

REPORT OF THE USAHA COMMITTEE ON SHEEP AND GOATS

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The Committee met on October 18, 2016 at the Sheraton Greensboro Hotel in Greensboro, North Carolina from 1:00 p.m. to 5:54 p.m. There were nine members and 33 guests present. All present were encouraged to sign in and if not a member of the committee, indicate if interested in becoming a member.

Presentations and Reports

***Brucella ovis*: Seroprevalence in U.S. Sheep Flocks**

Kerry Sondgeroth, Wyoming State Veterinary Laboratory

Brucella ovis (*B. ovis*) is a gram negative bacterial pathogen that is present in most major sheep-producing regions of the world. Infection is introduced into a flock through an infected ram, and historically is associated with epididymitis. However, less than half of infected rams have palpable clinical abnormalities of the epididymis, so if blood testing is not being utilized as part of the breeding soundness exam, *B. ovis* infection can persist. The implications of *B. ovis* infection for the flock include: ram infertility, decreased ewe conception rates, more abortions in pregnant ewes, and higher numbers of premature lambs. *B. ovis* has direct negative effects on lamb production, and is of major concern for sheep producers as lamb production accounts for approximately 35% of gross sales. The effect of *B. ovis* infection is not only economic, valuable genetics are also lost when infected rams are culled from the flock.

Infection spreads throughout a flock of sheep by multiple routes. Most commonly, transmission of *B. ovis* occurs via direct contact between rams, but can also be transmitted via the ewe when multiple rams mate with the same ewe during the breeding season. Clinical detection of the organism includes bacterial culture of infected tissues, but this is not a practical ante-mortem test. Serology can be used to detect exposure, and is variably used for males as part of the breeding soundness exam. While ewes are not typically tested, there is evidence that they can harbor the bacteria for multiple estrus cycles and be a source of ram re-infection. Additionally, some infected rams do not develop antibodies, and by testing the ewes, an infected but sero-negative ram would be identified. The enzyme-linked immunosorbent assay (ELISA) is utilized by most veterinary diagnostic laboratories in the United States that test for *B. ovis*.

A national study on the seroprevalence of *B. ovis* in sheep flocks, has not been performed in the United States. The NAHMS 2001 sera will not only provide historical data on the prevalence of this disease in the U.S., but also evaluate risk factors that are associated with infection (i.e. flock size, location, management system, etc.). Since *B. ovis* negatively impacts sheep production, this information is valuable to producers in order to increase the health of their animals and increase economic return.

The overall objective of this study is to determine the seroprevalence and risk factors associated with *B. ovis* in sheep flocks across the United States utilizing the National Animal Health Monitoring System (NAHMS) 2001 serum samples. The following objectives will be addressed:

- 1) Determine historical seroprevalence of *Brucella ovis* from samples collected from domestic sheep in 2001 using the National Veterinary Services Laboratory (NVSL), ELISA. Since there are not widespread control programs for *B. ovis*, the national seroprevalence estimates will likely remain unchanged from 2001.
- 2) Compare seroprevalence between 2001 samples and the more recent (2015/2016) samples collected in Wyoming as part of another *B. ovis* project.

Validation of a rBP26-based Commercial *Brucella ovis* Antibody ELISA

SA Hines, AL Grimm, CB Bandaranayaka-Mudiyanselage, and CJ Chung, Veterinary Medical Research and Development (VMRD)

Accurate and consistent serologic diagnosis of *Brucella ovis* has been a historic challenge for the sheep industry, one that has been identified and described previously by several USAHA Resolutions. This challenge can result in significant effects on trade and complicate successful flock management. The enzyme-linked immunosorbent assay components currently used for diagnosis in the United States are supplied to testing laboratories by the USDA, Veterinary Services (VS) National Veterinary Services Laboratory (NVSL). These components are not assembled into a standardized kit, however, and discrepant results can subsequently occur based on individual laboratory variation in procedures such as plate coating. To address this issue and provide a consistent commercial product, VMRD has developed an antibody ELISA utilizing recombinant *B. ovis* BP26 protein. This assay has been validated with over 450 samples characterized by the NVSL assay and western blot, with the goal of improving specificity and resolution as well as minimizing variation in results between laboratories. This should also serve to address the problematic "indeterminate" sample range found with the current testing method. Overall, an improved, standardized commercial ELISA will facilitate appropriate and precise management of sheep flocks to prevent unnecessary economic loss. The presentation can be found at http://www.usaha.org/Portals/6/3Hines-Brucella%20ovis%20USAHA%20final_Sheep.pdf.

No Kidding: Connecticut's Largest Outbreak of Human *E.coli* O157 Infections Linked to a Goat Dairy Farm

Kelly Gambino-Shirley, Centers for Disease Control and Prevention (CDC)

Dr. Gambino-Shirley discussed an investigation initiated by the Connecticut Departments of Public Health and Agriculture, CDC, and the local health district on an outbreak of human *Escherichia coli* O157 infections linked to a goat dairy farm. In addition, she discussed recommendations to prevent further illnesses when individuals have contact with animals, such as goats, and their environment. The presentation can be found at http://www.usaha.org/Portals/6/4Gambino-Shirley_USAHA_Final.pdf.

Caprine Uterine Amyloid Syndrome: Clinical and Pathologic Features of Abortion and Fetal Death

Joan Dean Rowe and Leslie W. Woods, University of California, Davis

An apparent increase in abortion of multiparous dairy goat does in several Northern California herds was noted by in 2010 and has continued. Detailed complete herd diagnostic and reproductive data were available from one of the affected herds. In that herd, with 22-29 kiddings per year, crude annual herd abortion rates ranged from 0 to 3.4% in the 4 years preceding the outbreak, and 4.5 to 27.3% in the 7 years since the outbreak began. Does that kidded in years 2010 and later had 10.88 (2.47, 47.96 95%CI) the odds of aborting or having term stillbirth/mummies compared to does kidding previous to 2010. Of 26 abortions in the herd, 1 doe aborted at 80 gestation days, 14 does aborted at 100-120 gestation days, 7 does aborted at 130-140 gestation days, and 4 does went to term with stillbirths or mummies only. Does in third or greater gestation had 11.6 (2.6, 51.4 95%CI) the odds of aborting or having term stillbirths or mummies compared to first gestation does, while second gestation does' risk was not significantly higher than first gestation does (OR=1.88; 0.25, 13.9 95%CI). The proportion of abortions attributable to amyloidosis could not be determined for all years, but in 2016 caruncular tissue was available by necropsy or biopsy on all aborting does; uterine amyloidosis was confirmed in all six cases of abortion in the herd.

Seventeen cases of abortion associated with caruncular amyloidosis have been submitted to the California Animal Health and Food Safety (CAHFS) Laboratory since it was recognized in 2012, including one retrospective diagnosis from 2010. Cases have been diagnosed in four different herds and in Toggenburg, Saanen and LaMancha goats. Amyloid is typically demonstrated in the interstitium of the caruncle when the doe or caruncular biopsy is submitted or there are some fragments of caruncle remaining in the expelled placenta. Full diagnostic workups on the fetuses have included: aerobic culture of the lung, liver, and abomasal fluid, culture for *Campylobacter* sp. on abomasal fluid and liver, gram stain and darkfield on abomasal fluid, PCR on kidney for *Leptospira interrogans*, serologic testing for *Leptospira interrogans*, bluetongue virus, *Coxiella burnetii*, *Toxoplasma gondii* and *Brucella melitensis*, histopathology and immunohistochemistry for *Chlamydophila* sp. and *Coxiella burnetii*. Diagnostic workup on the does have included: aerobic culture on uterus, lung and liver, culture for *Ureaplasma* sp., fecal flotation, heavy metal screen including selenium, congo red stain and immunohistochemistry for *Chlamydophila* sp. and *Coxiella burnetii* on placentomes and serologic testing for caprine arthritis

encephalitis virus, *Corynebacterium pseudotuberculosis* and *Leptospira interrogans*. There have been no consistent diagnostic test results on full examination of the does or fetuses thus far. Pathology on the fetuses include: leukoencephalomalacia and mineralization of the brain in fetuses from 10 cases, myocardial necrosis in 4 cases of the 17 cases. In addition to the caruncular amyloidosis, nonsuppurative endometritis is the most frequent finding in the does. Amyloid in the caruncles has been identified as serum amyloid A 3 which is locally produced in the uterus. This serum amyloid 3 protein has not previously been reported as a cause of amyloidosis until now.

Does aborting with uterine amyloidosis do not show signs of illness and so does are not usually submitted for necropsy, making diagnosis of uterine amyloidosis difficult. Caruncular biopsy is possible at the time of abortion and can increase likelihood of diagnosis. Minimal uterine discharge is present at time of abortion, making observation of abortion and submission of fetuses and placenta difficult, and placentas are usually retained. Detection of fetal death by ultrasound monitoring of pregnancy can help predict abortions in the herd and increase the ability to attain maternal and fetal diagnostic samples. Caprine uterine amyloid syndrome is a significant cause of abortion/fetal death in the herds examined. Further work is needed to understand the underlying cause of the amyloid production in the uterine caruncle and identify potential pathogens that may be responsible for this disease.

References

2013. Sigurdson C. Amyloidosis in the Uterus of Goats. In: Proc 117th Meeting United States Animal Health Association Report of Committee on Sheep and Goats, p346, San Diego, CA. October 17-23.
2015. Gaffney PM, Barr B, Rowe JD, et al. Protein profiling of isolated uterine AA amyloidosis causing fetal death in goats. FASEB 29(3) 911-919.

Medically Important Antimicrobials in Animal Agriculture

Mike Murphy, U.S. Food and Drug Administration

Dr. Murphy's presentation summarized policy and rule changes regarding the use of medically important antibiotics in food-producing animals. The presentation can be found at <http://www.usaha.org/Portals/6/1Updated%20VFD%20Web%20Slide%20Set%20modification%20Nov%2017th%202016.pdf>.

Emergence and Predominance of a Hypervirulent Tetracycline-resistant *Campylobacter Jejuni* Clone as a Major Cause of Sheep Abortion in the United States

Paul J. Plummer, Michael J. Yaeger, and Qijing Zhang

Presented by Orhan Sahin, Iowa State University

Abortion in ewes causes significant economic losses to sheep industry. *Campylobacter* infection is one of the most prevalent causes of infectious ovine abortion worldwide. Historically, *Campylobacter fetus* subsp. *fetus* (*C. fetus*) accounted for the majority of the *Campylobacter* species associated with sheep abortion worldwide, but recent studies have indicated a clear trend for *Campylobacter jejuni* as increasingly prevalent in some parts of the world. In the United States, the species shift (from *C. fetus* to *C. jejuni*) occurred during the early 1980, and by late 1980s and 1990s, *C. jejuni* became the predominant species causing sheep abortion. This species shift is further confirmed by our recent studies, in which more than 90% of the *Campylobacter* isolates from ovine abortions occurred on different lambing seasons and farms located in IA, CA, ID, OR, NV, and SD during 2003-2011 were identified as *C. jejuni*. Strikingly, genotype analysis of these *C. jejuni* strains indicated that majority (91%) belonged to a single genetic clone (named clone SA, for sheep abortion). This finding represents a paradigm shift, considering the fact that sheep carry heterogenic *Campylobacter* strains in the bile and the intestine and that genetically diverse strains of *Campylobacter* were traditionally associated with sheep abortion. Interestingly, all clone SA isolates were found to be resistant to tetracycline, the only class of antibiotics approved for control and prevention of *Campylobacter* abortion in sheep in the United States. We confirmed the hypervirulence of clone SA in abortion induction in a pregnant guinea pig model. In addition, clone SA was shown to be associated with human foodborne infections, causing mainly gastroenteritis. In contrast to the situation in the United States, *C. fetus* continues to be the major cause of *Campylobacter*-associated abortion in sheep in New Zealand and Great Britain, where both *C. fetus* and *C. jejuni* abortion isolates are of multiple genotypes and not predominated by a single clone. Notably, the Great Britain *C. jejuni* abortion isolates are essentially susceptible to tetracycline (as opposed to the universal tetracycline resistance in the U.S. strains), which could be associated with the common use of

tetracyclines for control of sheep abortions in the United States but not Great Britain. These results suggest that tetracyclines are no longer effective in the treatment of abortion storms caused by *Campylobacter* in the United States, corroborating the anecdotal evidence for the ineffectiveness of these drugs against *Campylobacter* abortions as observed by veterinary practitioners.

The presentation is available on the Committee web page.

Genetics Update

Stephen White, USDA, Agricultural Research Service (ARS), Animal Disease Research Unit (ADRU)

The major histocompatibility complex (MHC) is a cluster of genes known for immunological functions but it also includes some non-immunological genes. One important classical MHC gene is DRB1, which has been associated with many infectious disease traits in sheep. However, its relationship to sheep production has not been well-studied. For example, to our knowledge no studies have examined DRB1 in connection with ewe lifetime prolificacy traits. Therefore, this study analyzed association between DRB1 and production traits including individual growth and ewe lifetime prolificacy in U.S. sheep. A specific combination of markers in the DRB1 gene (*0404 and *0141 haplotypes) were associated with growth traits like weaning weight, mature weight, and average daily gain, as well as lifetime total number of lambs born to an ewe. These results suggest there is at least one functional mutation in or near the DRB1 gene that influences growth and prolificacy traits. While there have been other reports of genetic association with growth traits, to our knowledge this is the first report of an association between any gene on ovine chromosome 20 and ewe lifetime prolificacy. These data will spur additional mutation discovery work by comparison of haplotypes *0404 and *0141, and may lead to improvements in sheep breeding for growth and reproductive performance balanced with susceptibility to infectious disease. Furthermore, such association data in the important MHC gene DRB1 highlight the need to test production traits for genetic markers associated with infectious disease susceptibility to avoid undesirable correlated responses to selection.

PPR Global Eradication Program (GEP)

Buona Diop, FAO

Peste des petits ruminants (PPR), or sheep and goat plague, is a destructive, fast spreading viral disease that kills sheep and goats (referred to as small ruminants) and devastates livelihoods throughout most of Africa, the Middle East, West, Central and South Asia, and most recently East Asia. The PPR situation is dynamic and threatening. In 2016, the disease was reported for the first time in Georgia and Mongolia. Sheep and goats (2.1 billion heads worldwide) are the primary livestock resource of many low-income, food-insecure rural families worldwide. They are reared within a variety of production systems and provide milk, meat, wool, fibre (cashmere and angora, and skins). They also support the livelihoods of traders, processors, wholesalers, and retailers involved in local, national, regional and international trade of live animals and their products.

The annual global losses due to PPR have been estimated at between US\$ 1.4 billion to US\$ 2.1 billion. PPR's impact on sheep and goat populations adversely affects livelihoods, food security, and employment, including for women and youth. It both entrenches and exacerbates poverty and malnutrition.

Based on the experience of the successful eradication of Rinderpest in 2011 through a massive global effort spearheaded by FAO and OIE, PPR was identified as the most suitable and feasible animal disease to next be targeted for global eradication. The global eradication of PPR is readily achievable provided sufficient political, financial and technical investment. PPR is readily diagnosed and there is a reliable, inexpensive vaccine available that confers life-long immunity in vaccinated animals. In addition, there are no latent carrier states or wildlife reservoirs for PPR which simplifies the eradication efforts.

The PPR GEP aims to eradicate PPR by 2030, greatly contributing to small ruminant production for a growing world population, estimated to be 9.7 billion by 2050. Consumption of small ruminant meat and dairy products is forecast to increase by 1.7 million metric tonnes and 1.8 million metric tonnes per year respectively. In a recent benefit-cost analysis of global PPR eradication, the ratio is estimated at 33.8. Investing in PPR eradication will pay for itself many times over as a contribution to improving the lives of the world's most vulnerable pastoral and rural communities (over 300 million rural families). The PPR-GEP will contribute to the 2030 Agenda for Sustainable Development, supporting the achievement of

many of the Sustainable Development Goals. The PPR global eradication effort is framed as a 15-year process running through to 2030, divided into three five year phases. The first five years of activities are important catalysts to support and target the control and eradication achievements set forth in the Global Strategy, particularly in affected and at risk countries. The 62 countries (as of September 2016), that report infection with PPR and the 14 suspected of being infected or at risk are the major focus of the PPR GEP (total of 76 countries). The PPR GEP objectives for the first five-year phase are to:

- lay the foundation for and commence the eradication of PPR by reducing its prevalence in currently infected countries.
- develop capacity for non-infected countries to demonstrate the absence of PPR virus as a basis for official recognition of PPR free status by the OIE.
- strengthen national Veterinary Services (VS) and their systems as the key players in the successful implementation of the PPR GEP.
- where appropriate support activities to reduce the prevalence of other priority small ruminant diseases.

The program approach comprises a multi-country, multi-stage process involving assessment, control, eradication and maintenance (of PPR virus freedom) stages. The four stages described in the PPR, Global Control and Eradication Strategy (GCES) correspond to a combination of decreasing levels of epidemiological risk and corresponding levels of prevention and control.

Key components of the program:

- Building an enabling environment for PPR GEP implementation: logical and structured framework, full support and involvement of farmers, the adaptation of the legal framework, and the strengthening of Veterinary Services.
- Support efforts to better understand the presence (or possibly the absence) of PPR in a country or region, its distribution among the different farming systems, the patterns of spread and, ultimately, to establish a decisive control plan based on the information acquired. This requires both an assessment of the epidemiological situation and establishment of a functional surveillance system.
- Implement measures toward PPR eradication: different measures will be combined namely vaccination, improved biosecurity, animal identification, movement control, quarantine and stamping out. Vaccination will play a vital role. Depending on the assessment and surveillance data, the total number of animals to be vaccinated during the programme is estimated at around 1.5 billion. The 79 countries historically free from PPR will be assisted to prepare their dossiers to apply for OIE PPR free status on a historical basis.
- Functional coordination mechanisms established at global, regional and country levels will ensure successful implementation of the programme. The FAO/OIE PPR Global Secretariat established in Rome will insure coordination with regional and national stakeholders.

The estimated budget for the five-year programme is around: US\$996 Million.

By improving the livelihoods and increasing the resilience of hundreds of millions of the world's poorest people, PPR eradication is a key contributor to sustainable development and building peace through security in some of the most vulnerable and unstable regions on Earth. In this regard, the broad international consensus and political support, the high rates of return of investment in disease eradication, which spans generations, and the proven FAO-OIE partnership, are strong guarantees of success.

***Mycoplasma ovis*: Investigating an Under-Recognized Sheep Pathogen in the United States**

Margaret Highland, USDA, Agricultural Research Service (ARS), Animal Disease Research Unit (ADRU)

Mycoplasma ovis, referred to as *Eperythrozoon ovis* prior to 2004, is an erythrocytic agent with worldwide distribution that is reported to infect sheep, goats, deer, and reindeer. Transmission of this

bacterium is currently known to occur via biting insects or iatrogenically (i.e. reusing needles). Attachment to the surface of the host's red blood cells can cause hemolytic anemia, particularly in acute infections or during bouts of high bacterial loads in chronically infected hosts. Sequelae to infection can also include jaundice, submandibular edema ("bottle jaw") and weight loss, in addition to anemia. Personal observation of infection in lambs also indicates that infection can cause ill-thrift (poor weight gain and stunted growth) and may be associated with bouts of transient diarrhea. Often though, infected animals show no overt signs of clinical disease and consequences of subclinical infection with this microbe have yet to be thoroughly investigated. The vast majority of research reporting the importance of *M. ovis* as a relevant pathogen in domestic sheep has been done in Australia, with fewer publications and reports from other countries, including New Zealand, Turkey, Norway, and Japan.

We are currently investigating the prevalence and distribution of the bacterium in sheep within the U.S. and impacts of infection on health and production. Work in our laboratory has shown that *M. ovis* can be detected by standard polymerase chain reaction (PCR) from deoxyribonucleic acid (DNA) isolated from fresh or frozen-thawed whole blood and from frozen-thawed sera or plasma. In order to investigate the prevalence and distribution of *M. ovis* in the U.S., we tested sheep serum collected from 22 states during 2001 and 2011 by the USDA, Animal and Plant Health Inspection Service (APHIS), National Animal Health Monitoring System (NAHMS) Program Unit. Results indicate that *M. ovis* is widespread across the U.S., with an overall prevalence of 24.5% in 7,391 sheep sampled in 2001 and 30.2% in 12,506 sheep sampled in 2011. Collaborative efforts with the USDA, Agricultural Research Service (ARS) Range Sheep Production Efficiency Research Unit at the U.S. Experimental Sheep Station in Dubois, Idaho are ongoing and to date we have collected and tested blood samples from sheep of all ages over the last two years. Ongoing analyses include investigating prevalence (seasonal and age), effects of infection on production, and transplacental transmission.

Committee Business:

The committee reviewed the status of resolutions from the previous year. Four new resolutions were discussed and approved. Resolution topics included ensuring sound animal health policies, continued availability of plastic scrapie tags, goat genetic resistance to scrapie and laboratory approval for regulatory diseases.

There being no further business to come before the committee, a motion to adjourn was accepted at 6:54 p.m.