Editorial

I’d like to welcome Mary VanderKop back as co-editor of the Animal Health Forum newsletter.

Mary was instrumental in launching the Animal Health Forum and was one of the original editors in 1996. She recently completed her thesis defense for her M.Sc. in Public Health Science from the University of Alberta. Her epidemiology research was on Campylobacter jejuni in broilers and retail chicken. Congratulations Mary! Welcome aboard.

I’d also like to thank Ron Clarke for co-editing the newsletter for the past few issues. I’ve enjoyed working with Ron. As section head of Livestock Health for Market Access, Ron is keeping very busy these days. We look forward to his continued contributions to the newsletter.

Lynne Becker

Commentary

In Pursuit of Quality Lab Results
Ken Manninen, Agri-Food Laboratories Branch, Edmonton AB

The BSE situation reminds us of how dependent we are on the international agricultural market place. While the Canadian public rallied behind the industry and maintained their trust in the safety of Canadian beef, the same cannot be said of our trading partners. Politics aside, regaining the confidence of the international trading community will require increased surveillance data to provide evidence that a single positive animal was not the tip of the iceberg, but was an isolated occurrence. Increased laboratory testing will be an integral part of providing this evidence. Not only must the numbers be there to allay our trading partners’ concerns, they also need to know the data can be trusted.

Throughout our history as an animal health laboratory, our training, competence and integrity have been the basis for trust in our results. Indeed there was a time when results coming from a government lab were trusted, without question. Those days are over. Evidence of the quality of results is now expected. We now must be prepared to comprehensively answer the question, ‘How can you be sure?’ upon presentation of information that we claim is developed from quality test results.
The variety of lab tests for most risk agents has increased dramatically. We need to compare different methods to choose the most appropriate test for the specific target and situation. Evaluation of testing methods is becoming a science in itself; level of uncertainty, analytical and diagnostic sensitivity and specificity and predictive values are just some of the terms used to assess test performance.

How, then, does someone requesting a test judge merits of its results? What would give a trading partner confidence in lab tests?

Labs may participate in accreditation programs to provide assurance of the quality of their testing results. These programs provide third party evaluations and assessments of the systems in place to assure quality results. Accreditation programs vary from being test specific to assessing lab operational practices and may be recognized at the national or international level. While accreditation does not guarantee errors will never be made, it does ensure that labs have ongoing quality assurance processes in place, have evaluated the performance of their tests, have properly trained personnel performing the testing and have corrective procedures in place to deal with errors.

In 1997, the Food Safety Division (FSD) started down the accreditation road to provide assurances of the validity of our labs’ test results. This was a significant undertaking as it involved redesigning of processes, considerable staff training and a change in mindset of all personnel concerned. In September 2001, FSD labs achieved accreditation under ISO 17025. The ISO (International Organization for Standardization) was selected as the accrediting body because it is internationally recognized. Other versions of ISO (i.e. ISO 9001) focus on documentation, but ISO 17025 additionally incorporates assurance of the quality of lab testing performed.

The process does not end with attainment of accreditation. Rather, it is an ongoing process of continual quality monitoring and constant improvement. The processes associated with ISO 17025 are now the way of doing business in FSD labs. The re-accreditation of our labs this past June is a testament to the continuous improvement of our procedures.

Whether the challenge is BSE or some other risk agent threatening international trade, FSD labs provide credible laboratory testing that meets the requirements of internationally recognized standards.

E-mail: ken.manninen@gov.ab.ca

Surveillance/Research Update

Antimicrobial Resistance and Antimicrobial Use in Western Canadian Cow-Calf Herds: Study Update
Sheryl Gow¹, Cheryl Waldner¹, Margaret McFall², Andrijana Rajić²,³, Richard Reid-Smith³,⁴

¹ Western College of Veterinary Medicine, Saskatoon, SK
² Alberta Agriculture, Food and Rural Development, Edmonton, AB
³ Laboratory for Foodborne Zoonoses, Health Canada Guelph, ON
⁴ Dept. of Population Medicine, Ontario Veterinary College, Guelph, ON

Scientists from Alberta Agriculture, Food and Rural Development, Food Safety Division collaborated with Drs. Gow and Waldner, the study principals from the Western College of Veterinary Medicine as well as Health Canada researchers to evaluate prevalence and risk factors for antimicrobial resistant \( E. \ coli \) in western Canadian cow/calf herds. The study objectives and design were introduced in the March 2003 issue of the Animal Health Forum. This article provides the initial results on antimicrobial resistance (AMR) in beef calves.

The objective was to describe AMR patterns in calves from commercial Alberta and Saskatchewan cow-calf herds in the spring and the fall of 2002 using \( E. \ coli \) as an indicator organism. At spring calving, 1677 isolates (\( n = 559 \) calves from 92 herds) and at fall weaning 1186 isolates (\( n = 396 \) calves from 44 herds) were harvested from fresh fecal samples. The antimicrobial susceptibility of at least three \( E. \ coli \) isolates per sample was tested using microbroth dilution (Sensititre®, TREK Diagnostic Systems Inc., Cleveland, Ohio) and the 2002 National Antimicrobial Monitoring System (NARMS) panel.

Data on health, treatment history, fecal consistency, calf age and sex were collected. Levels of resistance are presented in the table below. In total, 49.5% of the spring isolates and 5.0% of the fall isolates had resistance to at least two antimicrobials. Initial analysis indicates that more resistance was detected in the spring isolates; therefore, seasonality, possibly related to antimicrobial usage (AMU) patterns, must be accounted for in studying AMR in western Canadian beef calves.
The preliminary results will be presented at the 2nd Agriculture Institute Food Safety Conference “From the Farm Gate to the Dinner Plate”, Edmonton, November 2003. Watch the Animal Health Forum for updates on the investigation of resistance profiles from cows and potential epidemiological associations between herd and animal AMU and the occurrence of AMR among fecal $E. \text{coli}$ isolates from calves and cows. This valuable and timely surveillance information regarding AMU and AMR in the western Canadian cow-calf industry will support appropriate and sound decisions regarding prudent AMU practices and future courses of action relating to AMU.

E-mail: andrijana.rajic@gov.ab.ca

The Alberta Food Safety Division Surveillance and Collaborative Research for Salmonella in Swine: Questions Addressed and Questions Remaining

Dr. Andrijana Rajic, Veterinary Scientist, Agri-Food Systems Branch, Food Safety Division, Edmonton AB

Salmonella is found worldwide in swine and pork and is considered the most important swine related zoonoses today.

Healthy swine can carry a broad range of Salmonella serotypes and be a source of contamination throughout the pork production and processing systems. In many countries, including Canada, the relationship between human illness and Salmonella contaminated pork is unclear, but in the European Union approximately 15 to 20% of human cases are attributed to pork. The public health aspect affects all segments of pork industry due to the economic impact of pork recalls and the impact of pork-related salmonellosis on human health. Major pork exporting countries are integrating Salmonella control programs into pork quality assurance programs. Denmark and the Netherlands recently reported a significant decrease of Salmonella incidence in pork using these programs and Canada may be expected to match their success.

Questions addressed: The Food Safety Division of AAFRD conducted two baseline studies related to Salmonella in swine. In the first study, Salmonella prevalence, serotypes and resistance profiles were investigated in Alberta swine at slaughter. $^{1(2)}$ Salmonella spp. were recovered from 35% (211/602) of cecal samples. The most common serotypes, California, Infantis, Derby, Mbandaka and Worthington, comprised 68.4% of all isolates. Resistance to streptomycin, sulfamethoxazole and tetracycline was relatively frequent but multi-resistant isolates were less common.

The second study was conducted on 90 swine operations representing ~ 25% of the Alberta annual market pig production. $^{2,3}$ The study objectives were to determine Salmonella farm prevalence and serotype distribution, risk factors associated with high Salmonella farm levels, and Salmonella susceptibility to 17 antimicrobial drugs. Most farms (~ 80%) were consistently low or moderately (<20% within farm prevalence-WFP) contaminated with Salmonella. This suggests that efforts targeted at those few farms (>20% WFP) that were highly contaminated (>20% WFP) with Salmonella may be effective in reducing the risk of carcass contamination. Relatively high Salmonella recovery from the farm environment indicated that it might contribute to the persistence of Salmonella infection within a farm.

More than 95% of the isolates belonged to the serogroups B, C1 or D1 indicating that the Danish ELISA test might detect most of the prevailing serotypes on these Alberta farms. The most common serotypes were Derby, Infantis and Typhimurium.

Preliminary analysis indicated that the type of feedstuff might be a risk factor for a high Salmonella farm level. Among 418 Salmonella isolates, 40.19% were susceptible to all antimicrobials. No resistance was observed to nalidixic acid, ciprofloxacin, amikacin and ceftriaxone. A low frequency of resistance (<5%) was observed to gentamicin, apramycin, cephaparin, ceftiofur, amoxicillin/clavulanic acid and trimethoprim-sulfamethoxazole. Most common resistances were detected to tetracycline (44.3%), streptomycin (29.7%), sulfamethoxazole (25.4%), kanamycin (15.1%) and ampicillin (10.4%).

<table>
<thead>
<tr>
<th>Antimicrobials</th>
<th>Spring Isolates %</th>
<th>Fall Isolates %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amoxicillin/clavulanic acid</td>
<td>4.7</td>
<td>0</td>
</tr>
<tr>
<td>Ampicillin</td>
<td>25.3</td>
<td>1.6</td>
</tr>
<tr>
<td>Ceftiofur</td>
<td>1.5</td>
<td>0</td>
</tr>
<tr>
<td>Cephalothin</td>
<td>7.2</td>
<td>0.6</td>
</tr>
<tr>
<td>Chloramphenicol</td>
<td>17.7</td>
<td>0.6</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>0.5</td>
<td>0</td>
</tr>
<tr>
<td>Kanamycin</td>
<td>22.8</td>
<td>1.1</td>
</tr>
<tr>
<td>Nalidixic acid</td>
<td>0.2</td>
<td>0</td>
</tr>
<tr>
<td>Streptomycin</td>
<td>0</td>
<td>2.8</td>
</tr>
<tr>
<td>Sulfamethoxazole</td>
<td>47.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Tetracycline</td>
<td>49.8</td>
<td>5.1</td>
</tr>
<tr>
<td>Trimethoprim-sulfamethoxazole</td>
<td>19.8</td>
<td>0.3</td>
</tr>
</tbody>
</table>
Questions remaining: Sampling protocols and laboratory tests for Salmonella surveillance in swine are not internationally standardized and harmonized, and are validated only to a limited extent. As a result, comparison of prevalence estimates within and among countries is almost impossible. The classification of swine herds in existing Salmonella control programs in swine is often based on practical capacity constraints and not on scientific arguments.(4)

The Food Safety Division of AAFRD, in collaboration with the Alberta swine industry, other agencies and universities, plans the following initiatives:

- Validate Salmonella laboratory culture, serology and PCR assays to understand their values and limitations for Salmonella surveillance programs in swine.
- Conduct epidemiological studies and risk assessments to determine risks of increased Salmonella in the pork production chain and to evaluate interventions.
- Develop the Salmonella fingerprint database for swine and pork to evaluate potential links to human isolates.

Surveillance and collaborative research information obtained from these studies will allow the Alberta swine industry to evaluate the existing and potential impacts of Salmonella on public health and market access. This will help to manage the issue and to guide intervention strategies in the most efficient and cost effective ways. In addition, feasible Salmonella monitoring and control programs could be integrated into a broader quality assurance program for pork production to demonstrate the safety of Alberta pork.

References

E-mail: andrijana.rajic@gov.ab.ca

Surveillance of Selected Antimicrobial Residues in Swine Slaughtered in Provincially Inspected Abattoirs in Alberta: Study Update

Julia Keenliside 1, Jim Henderson 2, Don Noot 3, Joe Kendall 4, Tom Thompson 5

1 Livestock Development Division, Alberta Agriculture, Food and Rural Development, #204 7000 - 113 Street, Edmonton, Alberta T6H 5T6
2, 3, 4, 5 Food Safety Division, Alberta Agriculture, Food and Rural Development, O.S.Longman Building, 6909 - 116 Street, Edmonton, Alberta T6H 4P2

The prevalence of detectable drug residues in federally inspected Canadian market hogs is extremely low, approximately less than 0.1%. However, today’s consumer often has zero tolerance for drug residues. Underweight (barbecue) animals are routinely tested for sulfamethazine at provincially inspected abattoirs in Alberta, but no previous data exists on the overall prevalence of drug residues in slaughtered swine. This study was designed to determine the prevalence of sulfonamide, tetracycline and beta-lactam residues in the sows, market hogs and underweight (barbecue) pigs slaughtered at provincially inspected facilities. The sulfonamide and beta-lactam residue results were reported in the March 2003 issue of the Animal Health Forum. The results of the tetracycline residue testing follow.

Eight hundred and four kidneys were analyzed for the presence of tetracycline residues. A number of kidneys contained detectable levels of tetracylines: 24 (3.0%) for tetracycline, 44 (5.5%) for oxytetracycline, and 133 (16.5%) for chlortetracycline, however, none of the tetracyclines were present at levels above their Maximum Residue Limit (MRL) allowed by Health Canada.

Implications: Drug residues in pork are still occurring at low levels. This study will assist producers in determining where residues are occurring and allow development of a surveillance program with a goal of zero prevalence.

E-mail: joe.kendall@gov.ab.ca
Food Safety Division Highlights

Alberta Johne’s Disease Control Program: Veterinary Accreditation and Continuing Education
Chunu Mainali, Surveillance Veterinarian, Food Safety Division, Edmonton AB

The Food Safety Division of Alberta Agriculture, Food and Rural Development, in conjunction with the Alberta Johne’s Working Group, designed and established a provincial veterinary accreditation program for veterinary practitioners in August 2001. Veterinary practitioners are required to obtain accreditation before they can participate in the Voluntary Johne’s Herd Status Program (VJHSP). Accreditation status is valid for three years.

During the last week of July 2003, two accreditation-training sessions were conducted for veterinary practitioners in Lethbridge and Airdrie. This training provided specific information regarding Johne’s disease issues in ruminants, description of the VJHSP for cattle, program logistics and updated and relevant information regarding the control of Johne’s disease. The training session was equivalent to three and half-hours of CE credit approved by the Alberta Veterinary Medical Association. The training sessions were well attended. Currently, 147 Alberta veterinarians are accredited for the VJHSP.

More information can be found on our website at: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/afs5602?opendocument

E-mail : ron.clarke@gov.ab.ca

Chief Provincial Veterinarian Report

From the desk of Dr. Gerald Ollis

West Nile Virus has arrived!

In the last issue of the Animal Health Forum, I advised you of the province’s West Nile Virus Response plan for 2003. The response plan was developed in anticipation of the incursion of West Nile Virus (WNV) into Alberta. As I write this column, there is no doubt about the arrival of the virus in Alberta. Alberta Environment is reporting WNV-positive pools of mosquitoes and over 210 positive wild birds have been detected. Fifty-nine infected horses have been detected, all of them as a result of practitioner examinations for exhibiting clinical signs attributed to WNV. We are awaiting the laboratory test results for over 60 more horses suspected of being sick with the virus.

Although several horses only exhibited mild illness, many horses have had variable signs of neurological disease. We are aware of several horses that have died or been euthanized. At this point in time, we have at least one horse confirmed with WNV in spite of having been vaccinated according to the manufacturers recommendations. Division staff are contacting the owners of affected horses in order to complete an epidemiological questionnaire. We hope to have the results of these interviews compiled, analyzed and available for the next issue of the Animal Health Forum.

There is still some confusion in the veterinary community as to the province’s role in WNV in horses. Horses suspected or confirmed of being infected with WNV must now be reported to the office of the Chief Provincial Veterinarian as per the Livestock Diseases Act. This notification can be by phone (780) 427-3448, by fax (780) 427-1437 or by E-mail (gerald.ollis@gov.ab.ca). Alberta Agriculture, Food and Rural Development (AAFRD) does not provide diagnostic services for suspected cases of WNV. However, Prairie Diagnostic Services, Central Laboratory for Veterinarians and Central Veterinary Pathology Laboratory are providing this service.

WNV in any species is immediately notifiable to the Canadian Food Inspection Agency (CFIA) as per the federal Health of Animals Act. The CFIA is expecting diagnostic laboratories in Canada to report these positive WNV diagnoses to them.

The status of WNV is Alberta horses is updated every Friday on AAFRD’s website http://www1.agric.gov.ab.ca. This site also contains a link to websites providing updated information on Alberta’s WNV surveillance in humans, wild birds and mosquitoes.

Environmental Issues

Biosecurity in Beef Cattle Operations
Ludovic Silasi, Agri-Food Systems Branch, Lethbridge AB

“The common disease prevention and control practices employed by the majority of beef herds today are inadequate to meet future demands. They rely on visual observation, regulatory compliance, vaccination and limited attention to biosecurity when animal additions are made to a herd.” – Anonymous

Biosecurity describes programs designed to prevent the introduction of pathogens (infectious agents such as viruses,
bacteria, prions and parasites) considered harmful to the health and well being of the herd.

Biosecurity measures occur at the federal, provincial and farm levels to protect animal and human health and economic health of the industry at the national level.

Infectious and parasitic diseases introduced into an operation can have devastating effects by:

- decreased reproduction efficiency
- decreased productivity
- increased morbidity
- increased mortality
- decreased cash flow and equity
- loss of marketing options – internationally and interprovincially.

A biosecurity program is like an insurance policy for the health and productivity of the herd. Producers, with the help of a qualified veterinarian, must make decisions about the risk tolerance level they will accept based on the chances of a disease occurring and the expected economic losses from the disease. When the risk tolerance level is determined, then appropriate risk management measures can be initiated.

Veterinarians must be an integral part of any biosecurity program. They are an important source of information on diseases, diagnostic testing and vaccination needs. Livestock producers must take every precaution possible to ward off all types of diseases that might possibly enter their livestock operation.

**What to Do?**

**Restrict Human Traffic to Farmstead**

- Display a sign at the farm gate stating that no one may enter the livestock operation unless accompanied by someone from the farm.
- Maintain the highest standard of hygiene for all movement on and off the farm.
- Supply a tub of disinfectant, (renew as needed) and a brush for scrubbing footwear.
- If people visit the farm, it is recommended that plastic boots, coveralls and other protective outwear be provided.
- Visitors should wash their hands before entering and after leaving the farm.
- Coveralls or other protective clothes and footwear worn on the farm should not be worn outside the farmstead. They should be washed and disinfected when necessary.

**Restrict Entry of Vehicles to Farmstead**

- Stop all non-essential vehicles from entering the farm and collect and deliver supplies at farm boundary.
- If a vehicle must enter the farmstead, ensure the vehicle wheels are sprayed with disinfectant prior to entry.
- Livestock haulers should disinfect and let the vehicles dry for as long as possible between loads.
- Identify an off-farm site for the farm livestock delivery and commercial pickup of animals for rendering. It is best if the entrance into the site does not intersect the exit for the rendering trucks.
- Postmortems and the opening of dead stock should not be performed in pens. A designated area for these procedures at the farm boundary is strongly recommended
- Keep records of all deliveries. In the event of a disease outbreak, record keeping of all deliveries may help in identifying the source of the outbreak.

**Record of Stock Movement on to and Off the Farm**

- New stock should be quarantined for 30 days from other animals and tested, as recommended by the farm veterinarian, prior to entry in the herd. During breeding and calving seasons, additions of new animals are not advised.
- Maintain detailed records of all stock movement on to and off the farm
- Each farm must be treated as a separate unit and animal movement between units (farms) should be recorded.
- Avoid contact of farm animals with animals in the vicinity (neighbours).

**Keep Dogs, Cats, Birds, Wild Game and Vermin Under Control**

Since domestic and wild animals and birds can serve as a source of disease for the herd, it is vitally important to make every effort for their elimination or control.

**Report to Your Veterinarian any Unusual Signs of Animal Sickness or Death**

Since control of any disease outbreak is greatly assisted by early detection and prevention of animal movement, it is important that livestock producers report unusual sickness or death to their veterinary practitioner.

**References**

- John G. Kirkpatrick DVM, Glenn Selk PhD: Biosecurity in Beef Cattle Operation.
- An Introduction to Infectious Disease Control on Farms (Biosecurity – A BAMN Publication, 2000).

E-mail: ludovic.silasi@gov.ab.ca
Who’s Who in the Division

Dr. Tom Inglis began working for Poultry Health Services Ltd. in June 2003 providing diagnostic and flock health consultation for Alberta poultry producers. He works at the O.S. Longman Building in Edmonton. Tom submits data generated from diagnostic and field investigations to the passive disease surveillance database for Alberta Agriculture, Food and Rural Development, Agri-Food Systems Branch.

Tom was born in Saskatoon and raised in Vermilion and Edmonton. He attended the U of A, completing a BSc. Ag. degree in 1999. He is a recent graduate from WCVM in Saskatoon where he received his DVM. His interest in poultry stems back to his involvement with the Alberta Poultry Research Center and poultry program at the U of A where he worked with Drs. Frank Robinson and Doug Korver. Tom has been able to participate in and present results from poultry nutrition and disease research done at the U of A and at the U of S over the last six years. He has had the opportunity to train under Drs. Jim Hanson and Detlef Onderka. Tom worked at the Aviagen Diagnostic Lab in Newton, Scotland and also completed an externship at the University of Georgia’s Poultry Diagnostic and Research Center. His primary areas of interest are preventative medicine, diagnostics and production management.

Tom is an avid fly fisherman and also enjoys hunting, hiking, camping, skiing, playing guitar and cooking.

E-mail: tom.inglis@gov.ab.ca

The Latest Info

Publications

Automation and ISO 17025 Test Validation of a *Toxoplasma Gondii* Antibodies Enzyme-Linked Immunosorbent Assay

John T. Y. Wu 1*, Lester S. Y. Wong 1, Eva Y. W. Chow 1, Evelyn E. Bowlby 1

1 Immunology Virology Unit, Biology Section, Agri-Food Laboratories Branch, Food Safety Division, Alberta Agriculture, Food and Rural Development, Edmonton, Alberta, Canada.

Abstract

The authors automated an enzyme-linked immunosorbent assay to detect porcine serum antibodies to *Toxoplasma gondii*. Two thousands swine sera can be assayed in two 8-hour shifts using a robotic workstation. The automated-ELISA programming is not complex and the test configuration is flexible. This high-throughput screening (HTS) a-ELISA can achieve a ten-fold increase (100 → 1000 tests) in test capacity over the manual method. The assay has been validated according to the requirements of the ISO/IEC 17025 standard. These include repeatability, reproducibility and optimal threshold value studies. Other requirements are proficiency panel testing, analyst training, standard operation procedure and equipment certifications.

E-mail: john.wu@gov.ab.ca

Accepted for publication in the Journal of the Association for Laboratory Automation (JALA Vol 8 Issue 5, October 2003).

Diversity, Frequency, and Persistence of *Escherichia coli* O157 Strains from Range Cattle Environments

Renter, D.G., Sargeant, J.M., Oberst, R.D., Samadpour, M.


Abstract

Genetic diversity, isolation frequency, and persistence were determined for *Escherichia coli* O157 strains from range cattle production environments. Over the 11-month study, analysis of 9,122 cattle fecal, 4,083 water source and 521 wildlife fecal samples resulted in 263 isolates from 107 samples presumptively considered *E. coli* O157 by culture and latex agglutination. Most isolates (90.1%) were confirmed as *E. coli* O157 by PCR detection of intimin and shiga-toxin genes. Pulsed-field gel electrophoresis of XbaI digestion revealed 79 unique patterns (XbaI/PFGE subtypes) from 235 typeable *E. coli* O157-confirmed isolates. The number of XbaI/PFGE subtypes, the variable frequency and persistence of subtypes, and the identification of identical subtypes in cattle feces, free-flowing water sources and wildlife feces indicate that the complex molecular epidemiology of *E. coli* O157 previously described for confined cattle operations is also evident in extensively managed range cattle environments.

The full abstract can be found at http://aem.asm.org/
Abstract

Enterohemorrhagic *Escherichia coli*, particularly the O157:H7 serogroup, have become worldwide public health concerns. Since cattle feces are often implicated as the source of *E. coli* O157 in human infections, considerable resources have been devoted to defining the epidemiology and ecology of *E. coli* O157 in cattle environments so control might begin at the farm level. Diagnostic limitations and the complexity of often interrelated microbial, animal, herd, environmental and production factors have hindered determination of the epidemiology, ecology and subsequent farm-level control of *E. coli* O157. The widespread distribution, transitory nature of fecal shedding, multiple potential environmental sources, lack of species specificity, and age-, feed- and temporal-related differences in cattle prevalence are documented. However, the significance and/or role of these factors in the epidemiology and ecology of *E. coli* O157 is still unclear. Cattle are a major source of *E. coli* O157, but it may be too simplistic to believe that most herds are relatively closed systems with small percentages of cattle serving as true reservoirs. Practical on-farm control may require explicit definitions of the seemingly complex system(s) and the microbial, animal, herd, environmental and productions factors involved in the multiplication, maintenance and transmission of *E. coli* O157.

E-mail: dave.renter@gov.ab.ca

Full article reprints are available from Dave Renter, Phone: (780) 422-1923