

Sheep HEALTH REPORT

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USDA Expands Genetic Testing In Flock Clean-Up Plans *DNA Testing for Scrapie Resistance Now Being Used Nationally*

The Accelerated Scrapie Eradication Program is stepping up to include a new national flock clean-up plan based on genetics.

Under the new National Genetic Based Flock Clean-up Plan, flocks that are scrapie infected, source or exposed flocks can salvage individual exposed sheep that are found to be genetically resistant to scrapie. The genes that control resistance to scrapie can be determined through a blood test in a process known as genotyping, or DNA testing.

Previously, individual states that desired to use genetics as a basis for scrapie eradication had to request such actions as part of a scrapie pilot project. The new, uniform national plan will bring more consistency to scrapie eradication.

In the scrapie control methods listed in the Code of Federal Regulation (CFR) removal of animals is based on an individual



sheep's exposure to scrapie, and in the case of a ewe with low levels of exposure, whether the ewe is genetically susceptible. The new plan focuses on identifying and retaining resistant sheep, and only considers exposure in cases where that exposure is unusually high.

Now that a genetic-based system is available nationally, producers may preserve a larger percentage of their flock in many cases.

"Under the CFR plan, producers may have only been able to preserve about 25% of their flock," said Dr. Diane Sutton, National Scrapie Program Coordinator with USDA-Animal and Plant Health Service-Veterinary Services (USDA-APHIS-VS). "Using the genetic plan, on average, will allow them to spare 60% of the flock, since most flocks have about 60% genetically resistant sheep."

Genetic ABCs. While genetic programs can be used to help producers eliminate scrapie from infected

flocks and prevent scrapie from spreading in exposed flocks, a little knowledge about scrapie and the unique "alphabet" surrounding this disease can help all producers minimize the risk of exposing their flock to scrapie.

Scrapie is believed to be caused by an infectious protein called a prion, which is a misfolded form of a normal cellular prion protein. Unlike bacteria or viruses, prions do

not actually replicate, but appear to "recruit" normal cellular prion proteins to convert to the abnormal form by acting as a type of template.

If a sheep has certain amino acids in place in specific locations its normal cellular prion protein, it may have protection against the "bending" of the protein into the form that causes scrapie.

Every sheep has two copies of a prion protein gene (called PRNP, shorthand for PRioN Protein gene), receiving one copy of the gene from each parent. Each of these genes contains codons, and these codons instruct the body's cells to place a specific amino acid at a particular place when building a protein molecule. In the case of the PRNP gene, there are codons numbered 1 to 256, representing each of the individual amino acids that make up the normal cellular prion protein.

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Plans Underway for 2003 NIAA Annual Meeting

"Maximum Preparedness ... Safeguarding Animal Agriculture" will be the theme of the 2003 annual meeting of the National Institute for Animal Agriculture (NIAA).

Scheduled for April 6-10, 2003, at The Westin Hotel in Cincinnati, Ohio, this gathering will include producers, veterinarians, business executives, scientists, academicians, state and federal regulatory officials

and other stakeholders in the animal food and fiber industry.

The opening general session will include a number of keynote presentations by homeland security officials, scientists and other pre-eminent agricultural leaders.

NIAA committees will present 15 information-packed seminars addressing the breadth of issues affecting animal agriculture today. Other groups that will meet in conjunction with the NIAA Annual Meeting include the National

Assembly of State Animal Health Officials, National John's Working Group and the National Animal Health Emergency Management Steering Committee.

NIAA's mission is to provide forums for building consensus and advancing solutions for animal agriculture and to provide continuing education and communication linkages for animal ag professionals.

The NIAA Sheep Health Committee will meet Tuesday afternoon, April 9, beginning at 1:15 p.m.

More information on the 2003 NIAA Annual Meeting can be obtained on the Internet at www.animalagriculture.org or by calling 270-782-9798.



Sheep Health Report

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AASRP urges action on MUMS legislation

The American Association of Small Ruminant Practitioners (AASRP) is urging members of Congress to act on proposed legislation that would encourage development of drugs to be authorized by the Food and Drug Administration for less common animal species and indications.

"On behalf of our organization's members and the animals we care for, we request that you support the amendment to the Animal Drug User Fee Act (ADUFAP) of 2002 that includes language from the Minor Use and Minor Species (MUMS) Animal Health Act of 2001," stated Dr. Richard Stobaes, Jr., AASRP president, in a recent letter to key congressional members.

The American Veterinary Medical Association (AVMA) is marshaling support for the legislation in the 108th Congress.

Stobaes pointed out that, with the current critical shortage of approved animal drugs for these uses, veterinarians and animal owners have very limited options for treating minor species or uncommon conditions. "Lack of approved therapies results in animal suffering and death, and potentially increases public health risks," he said.

The amendment will:

- Create a program similar to the human Orphan Drug Program to increase the availability of drugs to treat rare animal diseases and minor species;
- Provide oversight and control of these drugs by the Food and Drug Administration;
- Create incentives for animal drug manufacturers to obtain FDA-drug marketing authorization; and,
- Alleviate the shortage of approved drugs while maintaining and ensuring protection of the public health.

Glossary of USDA Acronyms

APHIS: Animal and Plant Health Inspection Service
ARS: Agricultural Research Service
FAD: Foreign Animal Disease
FSIS: Food Safety & Inspection Service
NADC: National Animal Disease Center
NAHEMS: National Animal Health Emergency Management Systems
NVSL: National Veterinary Services Laboratories
OCVI: Official Certificate of Veterinary Inspection
VS: Veterinary Services

Budget Boost

President Calls for \$42 Million Increase for Food Safety

President Bush will seek record-level support for USDA's meat and poultry food safety programs as well as increase efforts to strengthen agricultural protection systems in his FY 2004 budget. That's according to Agriculture Secretary Ann M. Veneman, who announced recently that USDA's food safety budget will increase to \$797 million, an increase of \$42 million over the FY-2003 request.

This represents a \$148 million (or 20%) increase in food safety programs since FY-2000. The FY 2004 request will fund 7,680 food safety inspectors, provide specialized training for the inspection workforce, increase microbiological testing and sampling, strengthen foreign surveillance programs and increase public education efforts.

In addition, USDA's budget will also include \$70 million in new funding through other USDA programs to strengthen agricultural protection systems, that would include increased laboratory security measures; biosecurity, animal disease and vaccine research; and additional animal and plant pests and disease monitoring programs.

"The President cares deeply about ensuring a strong food safety system and the protection of agriculture against potential threats," said Veneman. "This additional funding continues to build upon a strong record of achievement in further strengthening our protection systems to ensure the integrity of our food systems."

The Secretary outlined the following details that will be contained in USDA's FY-2004 budget for food safety and agricultural protection systems. More details were expected in early February, when the Bush Administration was to release its formal budget proposals.

Highlights include:

- A \$42 million increase to provide record-level funding for USDA's Food Safety and Inspection Service (FSIS). These additional resources will support FSIS food safety activities, including increasing its inspection workforce to 7,680 meat, poultry and egg products inspectors and veterinarians; providing specialized training for food safety authorities to ensure safety of the commercial supply of meat, poultry and egg products; increasing microbiological testing to ensure effective controls or elimination of pathogens in products; increasing foreign product surveillance; and new food safety public education efforts.

- A \$23 million increase for Animal and Plant Health Inspection Service programs for inspections at ports of entry; increase availability of foot-and-mouth disease vaccines; and expansion of diagnostic and other scientific and technical services.

- A \$47 million increase for USDA's various research agencies for strengthening laboratory security measures; conducting additional research on emerging animal diseases; new vaccine development; new biosecurity database systems; and continued development of the unified Federal-State Diagnostic Network for identifying and responding to high-risk biological pathogens.

Secretary Veneman made the announcement during remarks at the U.S. Poultry and Egg Association International Poultry Exposition in Atlanta. The Secretary toured exhibits highlighting new food safety research and technologies. She also conducted a roundtable discussion with local farmers to discuss food safety, homeland security and other farm issues.

APHIS Signs Agreement for New Electronic Health Certificates

USDA's Animal and Plant Health Inspection Service, Veterinary Services (APHIS-VS) has announced that it has established an agreement with Communications Resources Inc. to implement GlobalVetLink web-based technology for private practitioners to create certificates of veterinary inspection (health certificates) for movement of animals between states.

The application has already been used in Florida and can be easily modified for use by the other 49 states. The electronic health certificates will be web-based and incorporate the requirements endorsed by the United States Animal Health Association five years ago.

The system allows veterinarians to create certificates for printing, allow all states to access domestic import/export information, and produce a standard data dump that each state could use to populate their own local data systems.

APHIS-VS is targeting implementation to begin during the first quarter of 2003 for food animal species.

Electronic health certificates have been successfully applied in Florida with benefits realized by practitioners, the state veterinarian's office and Veterinary Services. APHIS-VS will build on that success by identifying four or five additional states to further pilot the current application.

"Real time data entry and retrieval of information for animal movement is of increasing importance," said Kevin Maher, GlobalVetLink president. "Our dream of a national, centralized web-based system is actualized with this important APHIS-VS relationship."

'A Plan We Can Build From'

USAHA Accepts Task Force's National Food Animal Identification Work Plan

A national animal identification work plan, developed by a task force representing more than 30 livestock organizations, was accepted through a unanimous resolution at the meeting of the U.S. Animal Health Association (USAHA) Committee on Livestock Identification Oct. 23 in St. Louis.

This support by USAHA is a positive step toward the establishment of a national identification program and system for U.S. animal agriculture, according to Neil Hammerschmidt, chair of the National Food Animal Identification Task Force. "For the first time, we have a work plan that we can build from. The resolution requesting the USDA Animal and Plant Health Inspection Service (APHIS) to use the work plan as a guide for the development of a national program is significant because several species groups brought it forward as a united industry on this issue," he said.

The task force, coordinated by the National Institute for Animal Agriculture (NIAA), spent the past six months developing the "National Identification Work Plan." More than 100 representatives of animal agriculture served on the task force and contributed to its five working groups: animal disease management, marketability, standards, producer concerns and funding, authority and oversight.

The task force mission is to ensure the United States has an adequate animal identification system that supports the financial viability of animal agriculture. It believes that an animal identification system is needed to maintain the health and biosecurity of the U.S. herd.

The USAHA resolution also calls for the establishment of a joint federal and state government, USAHA and industry animal identification development team by January of

2003. This team is to use the plan as a guide to develop an ID system that will enhance animal disease monitoring, surveillance, control and eradication in the United States.

John Wortman, chair of the USAHA Livestock Identification Committee, said industry groups are ready to work more closely with



Neil Hammerschmidt, chair, National Food Animal ID Task Force, unveils the work plan at the 2002 USAHA meeting.

the USDA Animal and Plant Health Inspection Service (APHIS) and state animal health officials to refine the animal identification systems necessary to maintain animal disease programs in the United States. USAHA is a national non-profit organization working with state and federal animal health officials, veterinarians, livestock producers, national livestock and poultry, and research scientists to control livestock diseases.

The ID task force determined that 48-hour traceback capability is the ultimate goal of a national ID system, especially in the event of a foreign animal disease outbreak in the United States. It concludes that a national ID system should have the

capability to identify all premises (livestock operations, feedyards, markets or other stops in the food production chain) that had direct contact with a disease within two days after discovery. It recommends that movement of individual animals or units of animals be recorded into a central database, or a seamlessly linked database infrastructure.

The ID task force recommends the integration of radio frequency identification (RFID) technology as the most feasible means to achieve a 48-hour traceback system.

The National Identification Work Plan outlines a phase-in program. Phase I, for example, would implement a National Premises System. Phase II would implement individual ID, where animals would have an official tag with a unique visual animal identification number, and later progressing towards RFID. A group or lot ID number would be used for market swine identification. In phase III, a system to report animal movements would be implemented.

Industry organizations and other stakeholders will have an opportunity to review and comment on the National Identification Work Plan through March 2003. "This allows livestock organizations time to review the plan at their respective conventions, board and committee meetings and gather producer feedback," Hammerschmidt said.

Editor's note: To request a copy of the 34-page National Identification Work Plan, contact the National Institute for Animal Agriculture at (270) 782-9798, or review it on the NIAA Web site at www.animalagriculture.org/ID.

For additional information on the National Food Animal Identification Task Force contact: Neil Hammerschmidt at office phone (608) 848-5237; or nhammerschmidt@wiid.org.

National Genetic-Based Clean-Up Plan

(continued from page 1)

When it comes to preventing scrapie, it is important to know the specific amino acids that are called for by just a few of these codon locations. The most important, at least in the U.S., is codon 171. This codon can give instructions to insert one of four amino acids: Histidine (H), Glutamine (Q), Lysine (K) or Arginine (R).

Having an "R" at codon 171 is very important, since it produces the greatest scrapie resistance in sheep. Q and H at this site indicate susceptibility to scrapie. K has been recently identified by the Agricultural Research Service in six Barbados sheep. It is unknown what effect it will have on the scrapie susceptibility of these sheep. K will be treated the same as Q for regulatory purposes when present in scrapie-exposed sheep until more is known, according to Dr. Sutton.

A second site, called codon 136, also can influence the susceptibility of a sheep to certain strains of scrapie.

This codon can instruct for Alanine (A) or Valine (V) to be the amino acid at this location. A sheep that is AV QR can be susceptible to these 136, or "Valine" strains. Scientists previously thought the U.S. had only the strain(s) of scrapie where codon 171 alone determines susceptibility and resistance, but recently an AV QR sheep in the U.S. was confirmed positive.

Fortunately, many seedstock suppliers with high scrapie prevalence breeds have a goal of producing RR sheep at codon 171, or in some cases, eliminating V at codon 136. Codon 171 RR sheep are always AA at codon 136, so they are resistant to both types of scrapie strains. AA QR sheep are also resistant to both types of scrapie strains.

Any sheep with a V at codon 136 (such as an AV QR, AV QQ or VV QQ sheep) is susceptible to 136 scrapie. AV QR sheep are less susceptible than either AV QQ or VV QQ sheep. Only sheep that are AA at codon 136

(which includes all RR sheep) are resistant to 136 scrapie.

Sheep that are AV QQ, or VV QQ are susceptible to both types of scrapie strains.

Dr. Sutton reminded producers that genotyping only indicates whether an animal is susceptible to scrapie, not whether it actually has the disease. Only biopsy of the lymphoid tissue of the third eyelid can be used to diagnose scrapie in a live sheep.

Action plan. Based on this science, the national genetic-based clean-up plan works by following three basic steps.

- When an infected flock has been identified, the sheep are genotyped by collecting a blood sample. As indicated previously, this DNA information indicates whether a sheep is or is not susceptible to the disease.
- Susceptible genotypes are removed, or restrictions are placed on their movement.
- The flock is placed under a

monitoring plan for five years.

The plan calls for owners to be able to retain, or sell without restriction, nearly all sheep that are AA RR, AA QR and most AV QR. The AA QR sheep would be restricted only in the rare cases in which the animal is the female offspring of an infected female; a clinical suspect; from a flock with an unusually high prevalence of the disease; from a flock in which scrapie has a history of recurrence; or from a flock that includes a positive sheep of a resistant genotype.

Likewise, an AV QR sheep would be restricted only if it is considered likely that the sheep was exposed to a strain of scrapie to which it is susceptible.

Under the plan, all exposed QQ ewes, exposed female goats and female offspring of scrapie-positive ewes will be removed or placed under movement restrictions.

Also, AV QR ewes will be required to be removed or restricted in flocks where scrapie-positive AV QR sheep have been identified.

For more information, visit: www.animalagriculture.org/scrapie.

Scrapie 2002: Annual Report

Dr. Diane Sutton, National Scrapie Program Coordinator, presented the program's annual report for 2002 at the fall meeting of the United States Animal Health Association.

Highlights of the report for the fiscal year ending Sept. 30, 2002, included:

- There were 1,533 flocks participating in the Scrapie Flock Certification Program (SFCP) of which 78 are Certified, 1,446 are Complete Monitored and nine are Selective Monitored flocks.
- There were 641 flocks newly enrolled or certified in SFCP in FY-2002.
- As of Nov. 30, 2002, there were 46 scrapie infected and source flocks in the U.S., while there were 76 newly infected flocks reported in FY-2002.

- The National Veterinary Services Laboratories (NVSL) confirmed 259 cases of scrapie in FY-2002. There were five cases of scrapie reported in goats for the fiscal year.

- Scrapie slaughter surveillance, which is intended to determine the prevalence of scrapie in the U.S. cull sheep population, is currently in Phase II. Through the end of FY-2002, samples from 3,269 sheep were submitted to NVSL for testing.

- During FY-2002, a total of 11,751 animals were tested for scrapie, which included 2,711 regular necropsy cases; 1,343 third-eyelid biopsies for the test validation project; 546 third-eyelid biopsies for the regulatory program; and approximately 7,151 animals for Phase I and Phase II of the scrapie slaughter surveillance program.

- APHIS distributed 9.9 million plastic and 6 million metal tags during FY-2002.

Scrapie Outbreak Provides First-Hand Learning Experience in Arizona High School Flock

An outbreak of scrapie in a Tucson, Ariz., high school flock has given students there a chance to learn first-hand how to use a genetics-based strategy to repopulate a flock and whip the disease.

As described in a recent issue of the magazine *Agricultural Research*, scrapie was found in a flock of about 36 Suffolk sheep managed by José A. Bernal, a science teacher at Amphitheater High School in downtown Tucson. Bernal housed the flock at the school's nearby "lamb lab," a facility where students could gain hands-on experience raising the animals for market and learn about science and agriculture.

The first sheep was diagnosed in 1997, and more cases followed. A U.S. Department of Agriculture veterinarian suggested that Bernal contact Dr. Katherine O'Rourke, who was leading a study to decipher the genetic underpinnings of scrapie resistance in sheep at ARS' Animal Disease Research Unit and Washington State University, both located in Pullman, Wash. There, O'Rourke had also helped pioneer development of the third-eyelid test to detect scrapie.

By combining this new, live-animal testing method with sanitation, genetics, and other measures, O'Rourke felt it would be possible to eliminate scrapie from the flock.

Assisted by John V. Duncan, an Animal and Plant Health Inspection Service-Veterinary Services veterinarian from Casper, Wyo., the flock went through live-animal and genotyping tests. Armed with the results, she and Duncan later worked up a genetics-based strategy by which Bernal's class could repopulate their flock and eventually certify it as scrapie free.

For Bernal, it was a golden teach-



USDA-APHIS veterinarian John Duncan draws blood from one of the sheep at Tucson's Amphitheater High School "lamb lab," a facility where students gain hands-on experience.

ing opportunity, despite the stress of losing several sheep and facing the possible closing of the lamb lab.

"Our kids had the opportunity to learn firsthand about scrapie and how you go about identifying diseases," Bernal said. "I always want my kids to work with people like Dr. O'Rourke who are on the cutting-edge of science."

His high school students were among the first to get real-world experience with the third-eyelid test. With this live-animal test, scrapie status of an animal can be determined from a small sample of

lymph tissue snipped from a special membrane covering the sheep's eye, called the third eyelid. Prions collect on this third eyelid, explained Dr. O'Rourke. She helped design a monoclonal antibody that binds to the malformed protein so that it can be identified.

Students also learned about leading edge work with genetic testing. Using polymerase chain reaction (PCR) and other molecular technologies to home in on a specific gene of interest, the students were able to test for variations of a gene that codes for the prion protein. (See page 1 of this newsletter for information about genetic testing for scrapie.)

With genetic testing, producers may soon be able to tip the scales in their flock's favor by checking for the pro-

protective gene in replacement rams. So far, the strategy seems to be working for Bernal's class. Their flock now boasts 35 ewes and two rams and, as of March 2002, the sheep have been deemed scrapie-free by inspectors.

Once again, Bernal's class plans on showing their sheep at the state fair, and he has high hopes they'll become Arizona's "first scrapie-free flock with a protocol in place" for preventing the disease.

"The whole thing is a great story," said Dr. O'Rourke. "It's a small-scale example of what's going on around the country to control scrapie."

Concern Grows About Parasite Resistance

Resistance to dewormers has been documented in sheep and goat flocks around the world. Ohio State University Extension veterinarian Bill Shulaw described a growing concern about such drug resistance during a report to the Sheep and Goat Committee of the United States Animal Health Association during its annual meeting last fall.

"Drug resistance to all the chemical classes of dewormers has also been described in flocks in the United States," he said. "In Ohio, we have documented ivermectin resistance in two flocks of sheep, and we have evidence that our cold winters are no barrier against ivermectin-resistant strains of the *Haemonchus contortus* parasite."

Dr. Shulaw pointed out that no new chemical classes of dewormer are in the drug approval pipeline, and apparently none are even in the planning stages. "We're not likely to receive a new compound to bail us out of this situation," he said.

He also expressed concern that many animals, particularly meat goats, are now moving from areas in the southern U.S., where parasite resistance has been documented, to areas in the north. These animals may bring along resistant parasites, he pointed out.

Management steps. Dr. Shulaw pointed out that some basic steps in small-ruminant management can help solve the resistance problem. Some of these management tools seem tedious and low-tech, he said, but they may be the best answer for dealing with resistance issues.

"We have observed that, although some producers believe that resistance to a particular drug exists on their farm, what has really happened has been failure of their control program resulting in heavy larval contamination of the pastures," he said. Deworming every two to three weeks

may be needed to keep sheep alive.

"The only way to really know if you have drug resistance is to conduct a test," Dr. Shulaw said. The simplest way to test is to collect fecal samples from at least 15 animals prior to treatment, treat the animals, and collect samples from the same animals again 10-14 days following treatment. If resistance is not present, the egg count reduction, expressed in eggs per gram, should be greater than 95%. "If the reduction is 90%, or less, you can safely assume that you are seeing resistance," he said.

He also pointed out how important it is to collect samples from the same animals both times. It is not uncommon for sheep sharing a pasture to produce egg counts that vary widely.

Drug resistance develops as a genetic trait of the worm, similar to the way genetics can change the makeup of a sheep flock. Once genetic resistance is bred into a parasite population, it usually doesn't go away, he said.

Once resistance to a specific dewormer develops, other drugs in that chemical class may also be less effective; this is known as side resistance. There are presently only three drugs licensed by FDA for use in sheep. They are Ivomec Sheep Drench (ivermectin - the avermectin class), Tramisol drench and oblets (levamisole hydrochloride), and Valbazen (albendazole - the benzimidazole class). Many shepherds also have used fenbendazole (Panacur, Safeguard) or thiabendazole (Omnizole or Thibenzole) in the past. If resistance to one of them is present, resistance to albendazole may already be present in the flock.

"All available dewormers in the U.S. today are members of one of these three classes of drugs," Dr. Shulaw said. "If resistance develops to all three chemical classes of dewormers, it may be very difficult to graze sheep on that property."

Resistance develops when worms are exposed frequently to the same drug, especially when there is significant pasture contamination. Although parasitologists disagree about whether drug classes should be rotated annually, continuous use of the same product usually results in resistance over time.

If a flock is large enough, it is possible to test all three chemical classes in a summer by dividing the flock into groups.

Some producers may keep an eye on egg counts each spring, but this is not really a test for drug resistance, according to Dr. Shulaw. "You must know pre-treatment egg counts before you can determine if drug resistance is present. Egg counts may be very low in early spring in ewes, and low egg counts following a worming only tell you that you are not contaminating your pasture."

Controlling parasite populations centers around preventing the overwintered larvae from completing their life cycle by using strategic spring treatments, by treat and move strategies, or by using alternate-species grazing. The ultimate goals are to keep larval contamination on pastures low and to minimize the use of dewormers to avoid selection for drug resistance in the parasites.

A control program based on worm biology, preventive strategies and a monitoring process offers the best hope for cost effective, long-term success, he said.



Dr. Bill Shulaw cautioned producers to use dewormers wisely or parasite resistance can build.

NIAA Special Issue Offer

Breeding for Improvement of Meat Production

The National Institute for Animal Agriculture (NIAA) has announced that a special issue of the *Sheep & Goat Research Journal* is now available on "Breeding for Improvement of Meat Production in Sheep".

Ten manuscripts from scientists at Texas Agricultural Experiment Station, University of California at Davis, Oregon State University, Virginia Polytechnic Institute and State University, U.S. Sheep Experiment Station, and the U.S. Meat Animal Research Center are included in this 60+ page special issue.

Contents include:

- Preface and Overview
- Selection for Reproductive Efficiency
- Genetic and Environmental Impacts on Prenatal Loss
- Lamb Mortality
- Opportunities to Reduce

Seasonality of Breeding in Sheep by Selection

- Strategies for Genetic Improvement of Carcass Value in Lambs
- Relationships Among Traits: Growth Rate, Mature Size, Carcass Composition and Reproduction
- Composite Trait Selection for Improving Lamb Production
- Fundamental Aspects of Crossbreeding of Sheep: Use of Breed Diversity to Improve Efficiency of Meat Production
- Use of Finnsheep Crosses in a Western Commercial Sheep Operation.

Serving as co-editors of this special issue were long-time *Sheep & Goat Research Journal* editor, Dr. Maurice Shelton of the Texas Agricultural Experiment Station, and Dr. Eric Bradford of the

University of California at Davis.

To order a copy of this special issue, send your request and check in the amount of \$25 (U.S.) made payable to National Institute for Animal Agriculture, 1910 Lyda Avenue, Bowling Green, Kentucky, 42104-5809; or, to order by phone with credit card, call 270-782-9798. Shipping is included for all domestic orders. Supplies are limited.

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