the single-highest quality/value attributes of U.S. wool. According to the Department of Commerce, the Berry Amendment is a statutory requirement that restricts the Department of Defense (DoD) from using funds appropriated or otherwise available to DoD for procurement of food, clothing, fabrics, fibers, yarns, other made-up textiles, and hand or measuring tools that are not grown, reprocessed, reused or produced in the United States.



**Figure 8-3** Quality/Value Attributes of U.S. Wool

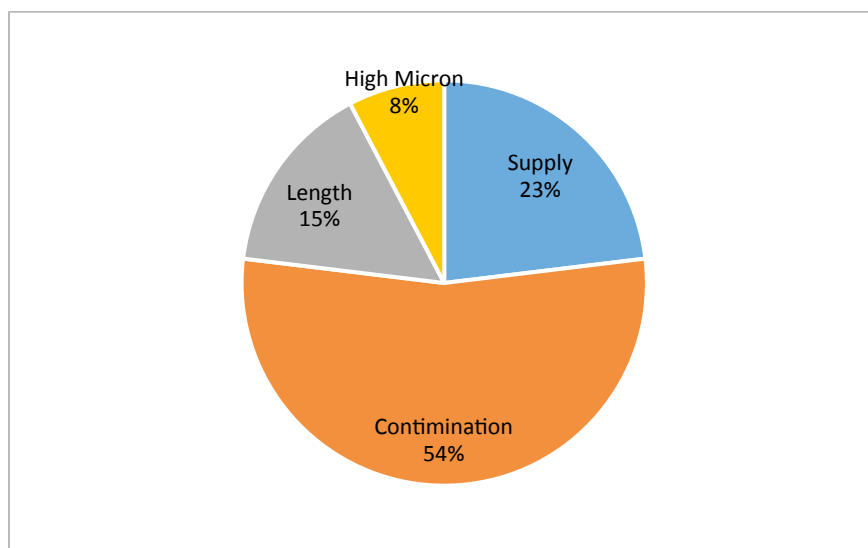
Wool buyers/processors also identified weaknesses in U.S. wool. Just over half (54 percent) of respondents reported that contamination was the single-greatest quality/value weakness of U.S. wool. Contaminates included paint, staining, vegetable matter, and polypropylene.

One-quarter of respondents reported vegetable matter contamination is the most costly quality defect/deficiency in U.S. wool that impacts their business. Another 25 percent reported paint

contamination. Other mentions were fiber diameter, staple length, colored fiber contamination, packaging, lot size, and “preparation at shearing time”.

About one-fifth (23 percent) of respondents reported that the top weakness was availability of U.S. wool, or lack of supply. Fifteen percent of respondents reported that fiber length was the greatest quality/value weakness. High micron was also mentioned as a quality defect.

Wool grower education was identified as an important step toward growth, but there were also areas for improvement in wool research and development. Expanded domestic marketing research ranked highest (38 percent) among areas for research and development among all survey respondents. Domestic market development (33 percent) also ranked highest as an investment priority for all survey respondents.



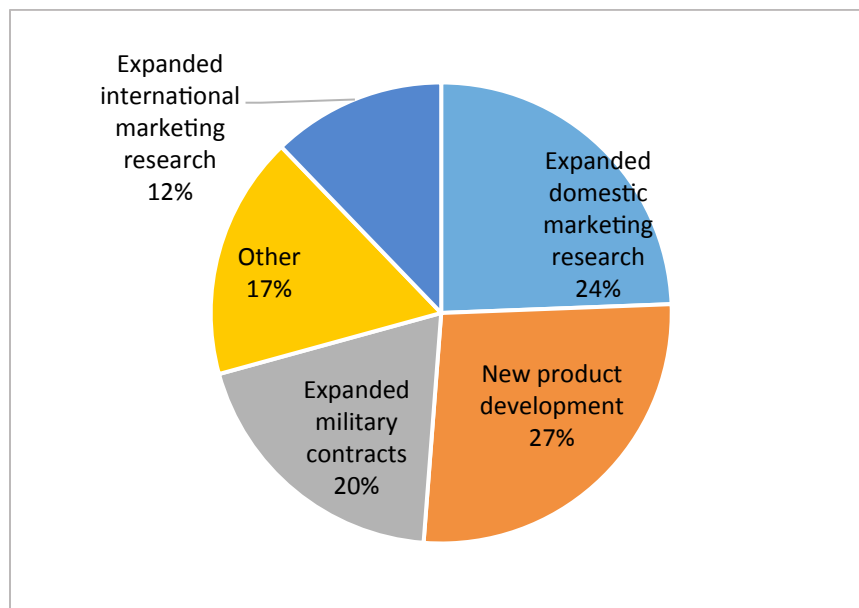
**Figure 8-4** Quality/Value Weaknesses of U.S. Wool

Wool buyers/processors were asked to identify areas of new or continued research emphasis important to their business. Forty-four percent of respondents made comments related to research needed for new product development. Comments relating to new product development ranged from new, improved packaging to “New natural use product and product lines,” and “Develop and promote viable certified Organic wool.”

Thirty-eight percent made a comment regarding the need for improved wool quality. One respondent commented: “Wool quality, especially paint, we could wash a lot more volume if there was more paint free wool.”

Mentions were made regarding “objective measurement of specific quality attributes” and “Quick and reliable objective measurement.”

Wool buyers/processors were asked: *What three areas of research and development could help add value to U.S. wool?* Twenty-seven percent of respondents reported “new product development” followed by 24 percent with “expanded domestic marketing research”. “Expanded military contracts” was also important at 20 percent of mentions.



**Figure 8-5** Research and Development Priorities that Add Value to U.S. Wool

### ***Research Priorities for Wool***

- **Value-based pricing** – *Research is needed to determine if wool prices accurately reflect wool quality. Does the market provide incentives through price signaling to encourage better wool quality and wool preparation?*

Prices should reward high-quality, contaminate-free, well-prepared wool. In turn, price premiums should encourage reinvestment in wool production and preparation by growers. The National Research Council concluded that price premiums from improved wool clip preparation provide a marketing opportunity for wool growers.<sup>29</sup> The survey results revealed that growers are aware of quality defects in their wool, and wool buyers/processors stressed that wool contamination is the number one shortcoming of U.S. wool.

### ***Development Priorities for Wool***

- **Marketing campaign** - *Develop a domestic wool marketing campaign to expand demand for domestic wool among U.S. consumers.*

The U.S. currently exports about 60 percent of its greasy wool clip. Expanded domestic demand for U.S. wool could raise U.S. wool prices, increase returns to industry stakeholders, and promote U.S. wool sector growth.

<sup>29</sup> National Research Council. *Changes in the Sheep Industry in the United States, Making the Transition from Tradition*. 2008.

- **New product/market development** – Develop new products that are market driven with private-sector collaboration, that may include social interest attributes such as “natural”, “organic”, “known origin”, etc. with appropriate wool marketing strategies and systems.
- **Military apparel** – The development of new and better military apparel will ultimately lead to greater usage of domestic wool in military apparel applications.
- **Dye-resistant fibers** - Solutions are needed to address the problem of dye-resistant fibers, including coordinated efforts between wool growers and wool industries.
- **Development and exploration of wool measurement equipment and technologies** - Objective measurement is the only way that wool can be accurately described and specified. Wool processes more efficiently, economically and produces superior products when it is uniform, clean and meets first-stage processor and mill standards.
- **Pelt defects** - Pelt defects can be difficult to detect in raw unprocessed pelts and can lead to significant economic losses. A rapid mechanical method to detect cockle, scarring and other imperfections in raw pelts is needed so that pelts can be sorted prior to processing based on quality and anticipated market.

Pelts are an important by-product of lamb production. Cockle, a blemish caused by sheep keds, and scarring caused by seed burrows, flystrike, etc. seriously downgrade pelt quality and limit market opportunities. Cockle is recognized as small dense nodules that disfigure the leather and are impenetrable to dyes, leading to significant economic losses of several million dollars for the leather industry in the U.S. per year.<sup>30</sup> Other types of scar tissue can leave small holes after processing and affected areas do not dye uniformly. A rapid mechanical method to detect cockle, scarring and other imperfections in raw pelts is needed so that pelts can be sorted prior to processing based on quality and anticipated market.

#### ***Education Priorities for Wool***

- **Continued education** - Develop continued education for wool growers aimed at improving wool quality and reducing contaminants and encourage the use of Code of Practice standards.
- **Return on investment** - Develop estimates for producers of the monetary return that can be realized with small investments in wool preparation.

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<sup>30</sup> Texas A&M AGriLife Extension. Livestock Veterinary Entomology: Sheep Keds. Web. May 2016.

## Chapter 9 Resource Allocation for Research and Education and Trends in Public Funding

Priorities for research and education are established at many levels (local, state, national, industry-wide, etc.) and there is competition for resources at every level. The complex priority setting process often involves people with varying degrees of knowledge about the specific disciplines, commodities, or programs for which they are making priority decisions. This becomes more evident as priorities are merged and packaged for justification at the next level of prioritization. Setting priorities for sheep research and education funding and resource allocation is no exception.

The process for the allocation of resources to research and extension/education has undergone significant changes over the past few decades many of which have not been favorable to sheep research and education.

Examples of changes and differences include:

- a decrease in targeted funding for research by Congress
- more emphasis on competitive research grants especially focused on basic research
- more emphasis on the allocation of resources to fewer commodities at the State level
- the allocation process differs greatly among universities, State agencies, and federal agencies (these differences make coordination of research and education activities more difficult)
- sharing of resources across universities is limited due to State funding accountability requirements and administration/political influences
- increased requirements for university faculty to obtain competitive grant funding whereby the grant priorities direct the type of funding
- less direct interaction with sheep producers (several factors affect this including travel restrictions)
- priority decisions are made at multiple levels in universities and in federal agencies
- many priorities are impacted by regulations, legislation, and special interest groups outside the traditional agricultural arena

The following comparisons provide an overview of the current resource allocation trends for sheep research and extension and a context for allocating and managing future resources for the sheep research and extension/education infrastructure.

Total public funding for all agriculture research decreased from \$4.04B to \$3.88B between 2002 and 2014, a 4 percent *decrease*. Public funding for animal agriculture research (poultry, beef, dairy, swine, sheep, horses, animals in general – excluding aquaculture) decreased from \$792.9M to \$737.3M between 2002 and 2014, a 7 percent decrease. Public funding for sheep research decreased from \$48.3M to \$33.7M between 2002 and 2014), a 30 percent decrease. Largest decreases were State Appropriations (sources outside federal government) and Other Non-Federal (e.g., product sales, industry grants, misc. non-federal). Public extension expenditures for the animal 300 Knowledge Areas (i.e., animal production and health) decreased from \$110.2M to \$97.1M from 2007 to 2014, a 12 percent decrease. Note, public extension expenditures for Subject of Investigation (e.g., sheep, beef, corn, etc.) are not reported to USDA-NIFA.



**Figure 9-1** Funding/Expenditure Trends

The national total number of scientist year equivalents (SYs) decreased from 111 in fiscal year 2001 to 61 in fiscal year 2014. However, the number of SYs at universities decreased from 85 to 42, a greater rate of decline. During this period, total national public funding decreased from \$42.7 million in fiscal year 2001 to \$32.5 million in fiscal year 2014. Data for each year are summarized in Appendix D.

### *Institutional Framework Priorities for Research, Education, and Development*

The sheep and lamb industry is challenged to do more with less and to do some things differently. The public research and education infrastructure has become smaller making it essential to focus on the priorities and challenges most important to the industry.

As the industry sees its second year of inventory increases it is imperative to maintain the momentum and ensure recent growth is sustainable and thus, long-term. The industry is challenged to help the growing number of sheep operations with their sheep challenges to mitigate risk and promote growth.

Moving forward, the challenge to the industry is how best to allocate limited research and education resources toward the most impactful gain. Focus group participants helped develop a plan for a future that will require heightened collaboration among sheep stakeholders to improve the efficiency of research and development programs and education delivery.

➤ **Improve information resources**

A panel of industry experts agreed that the number one challenge in providing support to sheep producers is getting the information to them in a timely, efficient, accurate and effective manner. There are fewer sheep extension specialists available for sheep producers given shrinking budgets, and at the same time there is an explosion of sheep advice on the Internet that may--or may not be--accurate. In addition, there is an expansion in the industry in certain geographic areas especially by producers with smaller flocks which creates more of a challenge for information delivery.

How to promote sheep education is the challenge moving forward. Surveyed producers were asked how often various sources of information are used. Among respondents answering how often each information source was used, the "Internet" was used the most routinely (67 percent), followed by "Other producers (informal)" (43 percent) and "Veterinarians" (37 percent). Twenty-four percent of operations reported using Extension specialists/county agents routinely.

➤ **Develop collaborative, regional sheep centers for research**

Overall, focus group participants agreed for the need for increased partnering between universities, sheep institutions, the private sector and federal sheep research efforts. Survey respondents recommended improved communication and sharing of resources among state sheep organizations, the American Sheep Industry Association, universities and the extension system.

The focus group participants recommend:

- Continued support for centers for sheep research and to develop a collaborative effort between the industry, universities and the U.S. Department of Agriculture, Agricultural Research Service.
- Encourage public and private partnering to leverage resources for efficiency and effectiveness.
- Continue to take advantage of the existing private and public research and education infrastructure.

The ALB Roadmap had a consistent finding. It asked whether a consortia of land grant universities could execute coordinated, collaborative applied research for their larger region. Coordinated activities could address specific issues unique to different regions and sheep production models. State sheep associations and state Extension Service personnel should collaborate to develop a long-term plan for producer education that is best for their state. In states with low sheep inventories, several states should consider developing a plan for a multi-state region.

➤ **Develop expanded sheep checkoff funds**

A recurring question among focus group participants is how to fund sheep research, development and educational efforts in a period of declining sheep budgets. One recommendation is to promote private sector funding options. An expanded sheep checkoff could provide funds for sheep research including broader lamb marketing research and wool research.

The American Lamb Board is currently funded with lamb checkoff dollars. Another option is to allocate a portion of the current check off funds to research and outreach.

- Develop an Internet online hub of sheep resources and support (The existing website eXtension is positioned to do this if resources are devoted to it).

There currently exists an online sheep eXtension system--a knowledge-to-action service with research-based information that is an integral part of the U.S. Cooperative Extension System<sup>31</sup>--that could be further populated with information and reorganized to better serve sheep producers. Creation of an online Internet hub was also recommended by industry experts across all priority topics to help educate producers. Key goals of this online hub would be first, it is easy to use. The site would not contain an overload of information, but relevant information that covers the range of topics prioritized in the survey. A chat room within the site could generate conversation. The online hub could be supported by a network of organizations and specialists to direct specific questions to, mostly public institutions.

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<sup>31</sup> Extension. <https://extension.org/> accessed 4/17/16.

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## **APPENDIX A—Demographic Profiles and Survey Results**

### **Chapter 1: Demographics and General Information**

- A.1.1 Producer Survey Response by Flock Size
- A.1.2 Percent Operations by Flock Size
- A.1.3 Percent Breeding Ewes by Flock Size
- A.1.4 Principal Type Operation by Percent Operations
- A.1.5 Primary Type of Flock Management by Percent Operations
- A.1.6 Identification of ASI Regions
- A.1.7 Percent Operations by ASI Region
- A.1.8 Percent Breeding Ewes by ASI Region
- A.1.9 Percent Respondents by Years of Experience Raising Sheep
- A.1.10 Percent Respondents by Age of Principal Operator
- A.1.11 Current Size of Operation Compared to 2010 by Percent Operations
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- A.1.13 Current Size of Operation Relative to 2010 by Flock Size
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- A.1.16 Percent Operations that have *Decreased* Flock Size over the Past Five Years by Region
- A.1.17 Expansion Plans over the Next Five Years by Percent Operations
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A.8.1 Wool Sales by Marketing Outlet

A.8.2 Producer-Identified Needs for Improving Wool

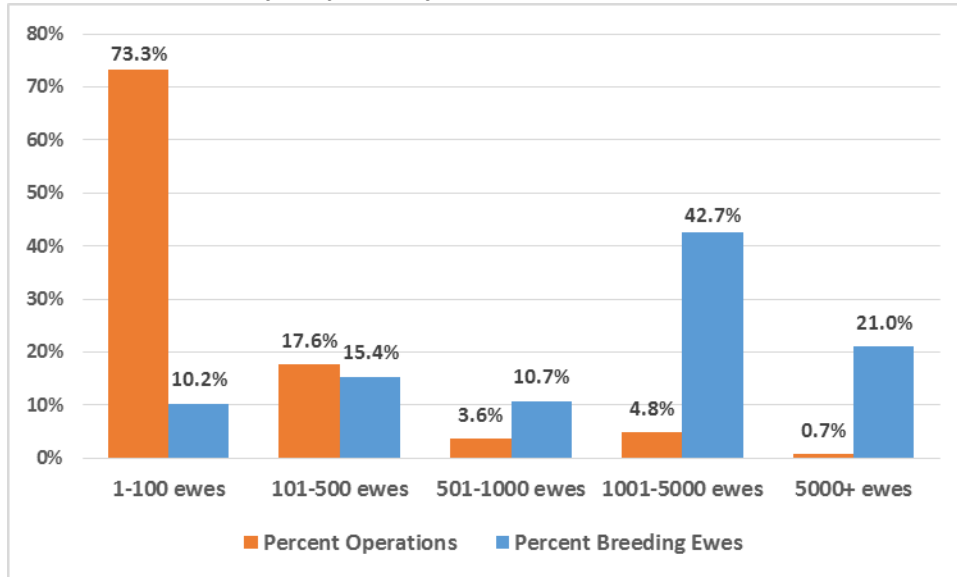
A.8.3 Wool Business-Identified Quality/Value *Attributes* of U.S. Wool

A.8.4 Wool Business-Identified Quality/Value *Weaknesses* of U.S. Wool

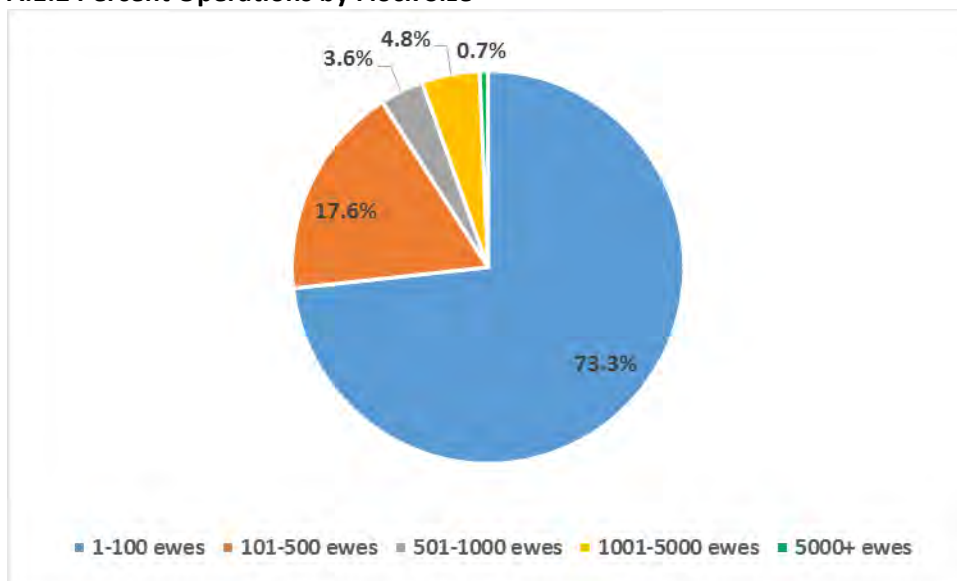
## Chapter 1: Demographics and Greatest Producer Challenges

### Demographics

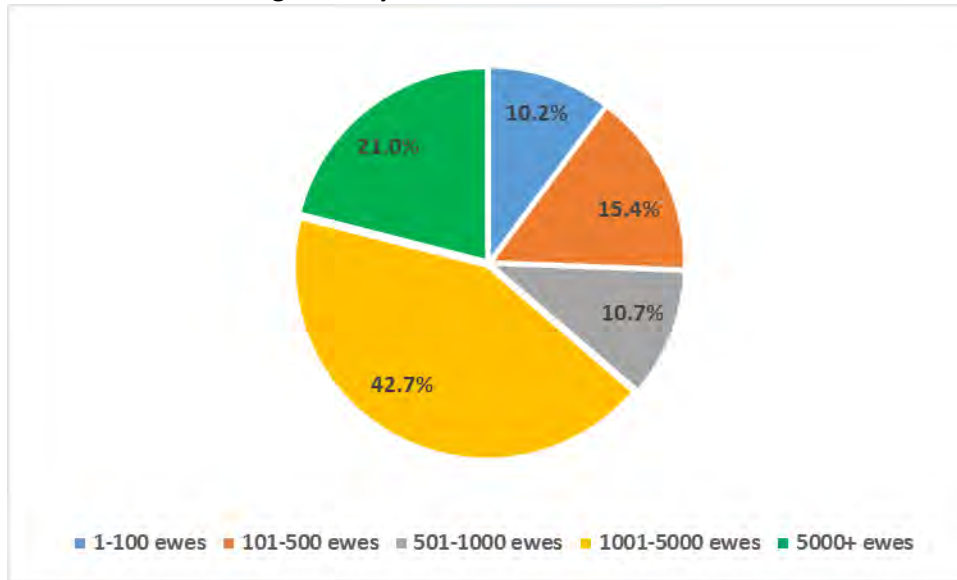
#### A.1.1 Producer Survey Response by Flock Size



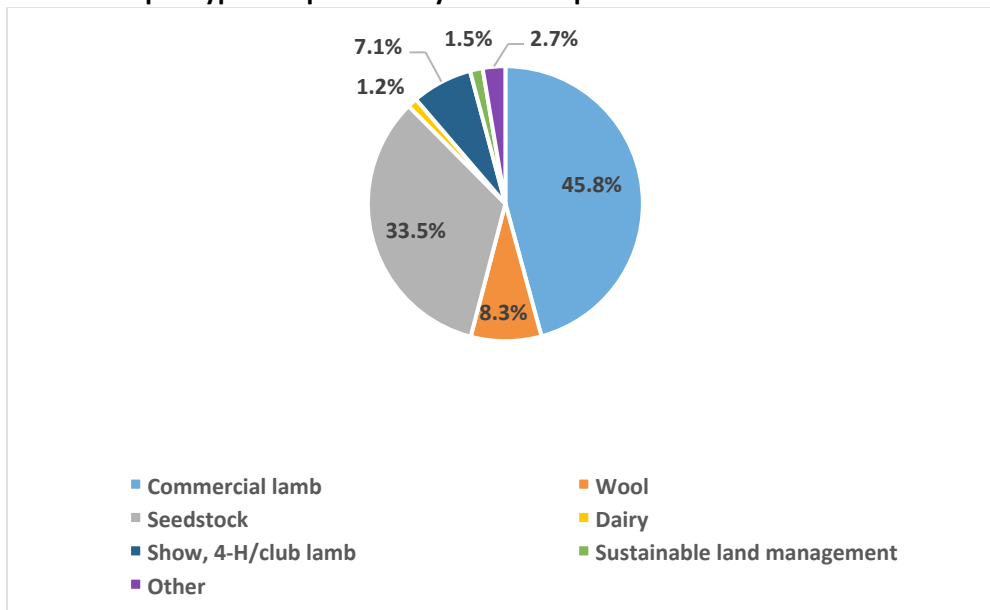
#### A.1.2 Percent Operations by Flock Size



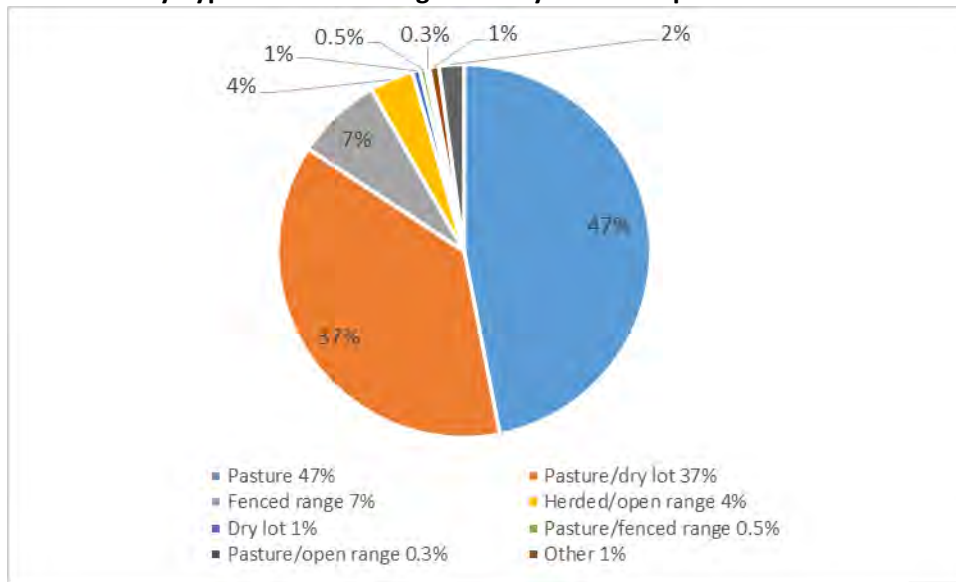
### A.1.3 Percent Breeding Ewes by Flock Size



### A.1.4 Principal Type of Operation by Percent Operations



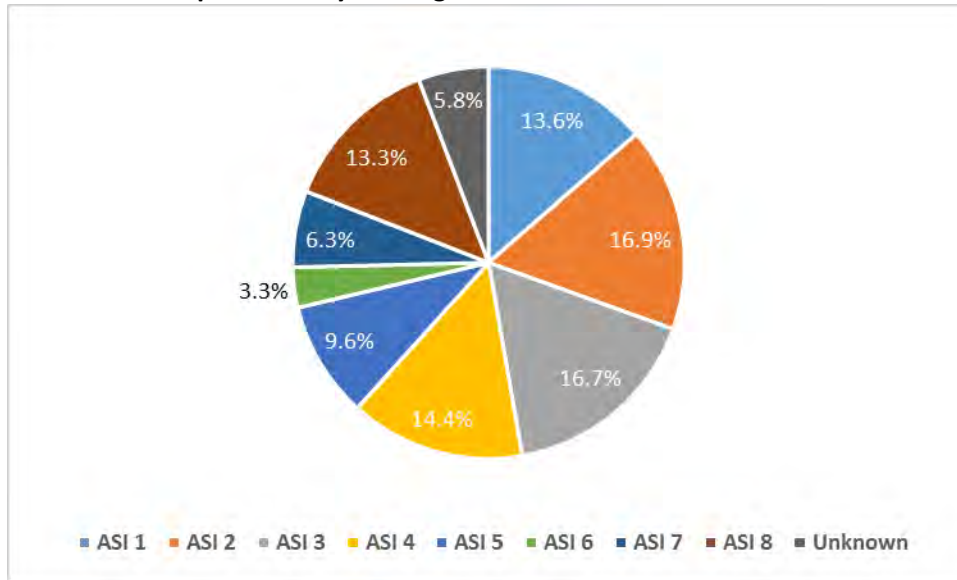
### A.1.5 Primary Type of Flock Management by Percent Operations



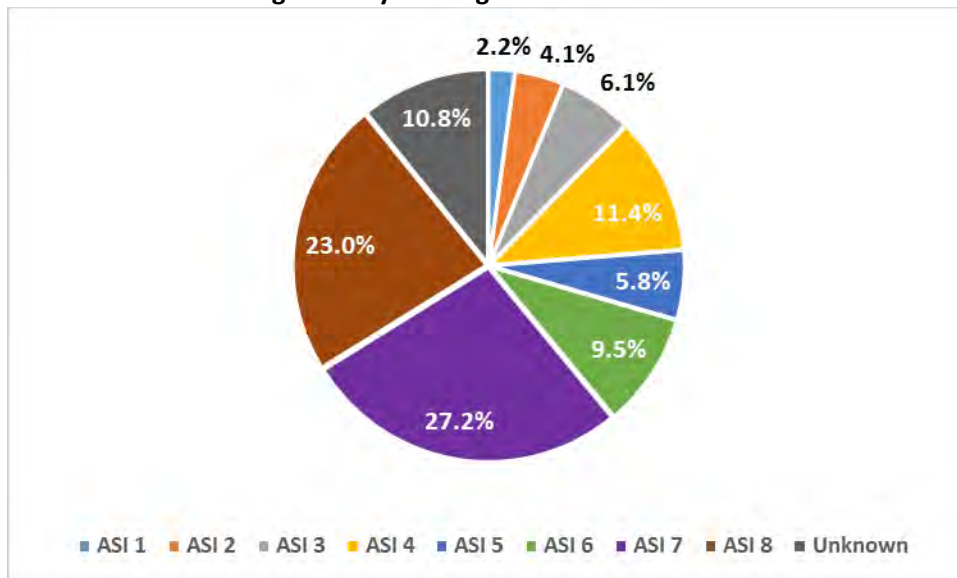
### A.1.6 Identification of ASI Regions

Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7	Region 8
Northeast	Mid-Atlantic South	Great Lakes	Mid & Upper Midwest	Texas	Mountain & Desert	Northern Rockies	Pacific
CT	AL	IL	IA	TX	CO	MT	AK
ME	AR	IN	KS		NM	ID	CA
MA	DE	MI	MO		UT	WY	HI
NH	GA	MN	NE		AZ		OR
NJ	FL	OH	ND		NV		WA
NY	KY	WI	OK				
PA	LA		SD				
RI	MD						
VT	MS						
	NC						
	SC						
	TN						
	VA						
	WV						

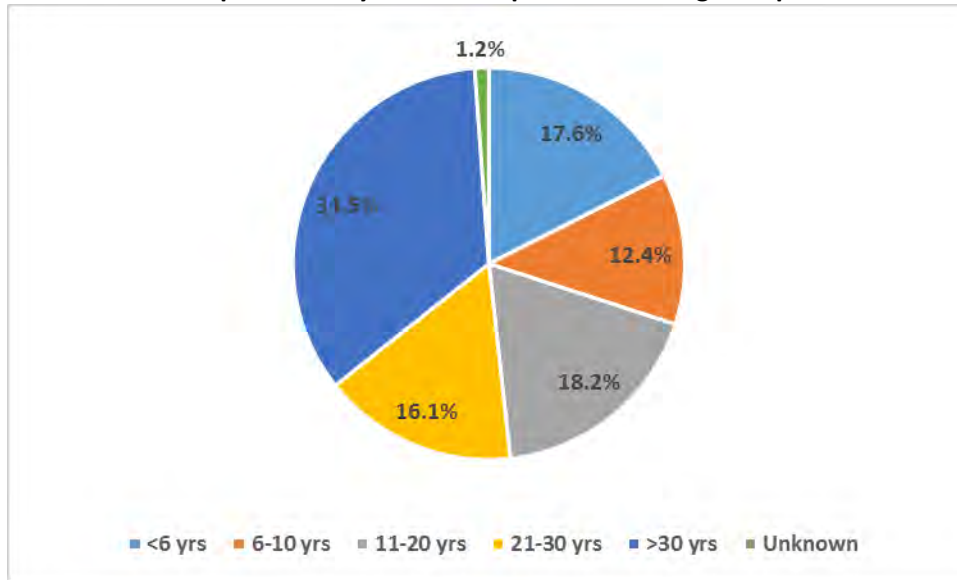
#### A.1.7 Percent Operations by ASI Region



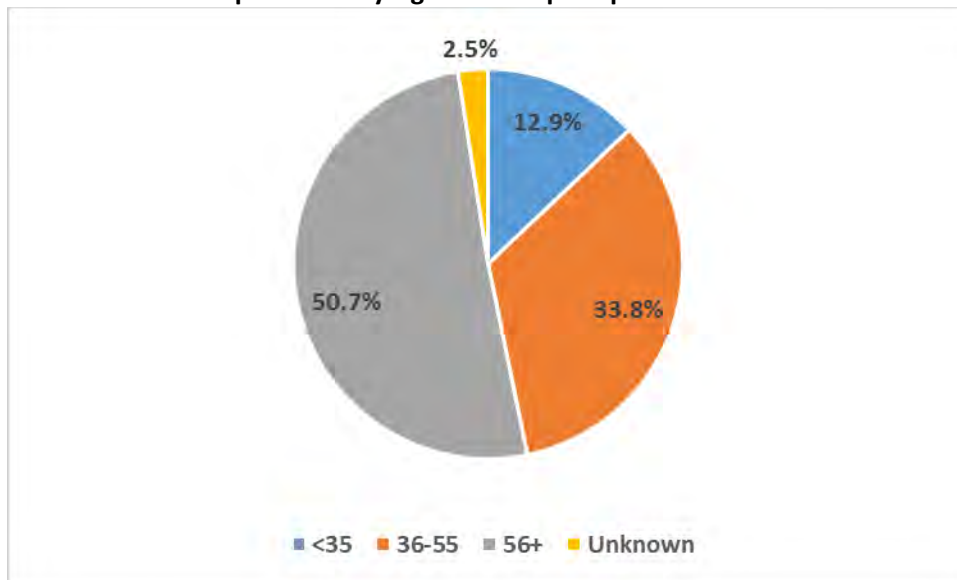
#### A.1.8 Percent Breeding Ewes by ASI Region



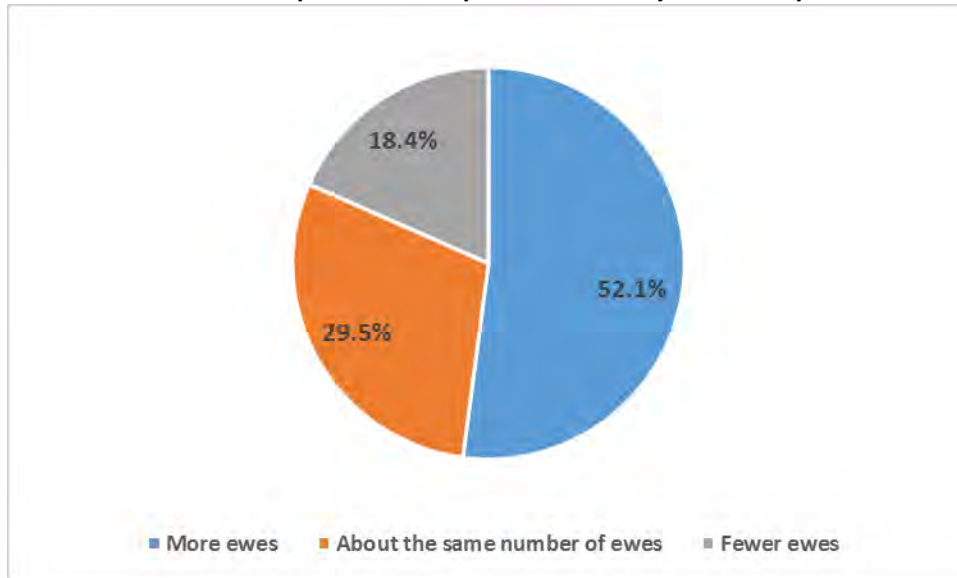
#### A.1.9 Percent Respondents by Years of Experience Raising Sheep



#### A.1.10 Percent Respondents by Age of Principal Operator



#### A.1.11 Current Size of Operation Compared to 2010 by Percent Operations



#### A.1.12 Current Size of Operation Relative to 2010 by ASI Region

ASI Region	More Ewes	Same # Ewes	Fewer Ewes
1=Northeast	54.7%	29.3%	16.0%
2=Mid-Atlantic/South	58.9%	27.4%	13.7%
3=Great Lakes	59.2%	27.6%	13.3%
4=Mid & Upper Midwest	58.3%	32.1%	9.5%
5=Texas	42.6%	29.6%	27.8%
6=Mountain & Desert	40.0%	35.0%	25.0%
7=Northern Rockies	26.5%	44.1%	29.4%
8=Pacific	48.7%	25.0%	26.3%
Unknown Region	46.7%	26.7%	26.7%
All	52.1%	29.5%	18.4%

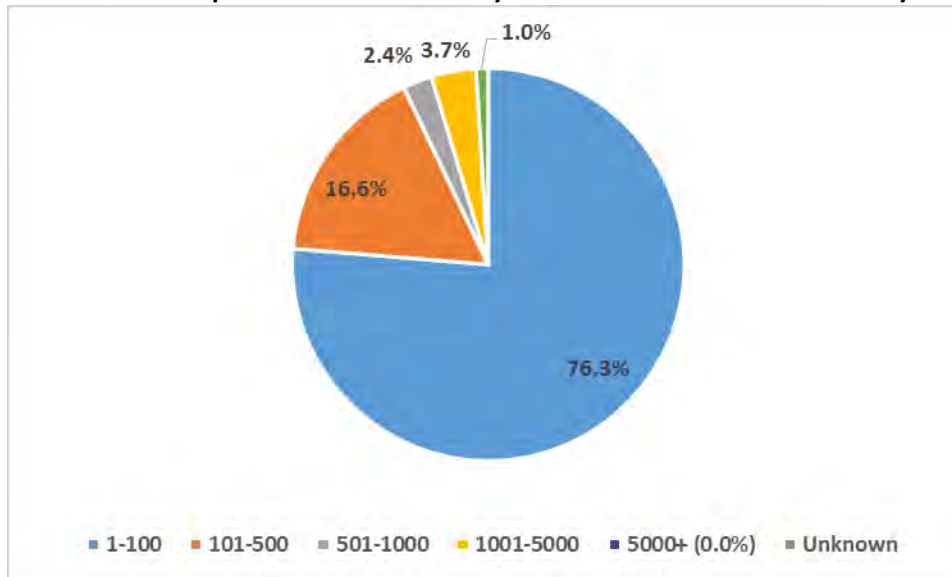
Across row total (within region) equals 100%.

#### A.1.13 Current Size of Operation Relative to 2010 by Flock Size

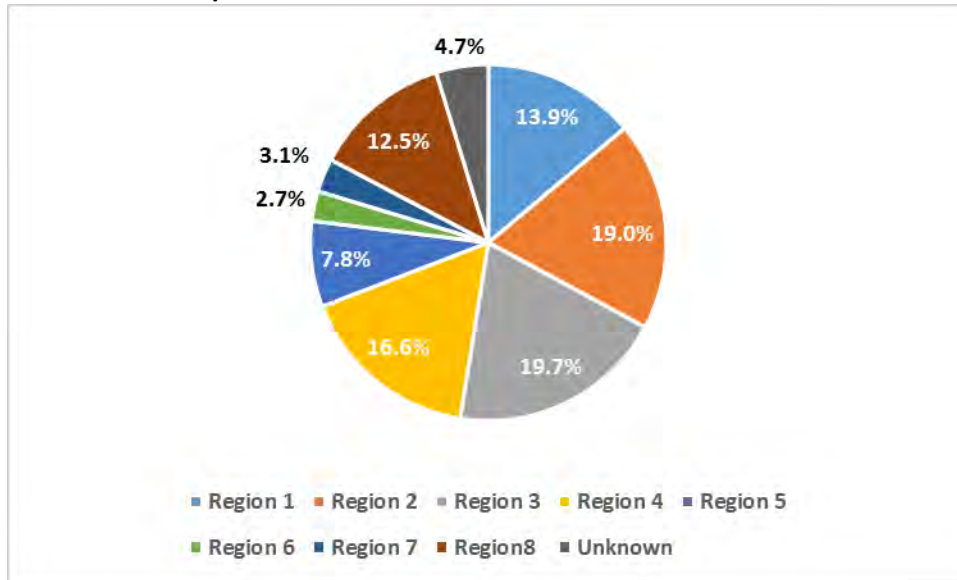
Flock Size	More Ewes	Same # Ewes	Fewer Ewes
1-100 ewes	55.1%	28.4%	16.4%
101-500 ewes	49.5%	28.3%	22.2%
501-1000 ewes	33.3%	38.1%	28.6%
1001-5000 ewes	40.7%	33.3%	25.9%
5000+ ewes	0.0%	100.0%	0.0%
Unknown Flock Size	42.9%	28.6%	28.6%
All	52.1%	29.5%	18.4%

Across row total (within flock size) equals 100%.

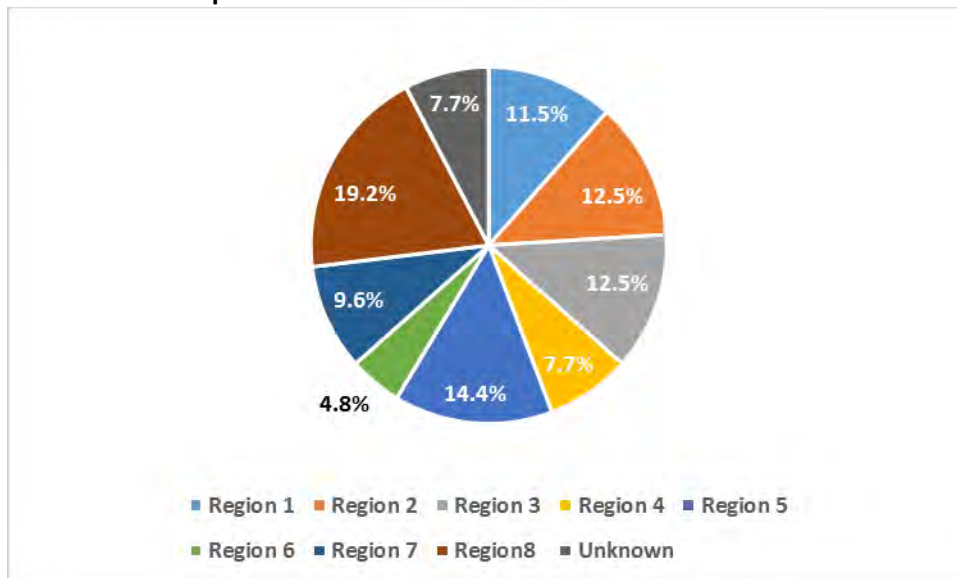
#### A.1.14 Percent Operations that Currently Have More Ewes than in 2010 by Flock Size



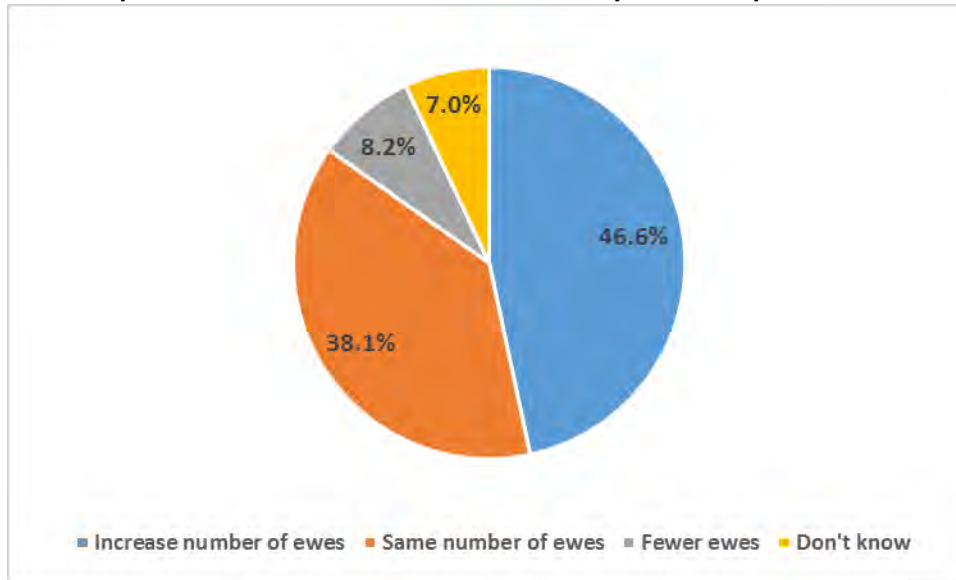
**A.1.15 Percent Operations that have *Increased* Flock Size over the Past Five Years by Region**



**A.1.16 Percent Operations that have *Decreased* Flock Size over the Past Five Years by Region**



#### A.1.17 Expansion Plans over the Next Five Years by Percent Operations



#### A.1.18 Expansion Plans over the Next Five Years by Region (percent operations)

ASI Region	More Ewes	Same # Ewes	Fewer Ewes	Don't Know
1=Northeast	35.4%	45.6%	13.9%	5.1%
2=Mid-Atlantic/South	53.0%	38.0%	5.0%	4.0%
3=Great Lakes	48.5%	35.6%	9.9%	5.9%
4=Mid & Upper Midwest	55.3%	32.9%	2.4%	9.4%
5=Texas	52.7%	38.2%	1.8%	7.3%
6=Mountain & Desert	36.8%	47.4%	10.5%	5.3%
7=Northern Rockies	29.4%	50.0%	14.7%	5.9%
8=Pacific	39.5%	39.5%	13.2%	7.9%
Unknown Region	54.5%	21.2%	6.1%	18.2%
All	46.6%	38.1%	8.2%	7.0%

Across row total (within region) equals 100%.

**A.1.19 Expansion Plans over the Next Five Years by Flock Size (percent operations)**

Flock Size	More Ewes	Same # Ewes	Fewer Ewes	Don't Know
<b>1-100 ewes</b>	45.6%	39.2%	7.6%	7.6%
<b>101-500 ewes</b>	46.9%	37.8%	12.2%	3.1%
<b>501-1000 ewes</b>	57.1%	28.6%	9.5%	4.8%
<b>1001-5000 ewes</b>	57.7%	23.1%	3.8%	15.4%
<b>5000+ ewes</b>	0.0%	100.0%	0.0%	0.0%
<b>Unknown Flock Size</b>	50.0%	30.0%	10.0%	10.0%
<b>All</b>	46.6%	38.1%	8.2%	7.0%

Across row total (within flock size) equals 100%.

**A.1.20 Percent Operations Planning to Increase Flock Size by Region**

ASI Region	% Operations
<b>1 = Northeast</b>	10.3%
<b>2 = Mid-Atlantic/South</b>	19.6%
<b>3 = Great Lakes</b>	18.1%
<b>4 = Mid&amp;Upper Midwest</b>	17.3%
<b>5 = Texas</b>	10.7%
<b>6 = Mountain &amp; Desert</b>	2.6%
<b>7 = Northern Rockies</b>	3.7%
<b>8 = Pacific</b>	11.1%
<b>Unknown</b>	6.6%

Column total equals 100%.

**A.1.21 Percent Operations Planning to Increase Flock Size by Size of Flock**

Flock Size	% Operations
<b>1-100</b>	71.6%
<b>101-500</b>	17.0%
<b>501-1000</b>	4.4%
<b>1001-5000</b>	5.5%
<b>5000+</b>	0.0%
<b>Unknown</b>	1.5%

Column total equals 100%.

**A.1.22 Primary Reason(s) for *Decreasing* Flock Size Relative to 2010 by Percent Operations**

Reason(s)	% Operations
Weather/drought-related	34%
Land availability	33%
Part-time or working off farm	23%
Labor cost/availability	20%
Age/Health	19%
Predation	17%
Flock health	17%
Market prices	14%
Other enterprises more profitable	10%
Other	9%
Access to financing	7%
Market access	5%
Government regulation/compliance	5%

Column total is greater than 100%.

**A.1.23 Primary Reason(s) for *NOT* Increasing Flock Size Over the Next Five years by Percent Operations**

Reason(s)	% Operations
Land availability	44%
Satisfied with current operation size	41%
Part-time/working off farm	32%
Labor cost/availability	28%
Retirement	24%
Feed resources	21%
Predation	12%
Market prices	9%
Weather related	9%
Market access	7%
Access to financing	7%
Flock health	7%
Gov't regulations/compliance	6%
Other enterprises more profitable	6%
Other	3%

Column total is greater than 100%.

## **Greatest Producer Challenges**

### **A.1.24 Greatest Challenges by Percent Breeding Ewes and Percent Operations**

<b>Greatest Challenges</b>	<b>% breeding ewes</b>	<b>% operations</b>
Labor/labor management	55.4%	29.6%
Predator management	51.8%	22.9%
Government regulations/compliance	47.9%	8.9%
Marketing	31.8%	33.3%
Flock health	26.5%	32.6%
Grazing and forage management	20.4%	42.0%
Facilities and fencing	14.7%	28.4%
Estate planning/generational transfer	11.7%	8.9%
Reproductive performance	11.1%	19.3%
Genetics	9.6%	22.3%
Financial management/financing	8.7%	14.9%
Nutritional management	7.4%	14.2%
Animal welfare issues	3.9%	3.4%
Biosecurity issues	1.0%	2.3%
Other	0.6%	3.0%

### **A.1.25 Greatest Challenges by Potential to Increase Profitability (percent operations)**

<b>Potential to Increase Profitability</b>	<b>% breeding ewes</b>	<b>% operations</b>
Marketing	27.8%	17.7%
Predator management	21.8%	6.5%
Labor/labor management	9.4%	6.3%
Grazing and forage management	8.0%	16.6%
Flock health	7.7%	11.4%
Reproductive performance	6.1%	10.6%
Government regulations/compliance	5.2%	1.3%
Genetics	4.7%	13.4%
Financial management/financing	4.1%	3.8%
Nutritional management	2.5%	2.9%
Nutritional management	1.1%	1.6%
Predator management	1.1%	6.3%
Other	0.4%	1.4%
Animal welfare issues	0.0%	0.0%
Biosecurity issues	0.0%	0.0%

Column totals equal 100%.

### A.1.26 Greatest Challenges by Percent Breeding Ewes and Region

Greatest Challenges by Percent Breeding Ewes	Region 1 Northeast	Region 2 Mid-Atlantic South	Region 3 Great Lakes	Region 4 Mid&Upper Midwest	Region 5 Texas	Region 6 Mountain & Desert	Region 7 Northern Rockies	Region 8 Pacific	Unknown Region	ALL Regions
Labor/labor management	32%	23%	28%	44%	60%	90%	63%	47%	64%	55%
Predator management	3%	46%	13%	17%	46%	46%	86%	36%	79%	52%
Government regulations/compliance	2%	5%	5%	1%	2%	39%	81%	69%	51%	48%
Marketing	27%	29%	31%	30%	9%	8%	53%	39%	3%	32%
Flock health	45%	57%	35%	39%	23%	5%	26%	22%	29%	27%
Grazing and forage management	38%	39%	21%	19%	48%	4%	25%	18%	7%	20%
Facilities and fencing	25%	24%	35%	15%	24%	1%	9%	9%	31%	15%
Estate planning/generational transfer	16%	8%	20%	16%	35%	4%	14%	8%	0%	12%
Reproductive performance	26%	20%	37%	30%	10%	7%	1%	11%	2%	11%
Genetics	19%	17%	25%	27%	20%	2%	2%	7%	3%	10%
Financial management/financing	18%	8%	18%	17%	3%	27%	0%	5%	8%	9%
Nutritional management	26%	8%	11%	22%	2%	1%	9%	1%	4%	7%
Animal welfare issues	2%	2%	2%	17%	4%	0%	1%	1%	11%	4%
Biosecurity issues	15%	0%	6%	0%	0%	3%	0%	0%	0%	1%
Other	9%	2%	2%	0%	1%	1%	0%	0%	0%	1%

Column and row totals are greater than 100%. Producers asked to select up to three.

### A.1.27 Greatest Challenges by Percent Operations and Region

Greatest Challenges by Percent Operations	Region 1 Northeast	Region 2 Mid-Atlantic South	Region 3 Great Lakes	Region 4 Mid&Upper Midwest	Region 5 Texas	Region 6 Mountain & Desert	Region 7 Northern Rockies	Region 8 Pacific	Unknown Region	ALL Regions
Grazing and forage management	49%	46%	37%	33%	48%	30%	38%	45%	36%	42%
Marketing	44%	33%	35%	41%	18%	30%	24%	37%	12%	33%
Flock health	28%	40%	40%	30%	36%	15%	11%	26%	42%	33%
Labor/labor management	31%	24%	29%	37%	21%	40%	38%	32%	33%	30%
Facilities and fencing	33%	35%	25%	25%	38%	20%	16%	22%	30%	28%
Predator management	9%	24%	10%	16%	30%	30%	46%	38%	33%	23%
Genetics	23%	19%	24%	25%	32%	15%	27%	15%	18%	22%
Reproductive performance	9%	21%	22%	24%	23%	20%	11%	18%	18%	19%
Financial management/financing	24%	12%	15%	13%	14%	15%	5%	13%	18%	15%
Nutritional management	17%	14%	18%	11%	9%	15%	22%	8%	12%	14%
Estate planning/generational transfer	6%	5%	9%	17%	7%	10%	16%	6%	3%	9%
Government regulations/compliance	6%	8%	7%	2%	4%	25%	27%	17%	18%	9%
Animal welfare issues	3%	4%	1%	6%	5%	5%	8%	5%	3%	3%
Other	9%	1%	5%	0%	4%	5%	0%	0%	3%	3%
Biosecurity issues	4%	2%	6%	1%	0%	5%	0%	0%	0%	2%

Column and row totals are greater than 100%. Producers asked to select up to three.

### A.1.28 Greatest Challenges by Type and Size of Flock

Greatest Challenges	Seedstock & Show Flocks				Commercial Flocks				ALL Flocks	
	Flock Size 1-75	Flock Size 76-225	Flock Size 226-500	All Seedstock & Show Flocks	Flock Size 1-99	Flock Size 100-1499	Flock Size 1500+	All Commercial Flocks	% All Breeding Ewes	% All Operations
Labor/labor management	23%	32%	43%	26%	27%	38%	61%	32%	55%	30%
Predator management	15%	21%	57%	18%	17%	43%	48%	27%	52%	23%
Government regulations/compliance	5%	6%	0%	5%	7%	9%	65%	11%	48%	9%
Marketing	35%	21%	43%	32%	39%	30%	17%	34%	32%	33%
Flock health	33%	32%	0%	32%	35%	31%	22%	32%	27%	33%
Grazing and forage management	41%	40%	43%	41%	51%	32%	13%	40%	20%	42%
Facilities and fencing	27%	17%	14%	24%	36%	26%	9%	29%	15%	28%
Estate planning/generational transfer	8%	9%	43%	9%	5%	15%	13%	9%	12%	9%
Reproductive performance	21%	21%	14%	24%	14%	23%	9%	16%	11%	19%
Genetics	36%	38%	14%	36%	15%	12%	9%	13%	10%	22%
Financial management/financing	19%	6%	0%	16%	17%	11%	9%	14%	9%	15%
Nutritional management	18%	9%	0%	15%	14%	13%	9%	13%	7%	14%
Animal welfare issues	2%	0%	29%	2%	4%	4%	9%	4%	4%	3%
Biosecurity issues	2%	9%	0%	4%	2%	2%	0%	2%	1%	2%
Other	2%	2%	0%	0%	4%	1%	0%	2%	1%	3%

Column totals are greater than 100%. Producers asked to select up to three.

### A.1.29 Greatest Challenges by Primary Type of Flock Management (percent operations)

Greatest Challenges	Herded Open Range	Fenced Range	Pasture	Combination Pasture & Dry Lot	Other
Animal welfare issues	5%	7%	2%	5%	0%
Biosecurity issues	0%	2%	2%	3%	0%
Estate planning/generational transfer	9%	16%	8%	8%	8%
Facilities and fencing	5%	35%	29%	29%	15%
Financial management/financing	14%	12%	12%	21%	8%
Flock health	9%	19%	35%	34%	23%
Genetics	5%	21%	23%	23%	23%
Government regulations/compliance	64%	16%	6%	6%	23%
Grazing and forage management	27%	28%	51%	35%	23%
Labor/labor management	73%	40%	26%	28%	54%
Marketing	14%	21%	35%	35%	54%
Nutritional management	5%	5%	15%	16%	0%
Predator management	59%	56%	19%	17%	38%
Reproductive performance	5%	9%	21%	22%	0%

Column totals are greater than 100%. Producers asked to select up to three.

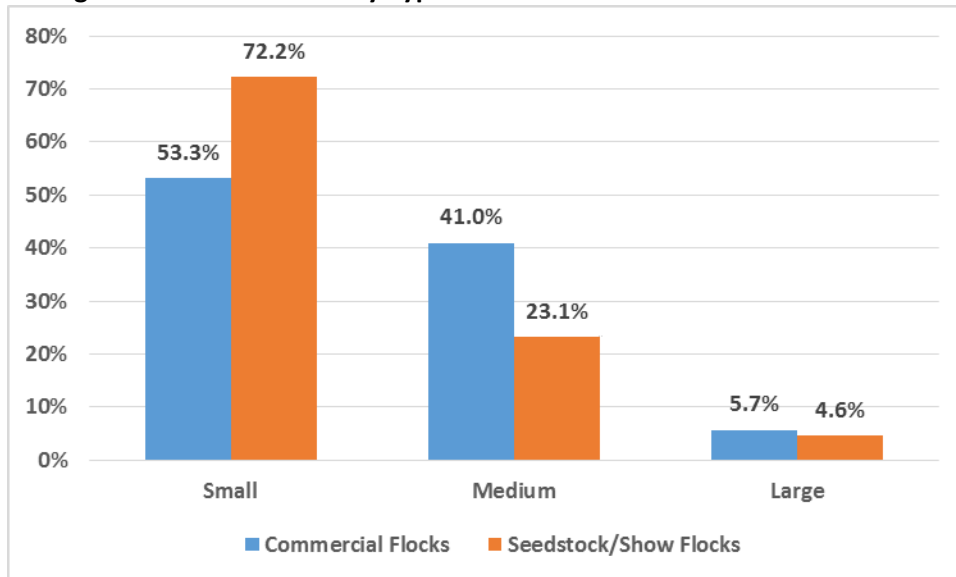
### A.1.30 Greatest Challenges by Years of Experience Raising Sheep (percent operations)

Greatest Challenges	< 6 years	6-10 years	11-20 years	21-30 years	> 30 years	unknown
Animal welfare issues	1.9%	2.7%	1.9%	3.2%	7.0%	16.7%
Biosecurity issues	1.0%	1.4%	5.8%	3.2%	1.0%	0.0%
Estate planning/generational transfer	5.8%	4.1%	5.8%	9.6%	12.9%	16.7%
Facilities and fencing	40.8%	31.1%	32.7%	19.1%	21.9%	50.0%
Financial management/financing	26.2%	13.5%	19.2%	10.6%	8.5%	33.3%
Flock health	33.0%	35.1%	24.0%	48.9%	27.4%	16.7%
Genetics	16.5%	25.7%	28.8%	20.2%	22.9%	0.0%
Government regulations/compliance	8.7%	2.7%	6.7%	4.3%	16.9%	33.3%
Grazing and forage management	49.5%	54.1%	47.1%	42.6%	28.9%	50.0%
Labor/labor management	20.4%	24.3%	31.7%	21.3%	41.8%	33.3%
Marketing	48.5%	28.4%	31.7%	34.0%	27.4%	33.3%
Nutritional management	12.6%	23.0%	17.3%	12.8%	10.0%	0.0%
Other	2.9%	1.4%	4.8%	2.1%	3.0%	16.7%
Predator management	11.7%	25.7%	8.7%	25.5%	34.8%	16.7%
Reproductive performance	12.6%	20.3%	21.2%	18.1%	21.9%	0.0%

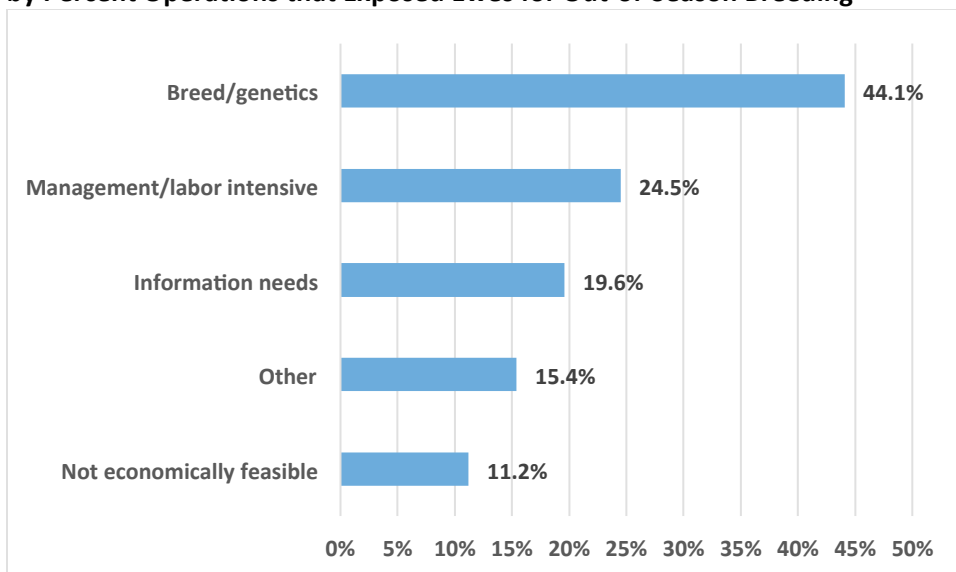
Column totals are greater than 100%. Producers asked to select up to three.

## Chapter 2: Genetics and Breeding

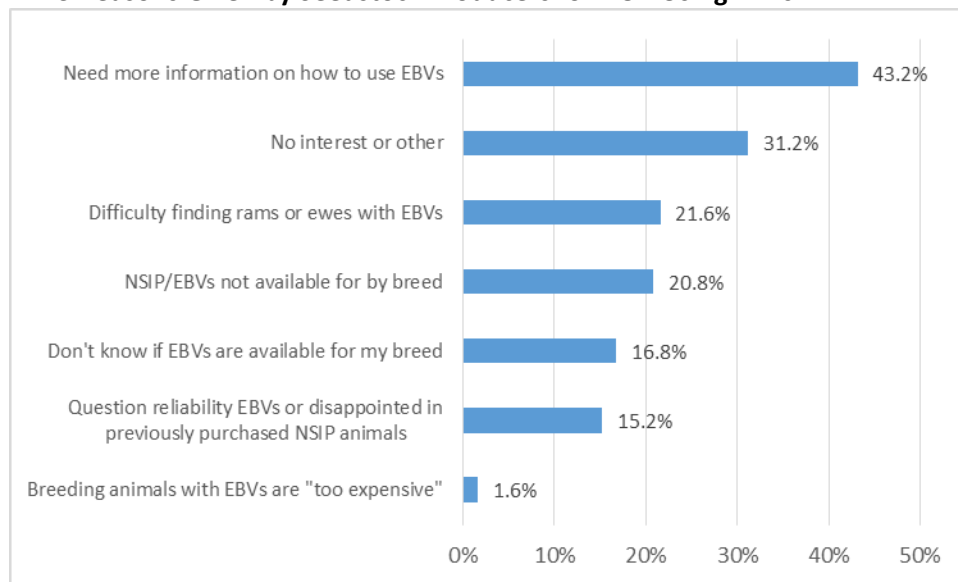
### A.2.1 Percent Operations with Ewes Exposed for Out-of-Season Breeding During the Past Three Years by Type and Size of Flock



### A.2.2 Factors Limiting the Success of Out-of-Season Breeding Programs by Percent Operations that Exposed Ewes for Out-of-Season Breeding



### A.2.3 Reasons Given by Seedstock Producers for *NOT* Using EBVs



## Chapter 3: Flock Health

### A.3.1 Lambs: Diseases Difficult to Manage by Flock Size

	1-99	100-499	500-1499	1500+	All
Internal parasites	44%	46%	46%	14%	43%
Starvation	34%	51%	61%	50%	40%
Pneumonia/respiratory disease	27%	46%	64%	45%	34%
Coccidiosis	27%	34%	18%	32%	28%
Enterotoxemia	11%	21%	11%	18%	14%
Diarrhea (scours)	14%	14%	0%	14%	14%
Other digestive problems	14%	8%	11%	23%	13%
None	16%	4%	4%	5%	12%
Other disease	9%	7%	4%	0%	8%
White muscle disease	6%	4%	0%	23%	6%
Navel or joint ill	4%	4%	21%	14%	6%
Sore Mouth	3%	7%	4%	5%	4%
Ring worm (club lamb fungus)	2%	3%	0%	0%	2%
Polyarthritis	1%	2%	4%	5%	1%

### A.3.2 Lambs: Diseases Difficult to Manage by Region (percent operations)

	Region 1 Northeast	Region 2 Mid-Atlantic	Region 3 Great Lakes	Region 4 Mid&Upper Midwest	Region 5 Texas	Region 6 Mountain & Desert	Region 7 Northern Rockies	Region 8 Pacific	Unknown Region
Coccidiosis	18%	40%	32%	34%	17%	20%	18%	23%	28%
Diarrhea (scours)	8%	16%	10%	11%	24%	25%	12%	11%	17%
Enterotoxemia	18%	7%	9%	18%	9%	15%	36%	12%	17%
Internal parasites	47%	65%	39%	36%	63%	20%	15%	32%	45%
Navel or joint ill	3%	2%	9%	4%	2%	15%	9%	8%	7%
Other digestive problems	9%	9%	14%	16%	15%	20%	21%	12%	3%
Other disease	9%	9%	5%	10%	9%	5%	15%	6%	7%
Pneumonia/respiratory disease	24%	25%	37%	36%	26%	35%	52%	43%	41%
Polyarthritis	0%	0%	3%	0%	0%	0%	0%	6%	0%
Ring worm (club lamb fungus)	0%	0%	4%	4%	4%	0%	0%	2%	0%
Sore Mouth	2%	5%	4%	3%	9%	5%	0%	5%	0%
Starvation	39%	35%	53%	45%	20%	40%	52%	28%	38%
White muscle disease	20%	1%	3%	4%	0%	10%	9%	9%	0%

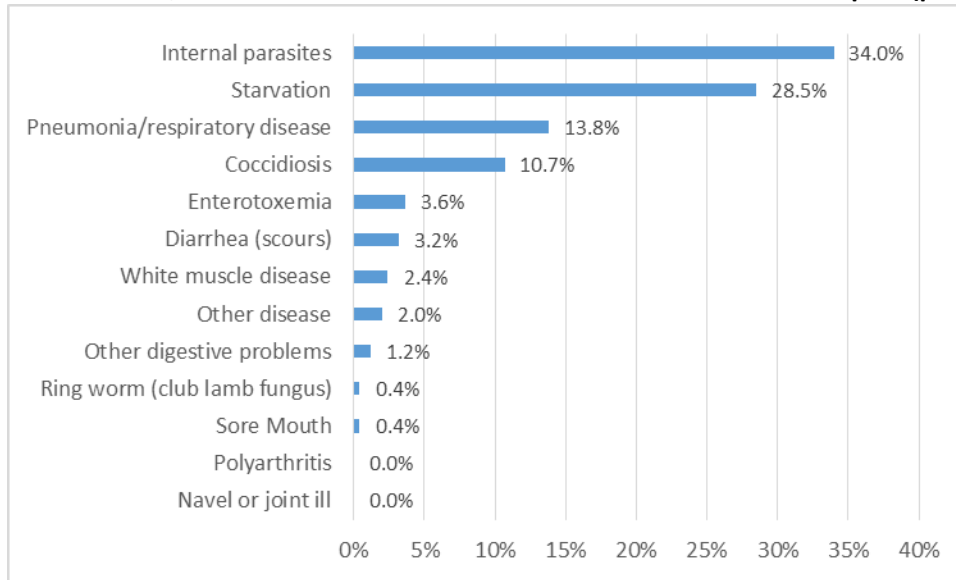
### A.3.3 Breeding Ewes/Rams: Diseases Difficult to Manage by Flock Size

	1-99	100-499	500-1499	1500+	All
Internal Parasites	55%	56%	36%	18%	53%
Mastitis	33%	44%	57%	45%	37%
Footrot/Scald	26%	30%	25%	23%	27%
Abortion	12%	15%	14%	18%	13%
Pregnancy toxemia	10%	12%	11%	32%	12%
Other respiratory disease	8%	13%	25%	18%	10%
Ovine progressive pneumonia (OPP)	4%	13%	32%	23%	8%
Caseous lymphadenitis	8%	10%	4%	0%	8%
External Parasites	7%	6%	7%	14%	7%
Thin ewe syndrome (chronic wasting)	4%	9%	7%	5%	5%
Bluetongue	2%	5%	7%	5%	3%
Other disease	3%	3%	4%	0%	3%
Pinkeye	3%	1%	0%	0%	2%
Ram epididymitis	0%	2%	4%	9%	1%
Scrapie	0%	1%	0%	0%	0%

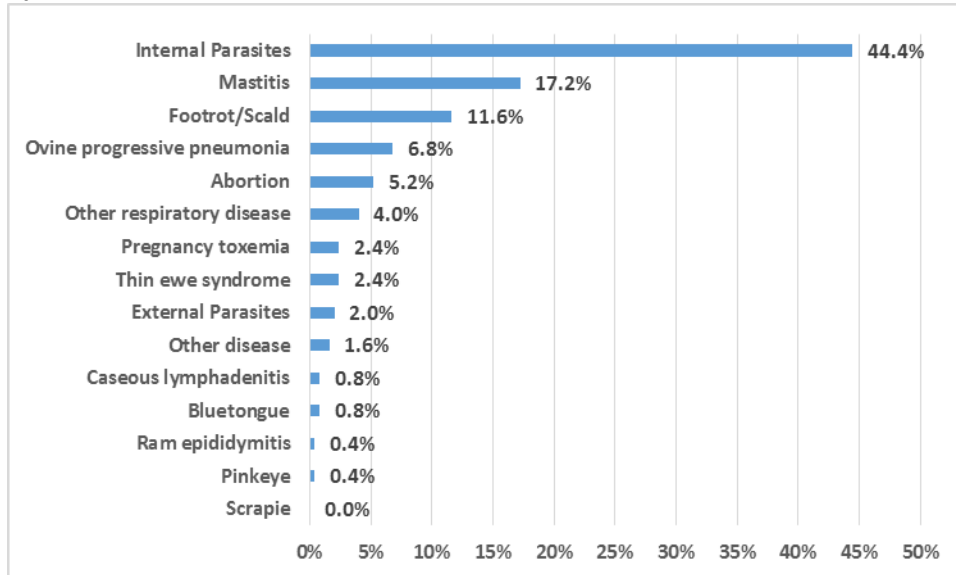
### A.3.4 Breeding Ewes/Rams: Diseases Difficult to Manage by Region (percent operations)

	Region 1 Northeast	Region 2 Mid-Atlantic	Region 3 Great Lakes	Region 4 Mid&Upper Midwest	Region 5 Texas	Region 6 Mountain & Desert	Region 7 Northern Rockies	Region 8 Pacific	Unknown Region
Abortion	8%	7%	18%	18%	9%	15%	18%	10%	12%
Bluetongue	0%	1%	0%	3%	2%	10%	9%	12%	0%
Caseous lymphadenitis	3%	4%	12%	3%	23%	10%	9%	6%	4%
External Parasites	6%	4%	7%	8%	2%	15%	3%	12%	8%
Footrot/Scald	23%	48%	27%	15%	0%	25%	3%	37%	38%
Internal parasites	63%	68%	54%	45%	68%	25%	24%	40%	50%
Mastitis	29%	31%	38%	49%	28%	45%	55%	34%	35%
Other disease	5%	3%	1%	6%	2%	0%	0%	1%	4%
Other respiratory disease	5%	4%	11%	13%	15%	20%	9%	13%	12%
Ovine progressive pneumonia (OPP)	6%	6%	8%	13%	2%	5%	15%	15%	8%
Pinkeye	6%	0%	2%	0%	4%	5%	0%	1%	0%
Pregnancy toxemia	15%	7%	15%	15%	9%	5%	15%	7%	8%
Ram epididymitis	0%	0%	0%	0%	0%	10%	3%	4%	0%
Scrapie	0%	1%	0%	0%	0%	0%	0%	0%	0%
Thin ewe syndrome (chronic wasting)	8%	4%	8%	6%	2%	0%	9%	4%	4%

### A.3.5 Disease/Disease Condition in Lambs with Greatest Economic Impact (percent operations)

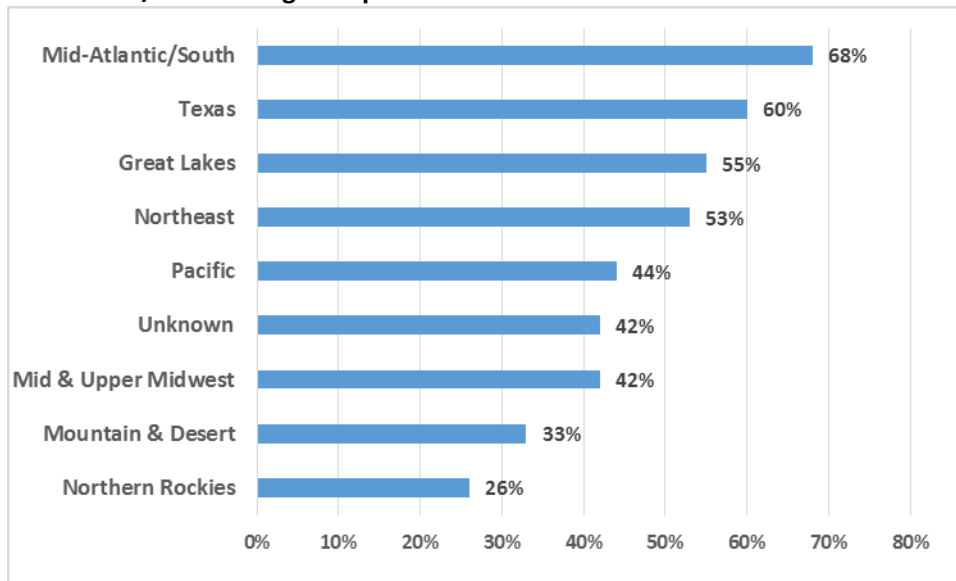


### A.3.6 Disease/Disease Condition in Breeding Ewes/Rams with Greatest Economic Impact (percent operations)

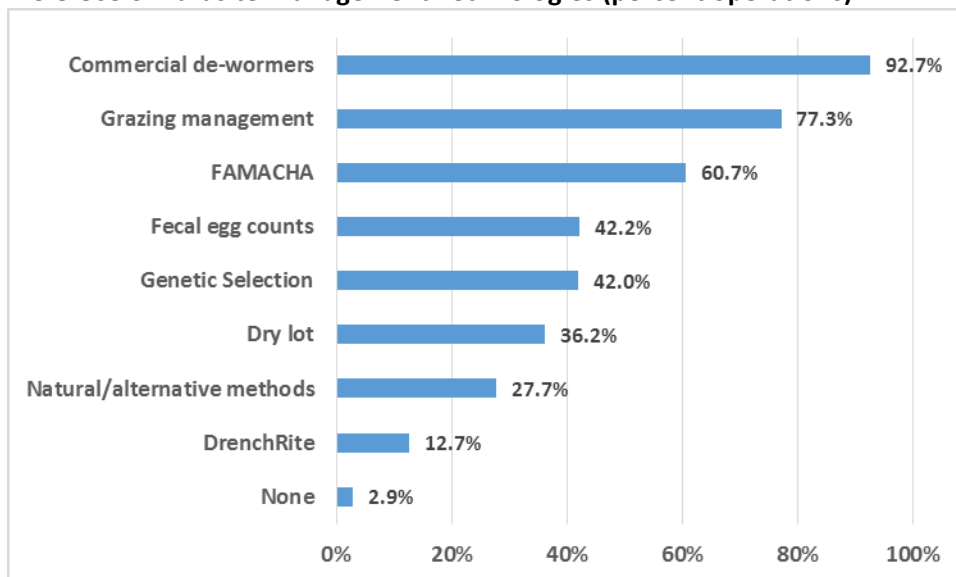


## **Parasite Management**

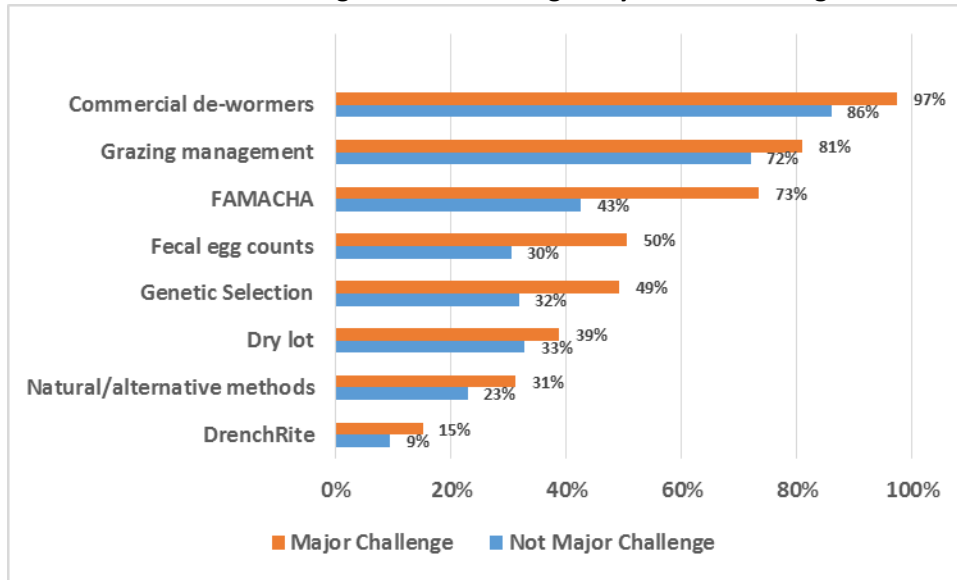
### **A.3.7 Percent Operations within a Region Identifying Internal Parasites as a Difficult Disease Condition in Lambs &/or Breeding Sheep**



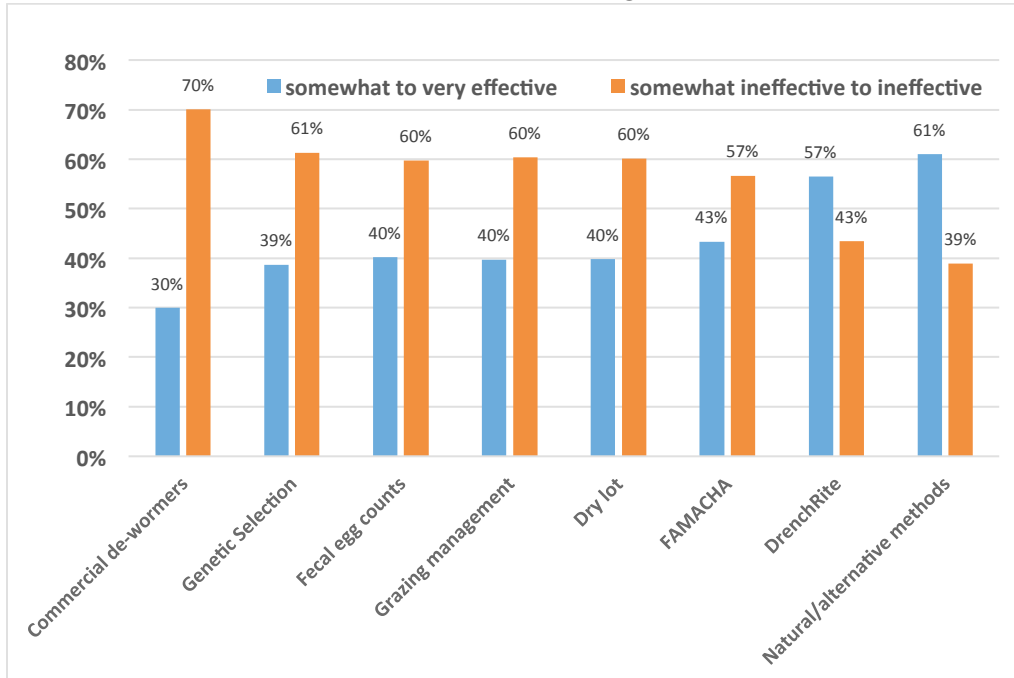
### **A.3.8 Use of Parasite Management Technologies (percent operations)**



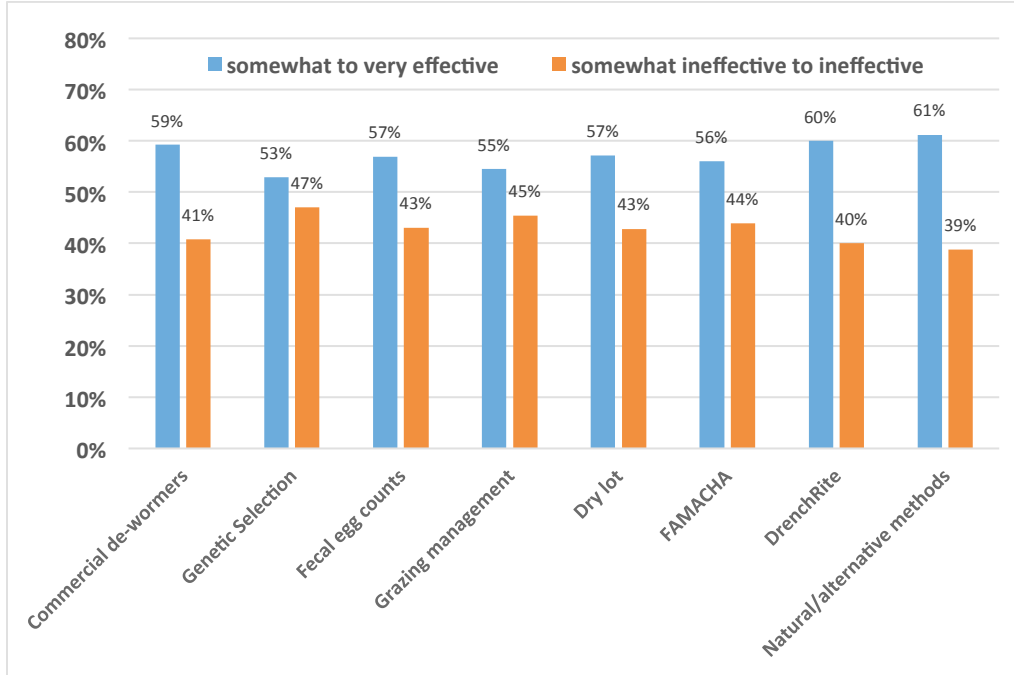
### A.3.9 Use of Parasite Management Technologies by Parasite Management Challenge



### A.3.10 Effectiveness of Parasite Management Technologies by Operations Reporting Parasites are a Difficult Disease Condition to Manage



**A.3.11 Effectiveness of Parasite Management Technologies by Operations Reporting Parasites are *NOT* a Difficult Disease Condition to Manage**



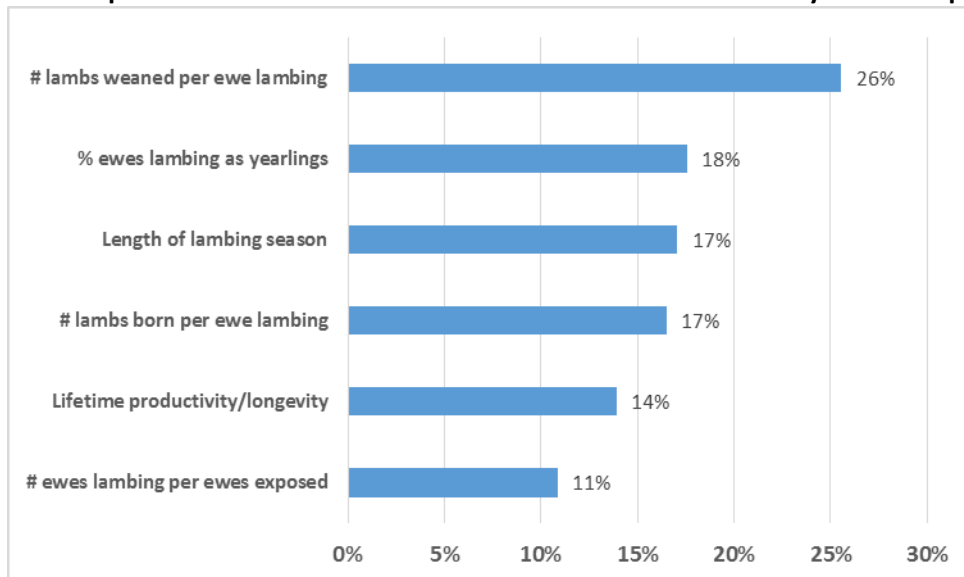
## Chapter 4: Reproductive Performance

### A.4.1 Satisfaction with Reproductive Performance by Percent Operations

	Not satisfied	Somewhat unsatisfied	Somewhat satisfied	Very satisfied
# ewes lambing per ewes exposed	3.6%	7.3%	41.9%	47.2%
# lambs born per ewe lambing	3.8%	12.8%	47.7%	35.8%
Length of lambing season	4.2%	12.8%	40.2%	42.7%
% ewes lambing as yearlings	4.9%	12.7%	39.6%	42.9%
# lambs weaned per ewe lambing	4.9%	20.6%	41.5%	33.0%
Lifetime productivity/longevity of ewes	3.1%	10.8%	42.2%	43.9%

Row totals equal 100%.

### A.4.2 Reproductive Performance: Least Satisfied with Outcomes by Percent Operations



## Chapter 5: Grazing and Pasture Management and Nutrition

### A.5.1 Grazing and Pasture Management Challenges by Percent Pasture-based and Percent Range-based Operations

	%Range-based	%Pasture-based
Multi-species grazing	50%	26%
Pasture renovation	41%	62%
Crop aftermath	37%	13%
Control invasive species	31%	19%
Intensive rotational grazing	30%	64%
Forage analysis	11%	19%
Alternative forages	6%	16%
Other	4%	4%
Soil testing	2%	15%

Column totals are greater than 100%. Producers asked to select up to three

### A.5.2 Grazing and Pasture Management Challenges with Greatest Potential to Increase Profitability

	%Range-based	%Pasture-based
Rotational grazing	22%	31%
Pasture Renovation	20%	39%
Multi-species grazing	18%	9%
Crop aftermath	18%	4%
Control invasive species	18%	4%
Alternative forages	4%	6%
Other	2%	3%
Forage analysis	0%	4%
Soil testing	0%	1%

Column totals equal 100%.

### A.5.3 Nutritional Management Challenges by Percent Range-based Operations, Percent Pasture-based Operations, Percent Breeding Ewes and Percent Operations

	%Range-based	%Pasture-based	%Breeding Ewes	%Operations
Alternative feeds in balanced rations	5%	8%	11%	8%
Balancing rations	11%	20%	11%	19%
Drought management	60%	27%	54%	31%
Early weaning/artificial rearing of lambs	11%	11%	9%	11%
Feed analysis/feed quality	16%	21%	23%	20%
Feed efficiency	9%	17%	18%	16%
Feed handling/delivery systems	9%	21%	13%	20%
Finishing rations for lambs	11%	6%	6%	6%
Growing rations for lambs	11%	14%	6%	14%
Least-cost rations	31%	36%	28%	35%
Micronutrient management	16%	11%	8%	12%
Nutritional management of ewes	31%	29%	35%	29%
Orphan lamb management	16%	21%	19%	21%
Supplemental feeding pasture lambs	9%	15%	5%	14%
Other	0%	1%	0%	1%

Column totals are greater than 100%. Producers asked to select up to three.

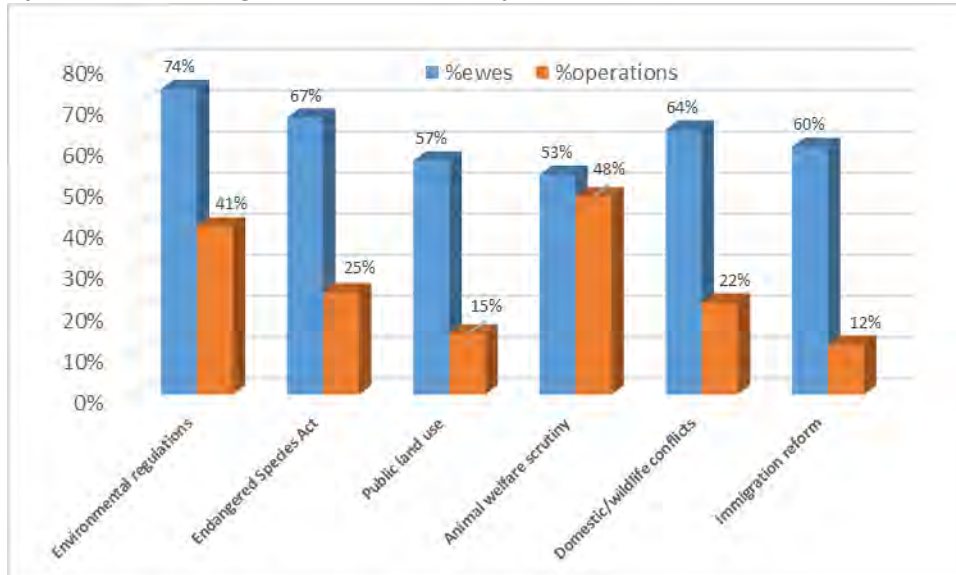
### A.5.4 Nutritional Management Challenges with Greatest Potential to Increase Profitability

	%Range-based	%Pasture-based
Alternative feeds in balanced rations	2%	2%
Balancing rations	2%	5%
Drought management	33%	13%
Early weaning/artificial rearing of lambs	6%	3%
Feed analysis/feed quality	8%	6%
Feed efficiency	2%	8%
Feed handling/delivery systems	4%	6%
Finishing rations for lambs	4%	2%
Growing rations for lambs	2%	5%
Least-cost rations	12%	20%
Micronutrient management	6%	3%
Nutritional management of ewes	12%	15%
Orphan lamb management	4%	6%
Supplemental feeding pasture lambs	2%	6%
Other	2%	1%

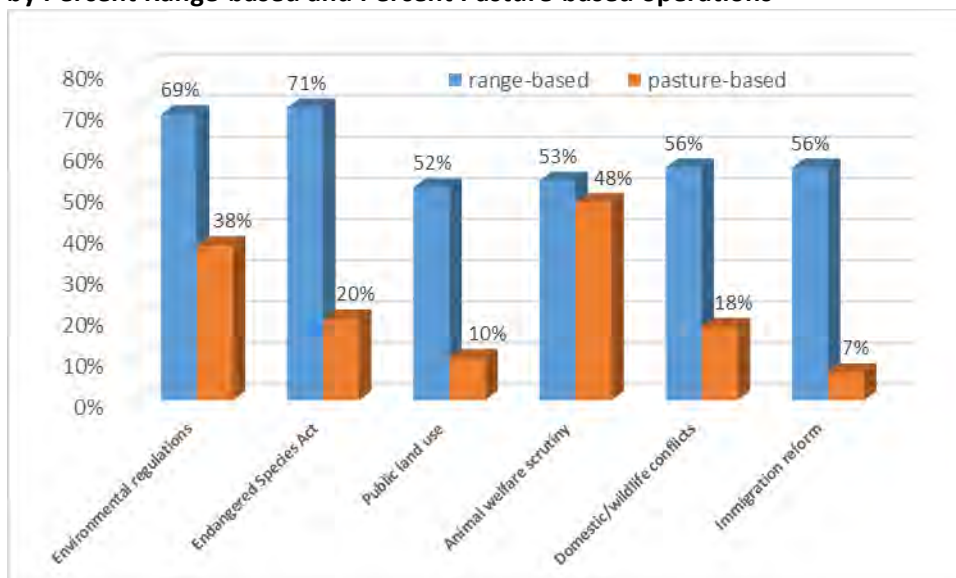
Column totals equal 100%.

## Chapter 6: Public Interest and Social Issues

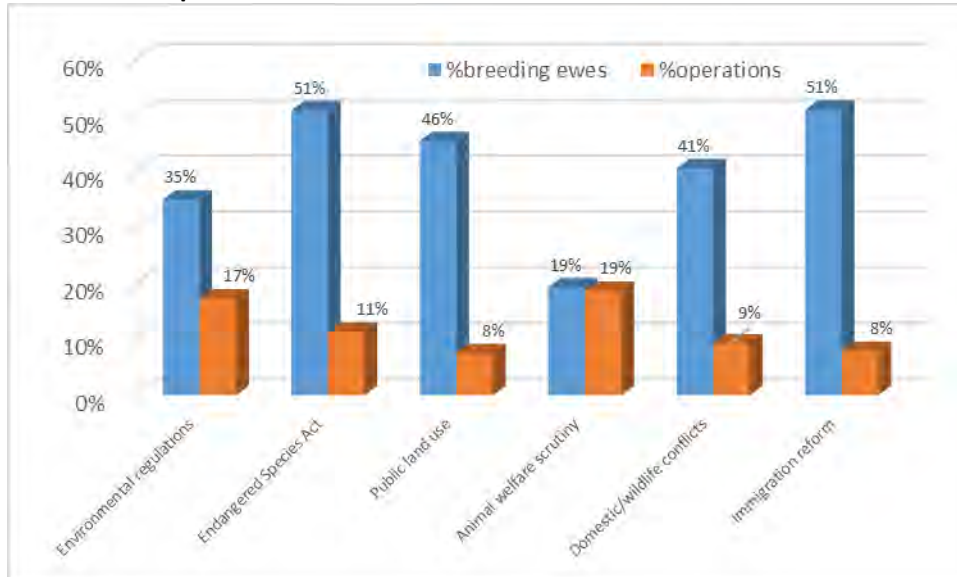
### A.6.1 Moderate to Significant Current or Potential Impact on Operation by Percent Breeding Ewes and Percent Operations



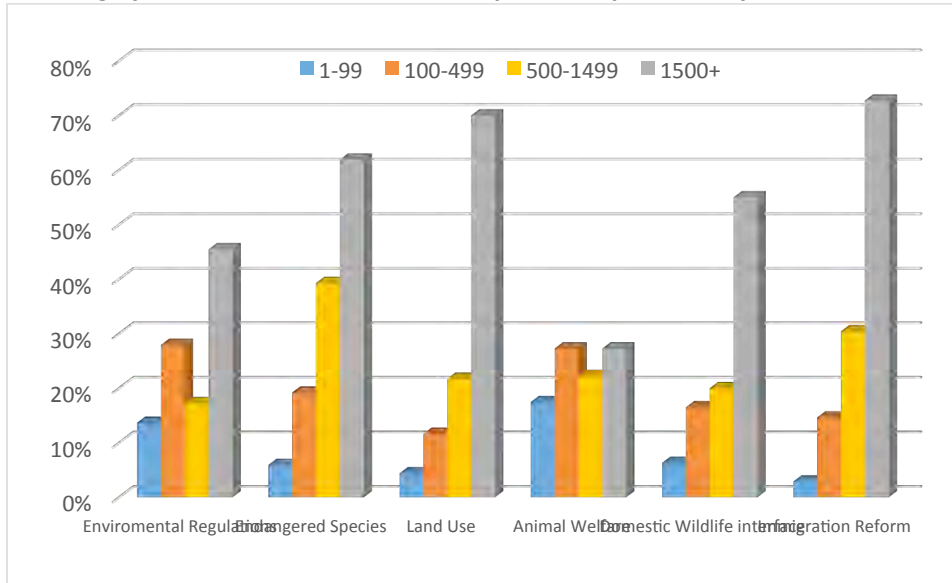
### A.6.2 Moderate to Significant Current or Potential Impact on Operation by Percent Range-based and Percent Pasture-based operations



### A.6.3 Significant Current or Potential Impact on Operation by Percent Breeding Ewes and Percent Operations



### A.6.4 Significant Current or Potential Impact on Operation by Flock Size (number breeding ewes)



## **Predator Management**

### **A.6.5 Respondents Identifying Predator Management as a Major Challenge by Region**

	%operations	%breeding ewes
Northeast	5.2%	0.1%
Mid-Atlantic/South	17.8%	3.6%
Great Lakes	7.4%	1.4%
Mid & Upper Midwest	9.6%	3.6%
Texas	12.6%	5.3%
Mountain & Desert	4.4%	8.6%
Northern Rockies	12.6%	44.0%
Pacific	22.2%	16.3%
Unknown	8.1%	17.0%

### **A.6.6 Respondents Identifying Predator Management as a Major Challenge by Flock Size**

Flock Size	%operations	%breeding ewes
1- 100	49.6%	3.6%
101-500	28.1%	13.7%
501-1000	5.9%	8.0%
1001-5000	9.6%	41.8%
5001+	2.2%	32.9%
Unknown	4.4%	--

#### A.6.7 Most Difficult Predators to Manage by Percent Operations and Percent Breeding Ewes

	%operations	%breeding ewes
Bear	11%	33%
Bobcat/lynx	10%	11%
Fox	15%	4%
Mountain lion	15%	32%
Coyotes	89%	96%
Wolves	9%	34%
Dogs	51%	21%
Eagles	13%	15%
Vultures	14%	10%
Unknown	7%	4%
Other	4%	8%

Note: column totals > 100%

Producers asked to select up to three.

#### A.6.8 Most Difficult Predators to Manage by Type of Management

	Open Range	Fenced Range	Pasture	Pasture & Dry lot	Other
Bear	18%	4%	3%	3%	14%
Bobcat/lynx	0%	11%	4%	4%	0%
Fox	0%	7%	7%	7%	0%
Mountain lion	18%	9%	4%	5%	0%
Coyotes	36%	36%	36%	40%	57%
Wolves	20%	5%	0%	4%	14%
Dogs	4%	4%	26%	27%	14%
Eagles	0%	11%	6%	4%	0%
Vultures	0%	9%	7%	5%	0%
Unknown	0%	2%	4%	2%	0%
Other	4%	4%	2%	0%	0%
	100%	100%	100%	100%	100%

#### A.6.9 Most Difficult Predators to Manage by Region

	Northeast	Mid-Atlantic/ South	Great Lakes	Mid & Upper Midwest	Texas	Mountain & Desert	Northern Rockies	Pacific
Bear	4%	3%	0%	0%	0%	22%	13%	2%
Bobcat/lynx	9%	2%	0%	5%	18%	0%	0%	1%
Fox	6%	7%	4%	5%	14%	9%	6%	1%
Mountain lion	2%	1%	1%	7%	2%	17%	11%	15%
Coyotes	45%	38%	45%	45%	27%	39%	40%	38%
Wolves	0%	4%	6%	0%	0%	0%	17%	6%
Dogs	21%	29%	32%	20%	8%	9%	8%	24%
Eagles	4%	2%	4%	13%	6%	0%	6%	7%
Vultures	6%	9%	3%	0%	16%	0%	0%	2%
Unknown	0%	4%	4%	5%	6%	0%	0%	0%
Other	2%	1%	0%	0%	2%	4%	0%	4%
	100%	100%	100%	100%	100%	100%	100%	100%

#### A.6.10 Effectiveness of Predator Management Technologies

	Have used technology	somewhat effective to extremely effective	somewhat ineffective to ineffective
Presence of herders	18%	66%	34%
Woven wire (or net) fences	74%	79%	21%
High-tensile, electric fencing	42%	75%	25%
Flagging/noise	11%	24%	76%
Livestock guardian dogs	48%	92%	8%
Livestock guardian llamas	23%	56%	44%
Livestock guardian donkeys	19%	58%	42%
Night penning sheep	44%	87%	13%
Electronic Guard	7%	31%	69%
Translocation	8%	8%	92%
Shooting	44%	80%	20%
Snares	21%	77%	23%
Leg-hold traps	18%	68%	32%
Livestock Protection Collar	5%	27%	73%
M-44 Cyanide Injector	11%	61%	39%

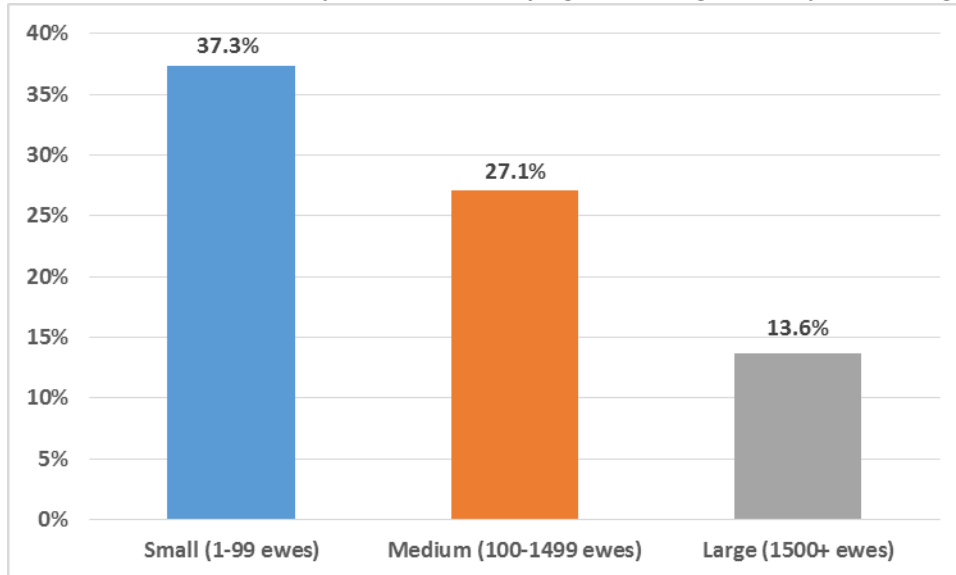
## Chapter 7: Lamb Marketing

### A.7.1 Operations Identifying Marketing as a Major Challenge by Type of Operation and Region

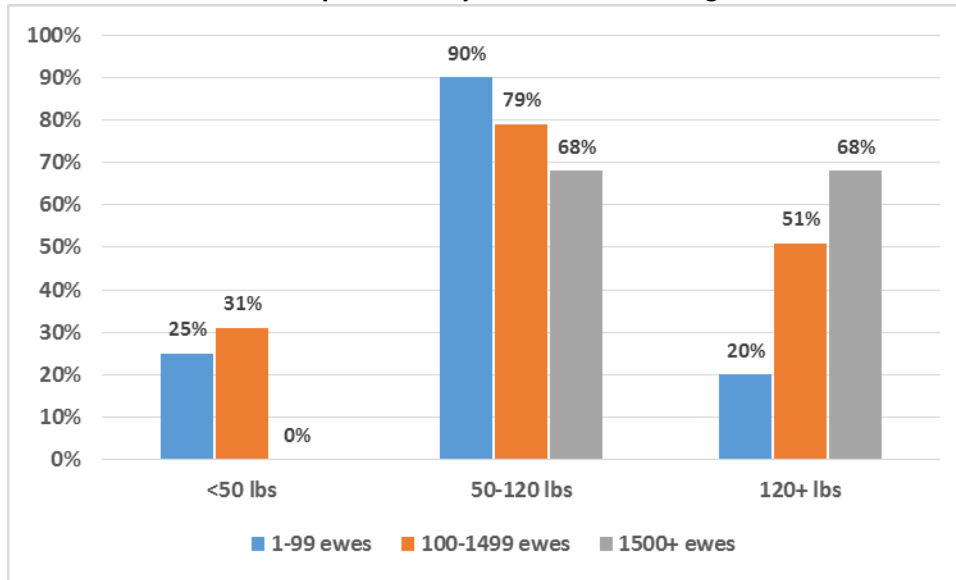
Type of Operation	Region 1 Northeast	Region 2 Mid-Atlantic South	Region 3 Great Lakes	Region 4 Mid & Upper Midwest	Region 5 Texas	Region 6 Mountain & Desert	Region 7 Northern Rockies	Region 8 Pacific	Unknown
Commercial Lamb	14%	22%	22%	15%	3%	5%	8%	10%	2%
Wool	45%	0%	20%	5%	0%	0%	0%	30%	0%
Seedstock	13%	16%	13%	30%	8%	2%	3%	14%	2%
Dairy	33%	0%	0%	0%	0%	33%	0%	0%	33%
Show/4-H	15%	23%	31%	0%	15%	0%	0%	15%	0%
Sustainable Land Management	50%	0%	0%	0%	0%	0%	0%	50%	0%
Other	25%	0%	0%	25%	0%	0%	0%	50%	0%

Across row totals equal 100%

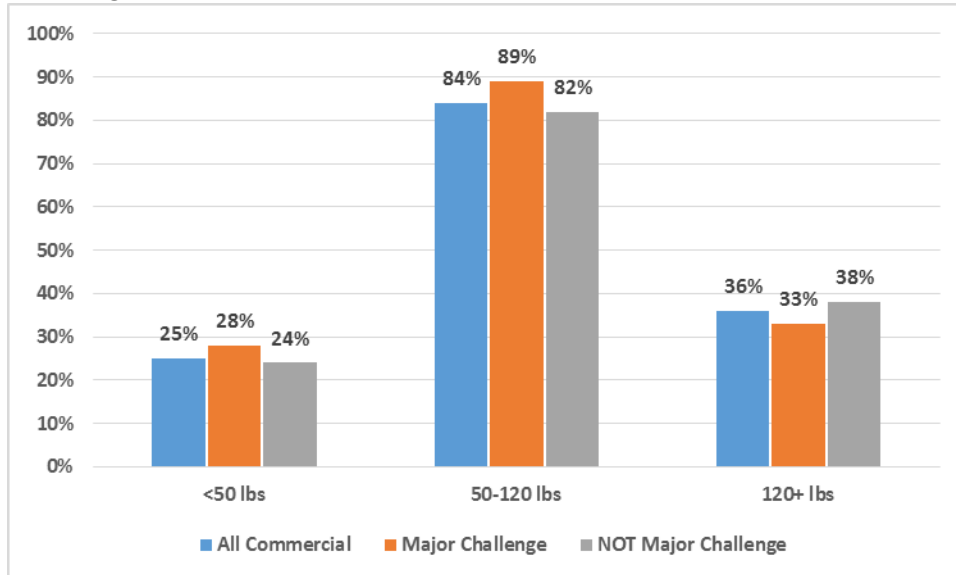
### A.7.2 Commercial Lamb Operations Identifying Marketing as a Major Challenge by Flock Size



#### A.7.3 Commercial Lamb Operations by Flock Size and Weight of Market Lambs Sold



#### A.7.4 Commercial Lamb Operations by Marketing as a Major Challenge and Weight of Market Lambs Sold



#### A.7.5 Commercial Lamb Operations by Market Outlet and Flock Size

Market Outlet	Small (1-99 ewes)	Mid-size (1-1499 ewes)	Large (1500+ ewes)
Local auction/sale barn	52.3%	56.0%	15.8%
Via internet auction	0.9%	1.2%	0.0%
Lamb pool/coop	9.0%	11.9%	21.1%
To a feedlot	4.5%	8.3%	36.8%
National packer	0.9%	13.1%	26.3%
Local/regional packer	4.5%	7.1%	5.3%
Local butcher	9.0%	9.5%	10.5%
Order buyer or dealer	10.8%	23.8%	10.5%
Restaurant	3.6%	8.3%	5.3%
Grocery store	1.8%	4.8%	0.0%
"All-natural" grocer	0.9%	1.2%	15.8%
Farmers Market	4.5%	15.5%	0.0%
On farm	62.2%	39.3%	10.5%

Column totals may be greater than 100%.

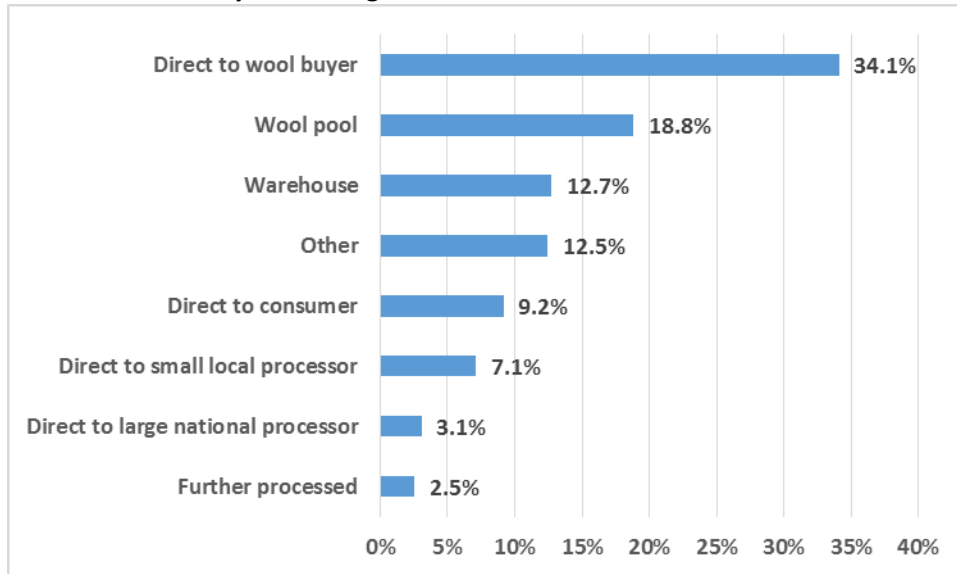
#### A.7.6 Commercial Lamb Operations Identifying Marketing as a Major Challenge by Market Outlet and Flock Size

Market Outlet	Small (1-99 ewes)	Mid-size (1-1499 ewes)	Large (1500+ ewes)
Local auction/sale barn	44.4%	75.0%	0.0%
Via internet auction	2.2%	4.2%	0.0%
Lamb pool/coop	6.7%	8.3%	50.0%
To a feedlot	2.2%	4.2%	50.0%
National packer	2.2%	20.8%	0.0%
Local/regional packer	8.9%	8.3%	0.0%
Local butcher	8.9%	16.7%	0.0%
Order buyer or dealer	8.9%	20.8%	0.0%
Restaurant	2.2%	8.3%	0.0%
Grocery store	4.4%	8.3%	0.0%
"All-natural" grocer	2.2%	0.0%	0.0%
Farmers Market	6.7%	16.7%	0.0%
On farm	73.3%	33.3%	0.0%

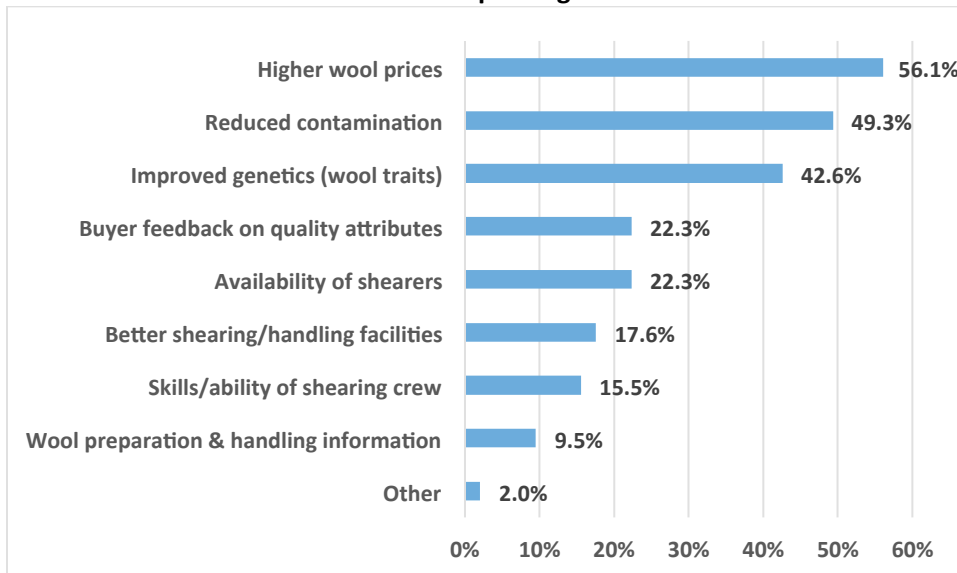
Column totals may be greater than 100%.

## Chapter 8: Wool Marketing

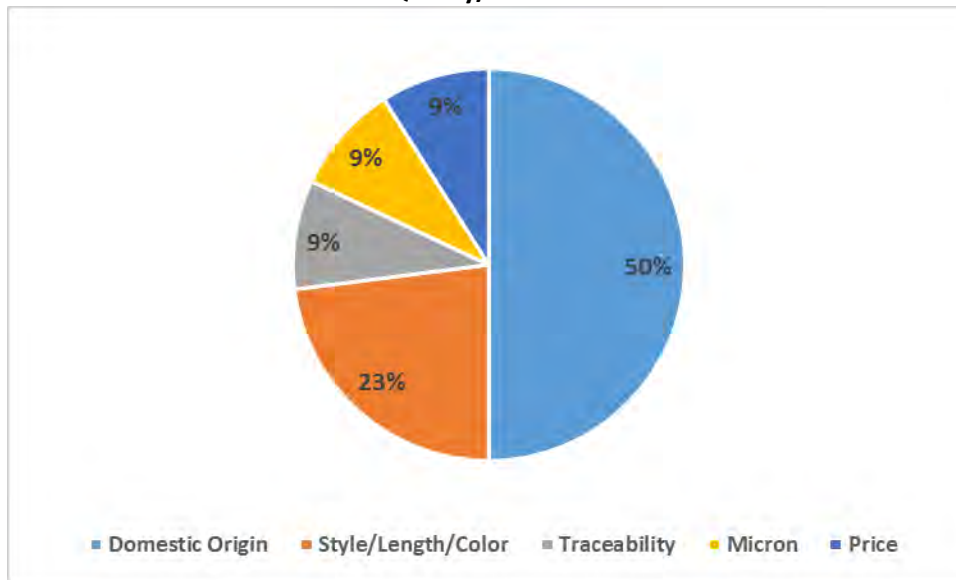
### A.8.1 Wool Sales by Marketing Outlet



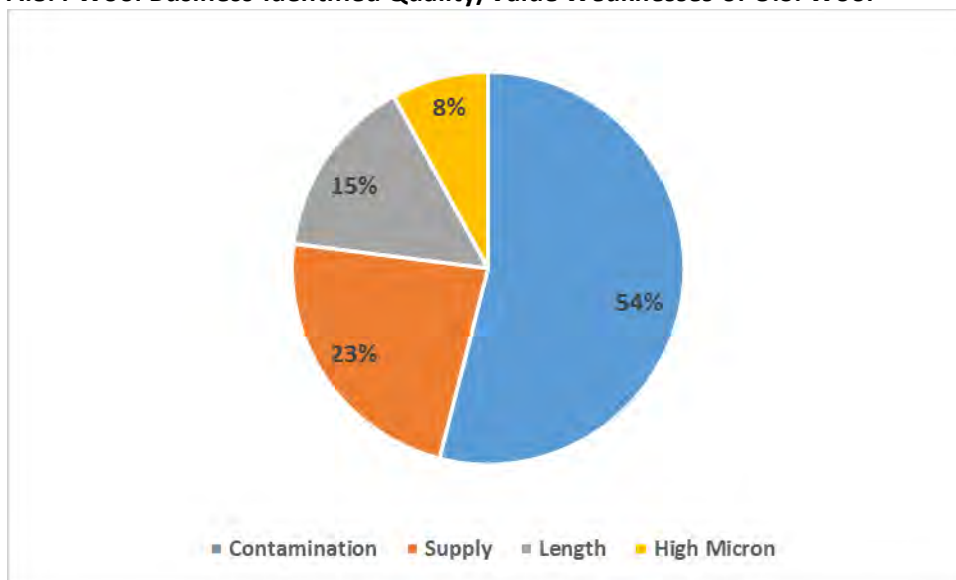
### A.8.2 Producer-Identified Needs for Improving Wool



### A.8.3 Wool Business-Identified Quality/Value *Attributes* of U.S. Wool



### A.8.4 Wool Business-Identified Quality/Value *Weaknesses* of U.S. Wool



## **APPENDIX B--Research, Development, and Education Priorities by Size of Operation**

The U.S. sheep industry consists primarily of two distinct management types: range operations in western U.S. and farm flock operations raising sheep on pasture and/or pasture/dry lots found primarily in the Midwest and East. In California, a hybrid of the two management types is often found: many larger, fenced operations.

For commercial operations, as flock size increases, the top ranking challenges shift away from grazing and forage management to predator management, labor/labor management and government regulations and compliance issues.

Flock health consistently ranks fourth across all commercial flock size ranges. Marketing ranks second among small commercial flock challenges and fifth among medium-size and large commercial operations.

### *Greatest Challenges of Commercial Operators by Type and Size of Operation*

Small commercial operations (1-99 breeding ewes). The top five challenges--in order of importance--were:

1. grazing and forage management,
2. marketing,
3. facilities and fencing,
4. flock health, and
5. labor/labor management.

Mid-sized commercial operations (100-1499 breeding ewes). The top five greatest challenges defined by this subset were (in order):

1. predator management,
2. labor/labor management,
3. grazing and forage management,
4. flock health, and
5. marketing.

Large commercial operators (1,500+ breeding ewes). Large commercial flocks ranked challenges as follows (in order):

1. government regulations/compliance,
2. labor and labor management,
3. predator management,
4. flock health, and
5. marketing.

### *Greatest Challenges of Seedstock Operators by Size of Operation*

For seedstock operations, small flocks were defined as 1-75 breeding ewes; medium-size flocks were defined as 76-225 breeding ewes; large flocks were defined as 226-500 breeding ewes.

Small seedstock operators ranked challenges (in order of importance):

1. grazing and forage management,
2. genetics,
3. marketing,
4. flock health, and
5. facilities and fencing.

Medium-sized seedstock producers ranked challenges (in order):

1. grazing and forage management,
2. genetics,
3. reproductive performance,
4. labor/labor management, and
5. flock health.

The largest seedstock operators ranked (in order):

1. predator management,
2. estate planning/generational transfer,
3. marketing,
4. labor/labor management, and
5. grazing and forage management.

## **APPENDIX C--Dairy Survey Results**

Only 1.3 percent of respondents reported that dairy was either their primary or secondary type of sheep operation.

Only one operation reported that 100 percent of both breeding ewes and breeding rams were of a dairy (milk) breed. The remaining operations reported 63 percent of ewes and 70 percent of rams were of a “milk-type” breed.

Response to the dairy-specific questions was limited among dairy operations, and not sufficient for valid inference.

Seventy-one percent of the dairy operations reported 50 breeding ewes or fewer and the remaining 29 percent of operations reported between 100 and 400 breeding ewes. Over half of dairy operations currently have more breeding ewes than in 2010 and 86 percent of operations plan to increase breeding ewe numbers over the next five years.

Grazing and forage management was the top ranking challenge among dairy operations followed equally by flock health, marketing, facilities and fencing, and financial management and financing. Pasture renovation was the top grazing/pasture management challenge among dairy producers and least-cost rations the top nutritional challenge.

Rankings for reproductive performance were not statistically different.

Internal parasites presented the greatest disease challenge for both lambs and breeding ewes/rams on dairy operations.

## APPENDIX D--Allocation of Public Funding for Sheep Research

Allocation of public funding for sheep research by CRIS Knowledge Area between FY 2004 and FY2013 has dropped significantly. Below is a national overview of the allocation of public resources for sheep research and education. The data represent research and education funding at public universities and federal laboratories. The public support for sheep research and education has declined over the past several years as illustrated in the table below.

**Figure D.1 Public Support for Sheep Research and Education**

Sheep Research Knowledge Area (KA)	KA No.	FY2004 Percent of Total	FY2013 Percent of Total
Reproductive Performance	301	31.0	37.6
Nutrient Utilization	302	8.1	6.1
Genetic Improvement	303	3.9	6.5
Animal Genome	304	3.9	15.3
Physiological Processes	305	5.9	7.3
Management Systems	306	18.0	5.9
Improved Products	308	4.4	5.6
Diseases	311	8.8	2.0
Internal Parasites	313	5.6	5.5
Animal Welfare	315	1.0	0.1
Marketing and Economics	600s	3.5	0.02
Other		6.3	8.1
<b>National Total</b>		100.4	100.02

The total public resources for sheep research, including scientist year equivalents (SYs) and funding, are summarized below for fiscal years 2001 through 2014. The data represent resources for federal laboratories and public universities.

The national total of SYs decreased from 111 to 61 during this period, whereas the number of SYs at universities decreased from 85 to 42. Total national public funding decreased from \$42.7 million in fiscal year 2001 to \$32.5 million in fiscal year 2014.

**Figure D.2 Public Resources for Sheep Research Fiscal Years 2001 through 2014  
Scientist Years (SYs) and Funding (\$ Millions)**

Public Resources for Sheep Research (1)	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
USDA (SYs) (2)	26.3	27.0	26.4	31.0	32.3	31.8	31.5	32.2	22.3	25.2	24.0	25.0	21.2	19.6
Non-USDA (SYs) (3)	84.8	74.8	87.4	78.3	60.2	63.2	67.5	66.0	60.3	59.7	57.0	54.6	46.3	41.5
National Total (SYs)	111.1	101.8	113.8	109.3	92.5	95.0	99.0	98.2	82.6	84.9	81.0	79.6	67.5	61.1
National Total Public Funding (\$M)	42.70	46.05	50.80	54.72	41.30	44.71	49.07	46.41	38.87	46.65	47.25	45.82	37.73	32.47

(1) Source: Current Research Information System (CRIS), National Institute of Food and Agriculture, USDA (National summaries, Table C)

(2) USDA scientist year equivalents

(3) University scientist year equivalents

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