Sheep & Goat HEALTH REPORT

A National Institute for Animal Agriculture Publication — SPECIAL ISSUE

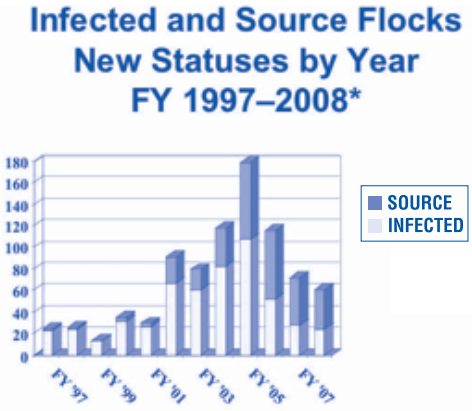
National Scrapie Eradication Program

Working and on Schedule, According to National Coordinator

The accelerated National Scrapie Eradication Program, now starting it's 8th year, is working and proceeding on schedule according to program coordinator, Dr. Diane Sutton, of the U.S. Department of Agriculture's (USDA)/Animal and Plant Health Inspection Service/Veterinary Service (APHIS/VS) at the October annual meeting of the U.S. Animal Health Association (USAHA).

"As a result of industry support and the hard work by our State and Federal personnel," Dr. Sutton said, there has been an 80% decrease in the percent positive black face sheep sampled at slaughter (.98% to .20%) between Fiscal Year (FY) 2003 and FY 2008 (fiscal years run from October 1 to September 30). She also noted that there had been 15% fewer newly infected and source flocks in FY 2008 compared to FY 2007.

Another important step forward



was the USDA approval of a rectal biopsy for the ante-mortem testing of sheep and goats in January 2008. Prior to this year, the only live animal test for scrapie was a biopsy of the third eyelid which is a more difficult procedure.

In the FY that ended in September, a total of 174 cases of scrapie were found, a decrease of 47% from FY 2007. There were 128 scrapie cases from regular necropsy, four from rectal biopsies and two from third eyelid biopsies. These field cases were found for the most part through testing scrapie exposed sheep from infected and source flocks found through slaughter surveillance. The other 40 cases were found through sampling cull sheep as part of RSSS (Regulatory Scrapie Slaughter Surveillance).

According to Dr. Sutton, one of the National Scrapie Eradication Program's (NSEP) top priorities in FY 2009 is to implement the National Scrapie Surveillance Plan (as funding permits) as follows:

- Develop area action plans to meet State-of-Origin sampling and ID compliance targets;

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Inside This Issue...

Canadian Company Works on Possible Blood Test for Scrapie

Amorfix Life Sciences has developed the EP-TSE™ blood test to diagnose scrapie in sheep using Epitope Protection technology and is in the "validation" or testing phase which, if successful will lead to commercialization of the test. There are only two live tests available in the US, both of which require biopsies—of either third eyelid or rectal lymphoid tissue.

Dr. Marty T. Lehto, Associate Director, R&D, Amorfix Life Sciences, Toronto, Canada, explained the new test to members of the Sheep and Goat Committee of the U.S. Animal Health Association at its meeting in October.

He said, "The assay detects aggregated PrP^{Sc} in a plasma sample by blocking the large excess of PrP^{C} by incubation with short-lived and highly reactive chemicals." PrP molecules within prion particles are "protected" from chemical modification, and can then be detected by our ultrasensitive immunoassay following sample disaggregation.

The EP-TSE™ test differentiates scrapie-infected sheep from

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Working and On Schedule

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- Enter into agreements with more low-volume plants to ship heads to a central collection site;
- Improve selection criteria used for white and mottled face sheep and goats;
- Complete and evaluate the live animal surveillance pilot being conducted in Texas.

Another priority for 2009 is the on-going effort to encourage compliance with the mandatory identification requirements of NSEP.

APHIS is also developing, spatial analysis techniques to identify areas within states that have been underrepresented by slaughter surveillance. Data from animals originating from the state of Iowa is being used to evaluate the usefulness of spatial analysis to enhance scrapie surveillance. It is believed that these efforts will assist States and Areas in developing and updating surveillance plans. ■

NATIONAL INSTITUTE FOR ANIMAL AGRICULTURE

Sheep & Goat Health Report

SPECIAL ISSUE

Sheep & Goat Health Report provides the latest information on issues pertinent to sheep & goat health initiatives, strategies, research and regulatory action. It is a communications initiative of the NIAA Sheep & Goat Health Committee and is produced in cooperation with USDA/APHIS. Reprinting is encouraged.

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Canadian Company Blood Test

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normal controls for AA, AV and VV genotypes and for both naturally and experimentally infected animals. Asymptomatic scrapie-infected lambs as young as 17 months of age were detected by the Amorfix EP-TSE™ test. The test can also identify infected lambs before the animals test positive by IHC tests of lymphoreticular tissue. Testing results on two blinded panels from independent sources were presented supporting good sensitivity and specificity of the EP-TSE™ test. The test requires meticulous specimen handling procedures so may be challenging to adapt to routine field use. If evaluations efforts prove successful it will probably be a year or more before a commercial product is available. ■

The Number of Certified Scrapie-Free Flocks Continue to Increase

The Scrapie Flock Certification Program (SFCP) is an important tool to assist producers in meeting requirements to export breeding stock and to provide US producers with a reliable source of breeding animals.

National Scrapie Eradication Coordinator, Dr. Diane Sutton, reports that 1,971 flocks are currently enrolled in the program. Of that number, 1,438 flocks have completed the monitoring phase of the program, while 505 flocks have been certified as scrapie-free.

In June 2007, APHIS revised the SFCP standards to create the export monitored category to insure that US breeding stock could meet the World Organization for Animal Health's guidance to importing countries and to increase the efficacy of the program. This was an important step since three complete monitored certified flocks (0.5% of flocks that have ever been certified) have been designated infected and/or source.

A priority in FY 2009 will be to make modifications to address issues for small flocks in the export monitored category. Currently, small flocks usually don't have enough culled breeding stock to meet the minimum testing requirements of five animals to be tested for scrapie in each two year period in order to participate in the export monitored category. ■

Importing Animals? Read This.

The U.S. government seeks to protect its livestock, poultry and equine industries. As such, the U.S. Department of Agriculture (USDA)/ Animal and Plant Health Inspection Service (APHIS)/ Veterinary Services (VS)/ National Center for Import and Export (NCIE) has developed different processes to be followed regarding the importation of different species of live animals into the United States.

Individuals and companies can learn more about these processes—including guidelines and regulations, permits and certification, and associated user fees—by visiting: *http://www.aphis.usda.gov/import_export/animals/live_animals.shtml*

Information is available at the USDA website for the importation of live animals which is listed by category. Here are the categories specific to sheep:

- Sheep from Canada Feeding
- Sheep from Canada for Slaughter

Note: Sheep for breeding are currently prohibited from Canada. ■

The Latest on Nor98-Like Scrapie

Many Questions Remain Unanswered

A different type of scrapie called Nor98-like scrapie was first identified in the United States in February 2007. Research on Nor98-like scrapie is going on throughout the world; however, many questions remain unanswered. Here is what has been learned so far, according to a paper presented by Dr. Mark Hall at the U.S. Animal Health Association (USAHA) in October.

- Nor98-like scrapie infected sheep are typically older animals—sheep with classical scrapie sheep typically show signs of the disease at 3.5 years of age whereas Nor98-like scrapie is usually found in sheep over 5 years of age sampled for surveillance.
- Clinical signs are rare, but ataxia (loss of muscular coordination) is sometimes seen.
- Diagnosis is based on immunohistochemistry and/or Western Blot.
- Affected flocks have very low incidence of disease (0.2%) and rarely is there more than one animal affected in each flock. This held true for the six cases discovered so far in the U.S., where only one infected animal was found in each flock.
- Nor98-like scrapie can occur in a wide variety of genotypes, including those with "resistant" genotypes (RR at codon171); however, the most susceptible sheep are those with $A_{136}H_{154}Q_{171}$ and/or $A_{136}F_{141}R_{154}Q_{171}$ alleles.
- There is no evidence that any type of scrapie is a threat to humans or animals other than sheep and goats.

The new strain gets its name because it was first discovered in Norway in 1998. It has since been found in many countries including in the offspring of a New Zealand sheep maintained in quarantine in England.

Nor98-like scrapie is not BSE (bovine spongiform encephalopathy) nor is it chronic wasting disease (CWD) in sheep. It has been found in goats in Europe but so far no goats have been diagnosed with Nor98-like scrapie in the U.S. Because the low rate of incidence within flocks and the wide geographic distribution, it is thought that it may be a sporadic disease. Nor98-like scrapie has been transmitted in laboratory tests to mice and sheep, but appears to be either not transmitted or poorly transmitted under natural conditions. The big question is does it occur spontaneously?

The answer to that question, and many other Nor98-like scrapie questions are being sought and will be reported as they become available within the years to come. ■

Johne's in Sheep

Novel Approach for Control in Western Range Flocks

It is a well established fact that Johne's disease affects sheep, but just what to do about it has been a big question—especially when it comes to large western flocks.

Researchers at University of Idaho are working on a solution to that problem and one of their team members, Dr. Marie Bulgin, reviewed the current status of this project at the recent U.S. Animal Health Association (USAHA) annual meeting.

The current diagnostic tests work well in identifying the disease in sheep, but are not practical for large western range flocks which often number in the thousands. The bottom line is that there is a need for accurate, economic, and dependable test(s) to identify clinical and subclinical animals.

- The objective of the Idaho study was to set up a practical, economical plan to control or eradicate Johne's in large range flocks.

Preliminary data suggest that the testing of colostrum and/or milk samples from dams may work as a selection tool for ewe lamb replacements. However, it is not economical or practical to test every sheep in large flocks. Further, even if all ewes were tested, it's not economic to sell every ELISA positive sheep. So for this study, only ewes raising potential replacement ewe lambs were tested using the IDEXX ELISA. Only the youngest (1-3 yrs old) ewes were used to raise replacements to reduce percentage of ewes likely to be positive.

Owners sampled colostrum / milk, of ewes with white faced ewe lambs taken on 2nd day post-partum. ELISA tests were run as soon as possible. (Test results had to be reported to the producer before the ewe and her lamb(s) left the initial holding pen within 2-4 days).

Positive and suspect ewes and their female lambs were identified with ear tags of a unique color. Tagged lambs went to slaughter and tagged ewes in good breeding condition were bred to Suffolk rams the next season to produce slaughter lambs. Ewes losing condition were culled. Only lambs from negative tested ewes were kept for replacements.

While preliminary results look good the study is still underway. "Because Johne's has a long incubation period and signs are seen only late in the disease, we plan to follow these flocks and herds at least five years. That should give us a good idea of how effective this method of detection is going to be," said Dr. Bulgin. "Also, it seems that there might be a difference between goats and sheep," she added.

For more details and information, contact Dr. Bulgin at mbulgin@uidaho.edu or (208) 454-8657. ■

Industry Leaders Agree

Scrapie Eradication is Cost Effective

The current National Scrapie Eradication Program (NSEP), if funded adequately, is the most cost effective way of dealing with the disease according to Paul Rodgers, American Sheep Industry Association (ASI) and James Robb, Livestock Marketing Information Center (LMIC.)

Rodgers presented their joint study at the recent annual meeting of the U.S. Animal Health Association (USAHA).

Rodgers said there were animal health and numerous economic reasons to eradicate scrapie. "Scrapie costs the United States' sheep industry an estimated $25 million annually in death loss and loss of marketability. Scrapie prevention costs are also significant. Closed flocks and movement restrictions limit genetic improvement which is an additional, unmeasured cost. The economic value of the sheep industry was estimated to be $767.5 million in 2007. The current federal investment in scrapie eradication is $3 per head of sheep in the U.S., making the value 43 times the cost at current spending."

The National Accelerated Scrapie Eradication Program began in 2001. Many millions of dollars were spent trying to eradicate scrapie between 1952 and 1992. From 1992-2001 approximately $3 million per year was spent on scrapie control by USDA/APHIS through the Scrapie Flock Certification Program. Ten million dollars in CCC funds was added in 2001 when the accelerated program began. Current spending is approximately $18 million annually.

Rapid, aggressive disease eradication programs are efficient, according to Rodgers and Robb. Federal program disease eradication history proves that low or slow investments made over time ends up costing the public and private sector significantly more. Strong investment in diagnostic tools, animal identification and tracking, and enforcement of compliance with program requirements will increase the return on investment to both the livestock industry and public sector.

In the Sheep and Goat Committee business session, the following resolution was passed. "The United States Animal Health Association (USAHA) urges the United States Department of Agriculture (USDA)/Animal and Plant Health Inspection Service (APHIS)/Veterinary Services (VS) to request adequate funding for the National Scrapie Eradication Program's budget to achieve eradication and conduct subsequent surveillance. This amount is equal to $10 million beyond the Fiscal Year 2007 appropriation or a total budget of $28.6 million annually adjusted for inflation."

In the Future

Producers May Have a New Tool to Fight OPP

In the not too distant future, sheep producers may have a genetic tool to fight the costly, common sheep virus, Ovine Progressive Pneumonia (OPPV.) This is according to a paper given by Dr. Stephen White of the U.S. Department of Agriculture's Agricultural Research Service (USDA/ARS) Animal Disease Laboratory in Pullman, Washington.

Dr. Stephen White

In presenting the research that he and his team are doing, Dr. White compared their work to that which was done on scrapie more than a decade ago. "Once it was discovered that certain sheep carried a gene that made them resistant to classical scrapie, then by using a DNA test, producers could use that test as a tool to begin building scrapie-resistant flocks."

As in scrapie, producers one day may be able to cull sheep that are more susceptible to the OPPV and breed animals that carry some genetic resistance. This is called "DNA Marker-Assisted Selection".

Dr. White reported that their research has found a flock with some animals that have partial genetic resistance to OPPV. These sheep have two copies of a special version of the CCR5 gene that dials down gene expression substantially. "We are now in the process of 'validating' these results by testing whether different flocks of sheep also show better containment of the virus based on the CCR5 gene."

"We expect the validation to take approximately a year's time," Dr. White said. "Assuming, we are able to validate this more broadly in other flocks—and it looks like we will be able to do that—then we will enter the research phase, we want to make sure that in breeding for the OPPV resistant gene, that we don't lose

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NIAA 2009 Annual Meeting - *The Changing Face of Animal Agriculture*

The dates, location and theme for the 2009 National Institute for Animal Agriculture (NIAA) annual meeting has been set, and individuals involved in animal agriculture–the beef, dairy, swine, goat, sheep, equine and poultry industries–are encouraged to attend and participate in the two-day event. *The dates:* **March 31-April 1**. *The location:* **The Galt House Hotel and Suites in Louisville, Kentucky.** *The theme:* **The Changing Face of Animal Agriculture.**

Registration for the two-day event is **$450**, with a **$50** discount if you register before **February 20**. Additional discounts are available to NIAA full members and affiliate members along with a New Member incentive. To learn more about the NIAA's '09 annual meeting or to register for the meeting, please visit ***www.animalagriculture.org***, call 270.782.9798 or fax 270.782.0188. ■

Implement Preventive Steps to Lessen Spontaneous Abortions

The challenge: Toxoplasmosis is the No. 1 cause of spontaneous abortions, and there are no vaccines to help prevent Toxoplasmosis. A helpful solution: Implement preventive measures to help prevent and control this abortion challenge.

"Toxoplasmosis (caused by the protozoan parasite *Toxoplasma gondii*) can be prevented since it is spread by kitten poop," states Dr. Marie Bulgin, Caine Veterinary Teaching Center, University of Idaho.

"Since one of the favorite bathroom facilities for half-grown barn kittens is the grain bin or feed trough, it is not difficult to imagine how the bacteria are passed to ewes/does."

Research shows that at least one-third of all cats in the United States carry Toxoplasmosis oocysts, and about 1 percent of cats in the population are found to be shedding oocysts at any given time. Cats, especially kittens under six months of age, pass the oocysts in their feces when they eat infected rodents, raw meat, or placentas of Toxoplasmosis-infected animals.

Although adult cats tend to be immune to Toxoplasmosis and free of the bacteria, kittens under the age of six months pass the oocysts in their feces when they eat infected rodents, raw meat or placentas of toxomplasmosis-infected animals. That said, adult cats can come into play with the spread of Toxoplasmosis oocysts when they bring back infected birds, rabbits and small rodents to their kittens.

Oocyst Shedding

Although oocysts are shed for only about one or two weeks in the life of the cat, research shows that the enormous numbers shed assure widespread contamination of the environment.

Under experimental conditions, researchers have found that infected cats can shed oocysts after re-inoculation with tissue cysts. It is not known whether repeated shedding of oocysts occurs in nature, but researchers point out that this would greatly facilitate oocyst spread.

Sporulated oocysts survive for long periods under most ordinary

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Implement Preventive Steps

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environmental conditions--surviving in moist soil, for example, for months and even years. Oocysts in soil do not always remain in the soil as invertebrates such as flies, cockroaches, dung beetles and earthworms can mechanically spread these oocysts and even carry them onto food.

Congenital infection can occur in cats, and congenitally infected kittens can excrete oocysts, providing another source of oocysts for contamination.

Infection rates in cats reflect the rate of infection in local avian and rodent populations because cats are thought to become infected by eating these animals. The more oocysts there are in the environment, the more likely it is that prey animals will become infected, and this results in increased infection rates in cats.

The parasite enters the body through the small intestine and nearby lymph nodes, then spreads throughout the sheep or goat's system via the bloodstream.

Toxoplasma gondii can be encysted for years in the sheep/goat's brain, muscles, liver or other vital organs. Some resistance to future infection (immunity) is usually acquired by previously-infected ewes/does.

Toxoplasmosis-caused abortions usually—but not always—occur during the first half of gestation. Once the pregnant ewe/doe has been infected, it takes about two weeks for the parasite to infiltrate the placenta and kill the fetuses.

Blood tests can be performed on ewes/does immediately after they have aborted. But, a ewe or doe can test positive for Toxoplasmosis for years after becoming infected.

Ed Lehigh of Colorado Serum Company notes that it is easier to prove that the cause was not this protozoan by obtaining a negative serological (blood) reading.

"It is reasonable to conclude that any doe testing positive for Toxoplasmosis as long as six months after she has aborted is still highly infected with the disease and therefore is a threat to the other animals in the herd," he states.

Although aborted placentas can be tested, getting accurate results can be difficult. Lehigh points out that the longer a ewe or doe was infected before she aborted, the easier it is to determine if Toxoplasmosis was the cause. He also maintains that, because most producers have no idea when the actual infection took place, placental testing is less helpful than blood testing.

A fetal blood test is available and works best during the last half of the pregnancy. If the fetus is infected when quite young, antibodies may not appear in the blood, but it could still be harboring Toxoplasmosis.

Prevention

To help prevent Toxoplasmosis, Dr. Bulgin suggests keeping kittens out of the barn and feeders during the late pregnancy period of ewes. She also recommends feeding Rumensin of monensin during the last six weeks of pregnancy as this will prevent the toxo cysts from hatching and infecting the tissues, including the fetus and placenta of the ewe.

Other steps that can be taken to help reduce the spread of Toxoplasmosis include keeping feed, grain and hay away from cat feces; neutering/spaying all adult cats; and immediately getting rid of cat feces since the disease-causing organism "comes alive" after a 24-hour period. Another preventive measure is carefully placing containers of rat bait to keep the rodent populations as low as possible. Relying on cats to keep the rodent population down is a Catch-22 as such action could compound the potential of introducing Toxoplasmosis to your sheep, goats and cats. ■

New Tool

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good traits," he explains.

So when will sheep producers have this as a practical tool? "Theoretically, as soon as we finish the validation phase sometime during 2009, DNA testing for OPPV could begin. As a practical matter, it is likely to be several years before the test is widely used as a breeding selection tool," Dr. White concludes.

In addition to Dr. White, other members of the OPPV research team include Dr. Lynn Herrmann-Hoesing and Jim Reynolds of ADRU, and Drs. Michelle Mousel and Greg Lewis of the U.S. Sheep Experiment Station. ■

English and Spanish Materials are Now Available!

Recently, educational materials of the National Scrapie Eradication Program (NSEP) have been revised and are now available in both English and Spanish.

Revised materials are: **Goat Identification: Visual and Electronic** (PowerPoint Presentation), **Identification Requirements of the National Scrapie Eradication Program for Sheep** (PowerPoint Presentation), **National Scrapie Eradication Program Record Guide, The Use of Genetics to Control Scrapie** (PowerPoint Presentation), and **What You as a Producer Need to Know**.

Spanish materials available are: **What You as a Producer Need to Know, The ABCs of Genetic Based Flock Clean-up and Monitoring Plans, Requirements for Going to "The Show"**.

Go to ***www.eradicatescrapie.org***, the official website of the NSEP, and place your order today or call NIAA at 270.782.9798.

Wormer Resistance Not Just a Problem in the South

Preliminary data from the University of Minnesota suggests that producers in the Midwest should be aware of the resistance status of the parasites in their herd or flock, according to a paper presented by Kate O'Conor, a third year student at the University of Minnesota's College of Veterinary Medicine, at the recent U.S. Animal Health Association (USAHA) annual meeting.

O'Conor pointed out that although anthelmintic resistance is a known problem in the southern and southeastern United States, there has been very little study of the prevalence of resistant parasites in the rest of the country. Therefore, a better understanding of the drug resistance profiles of gastrointestinal parasites such as *Haemonchus contortus* in small ruminant flocks and herds in Minnesota will allow producers and their veterinarians to make more informed decisions about their deworming protocols and management practices.

Some animals in the Upper Midwest have been transported from the Southeast and are a source of potentially resistant parasites. But an even bigger risk factor that

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Biosecurity Risk Assessment Chart for Visitors

While visitors to a farm or operation are often welcomed or even necessary, every person stepping onto a farm or operation can be a biosecurity risk. The degree of biosecurity risk depends on the person—family friend, neighbor, fellow producer, veterinarian, employee, feed deliver person, extension agent, foreign guest, etc.— and his or her habits, travels and business.

Upon arriving at the farm or business enterprise, each visitor should check in at the house or office upon arrival and be classified as a low risk (low farm, low animal contact), medium risk (high farm, low animal contact) or high risk (high farm, high animal contact). The accompanying chart can help you ascertain each visitor's biosecurity risk.

No visitor should be allowed to bring along a dog or other pet and all visitors should be required to wear clean clothing and boots or have disposables or guest clothing and boots available for them onsite. ■

Activity	Low Risk	Moderate Risk	High Risk
Other farm visits per day.	One farm, little to no animal contact.	Occasionally visits more than one farm/day, minimal animal contact.	Visits many farms or livestock facilities. Much animal contact.
Ownership of similar animals.	Does not own similar species at home.	Similar species at home but different production type.	Owns and/or cares for similar species and production type at home.
Contact with potentially ill or infectious animals.	Minimal or no contact with potentially ill or infectious animals.	Contact with healthy animals but avoids contact with potentially infectious animals.	May own or be exposed to many animals of unknown or poor health status.
Use of protective clothing.	Wears sanitized shoes or boots. One pair of coveralls per site.	Wears sanitized boots and clean coveralls. If clean, may not change coveralls.	Does not wear boots or protective clothing or wears same clothing between farms.
Leaves or borrows supplies, equipment	Supplies and equipment kept away from animals or feed areas.	Supplies and equipment in areas of minimal animal or feed contact.	Supplies and equipment may be left in animal or feed areas.
Work in animal contact areas	Does not work in areas with highly susceptible animals.	Minimal exposure to high-risk animals and only with protective clothing.	Works with highly susceptible animals. Few precautions taken.
Biosecurity knowledge	Understands and promotes biosecurity practices.	Exposed to biosecurity principles but is not an advocate.	Little appreciation for biosecurity principles and does not view it as important to the industry.
Foreign travel	Does not travel outside of the U.S. or Canada.	Limited travel outside the U.S. or Canada, with minimal or no animal contact.	Travel to foreign countries, with animal contact in those countries.
Foreign visitors	Prohibits foreign visitors contact with feed or animals.	Foreign visitors allowed in animal or feed areas following adequate quarantine.	Visitors are permitted in animal or feed areas without screening or quarantine.

(Adapted from Pennsylvania State University Cooperative Extension Bulletin and Mississippi State University Extension Service Bulletin)

Wormer Resistance

(cont'd from page 7)

increases the chances of developing anthelmintic resistance include underdosing, either due to faulty equipment or underestimating the weight of each animal. Dosing guns should be checked to make sure they are dispensing the correct amount of dewormer, and the dose should be delivered over the back of the tongue to ensure that the entire amount enters the rumen where the drug is most effective.

Goats in particular present difficulties in the management of gastrointestinal parasites, according to O'Conor. The selection of approved anthelmintics is limited, and the dosages recommended by Dr. Ray Kaplan at the University of Georgia are twice the label dose for cattle with the exception of levamisole. This drug would be toxic at 2x dosages, and 1.5x is recommended. Since the effective compounds and doses are off-label, it is vital that veterinarians work with producers to design parasite control programs for goats.

She reminds everyone that it's important to remember that the anthelmintic resistance exists in the population of worms on a given farm. Each farm is different and the parasite control program will need to be modified for the needs of each location. Part of the worm population is found in the animals, but a large portion of the population is found on the ground, as eggs or larvae. Although it seems counter-intuitive, moving animals that have just been dewormed to a completely clean pasture means that all of the eggs shed onto the new pasture are from resistant worms. So in most cases, it is advisable to not move to 'clean' ground post-deworming as parasite resistance is slowed when non-resistant and resistant worms can mate with each other.

"In any given herd or flock, 70-80% of the animals will have little to no worm burden, while the rest of the group will harbor the majority of the adult worms and shed the largest number of parasite eggs," said O'Conor. "The individuals with a large worm burden should be identified through a fecal egg count such as a modified McMasters test or an indirect measure such as FAMACHA (an eye color chart). Treating only the most heavily parasitized animals maintains a population of worms that have never been exposed to anthelmintics, called a refugia."

For excellent information on anthelmintic resistance in small ruminants, how to prolong the efficacy of anthelmintic compounds and alternative methods of parasite control, visit the Southern Consortium for Small Ruminant Parasite Control at *www.scsrpc.org*. ■

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