ECONOMIC IMPACT OF REPRODUCTIVE DISEASES IN BEEF CATTLE

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Cows that fail to conceive are typically the single biggest factor reducing net calf crop.[1,2] Widespread poor body condition (BCS <5) of the mature cow herd is a tell-tale sign that nutritional compromise is the likely culprit for this low reproductive efficiency.[3,4] Provided the bull battery is reproductively sound and exhibits good libido, cows in seemingly adequate body condition that exhibit poor reproductive performance should be examined for certain trace mineral (copper, zinc, and manganese) deficiencies or infectious or noninfectious diseases or toxicities.[5-9]

In vitro studies have shown that exposure of copper, zinc, and magnesium (as chelated CuATP, ZnATP, and MgATP) to a suspension of luteinizing hormone releasing hormone (LHRH) granules isolated from hypothalamic tissue resulted in seventeen-, six-, and twofold increases, respectively, in LHRH release.[5] This same biological process may become operational in vivo when more of these microelements appear incrementally in hypophyseal portal blood. Research trials have shown that enhanced reproductive performance can result from the use of organic sources of minerals.[5] Dietary supplementation of proteinated trace minerals has also been reported to improve embryo and/or fetal survival.[5]

Embryonic loss (defined as losses before day 45 gestation)[10] from infectious or noninfectious diseases is another potential cause for conception failure of cows and first-calf heifers. Infectious diseases causing infertility are characterized by multiple services per conception and/or frequent occurrence of a prolonged period between estrual periods after breeding.[6] Common etiologic agents include Trichomonas fetus, Neospora caninum, Campylobacter fetus venerealis, Brucella abortus, Hemophilus somnus, Ureaplasma, Mycoplasma spp., infectious bovine rhinotracheitis-infectious pustular vulvovaginitis (IBR-IPV) virus, and bovine virus diarrhea (BVD) virus.[6,7] When infectious disease is suspected as the cause of poor conception rates, these common etiologic organisms should be investigated prior to exploring more exotic pathogens. Vaccination of the cow herd for many of these infectious agents should improve the general resistance to any subsequent disease exposure. In some instances embryonic death occurs due to noninfectious causes (e.g. spontaneous luteal regression).[8] Noninfectious causes of embryonic death can be an important source of infertility in certain individual females but, generally, not from a herd infertility standpoint.

Fetal losses from abortions occur between the 45th day of gestation and the day of calving.[10] The most common causes of fetal losses during this stage of pregnancy include brucellosis, leptospirosis, campylobacteriosis, trichomoniasis, anaplasmosis, IBR-IPV, BVD-MD, and certain plant toxins (e.g. pine needle, locoweed, nitrates).[9] These etiologic organisms should be investigated prior to considering less common pathogens.

As mentioned above, a plethora of infectious and non-infectious diseases and toxicities can cause reproductive failure in beef cows. This paper will concentrate on the economic impact of only two diseases: BVD and Neospora caninum.

Bovine Viral Diarrhea

Bovine viral diarrhea (BVD) virus is nearly ubiquitous in our cattle population and is responsible for many different disease syndromes. There are numerous variables that interact in any specific outbreak of BVD associated disease to determine severity of losses. Some of the variables are strain of virus, vaccination status of herd, trace mineral status of herd, stocking density of herd, percentage of females that are in the more susceptible 2 and 3 year age group and the percentage of herd in the first and second trimesters of pregnancy. [11-20] Thus, severity of losses associated with the introduction of a persistently infected (PI) animal into a beef herd will vary tremendously with each herd situation.

Our understanding of the epidemiology of this disease predicts that disease losses would be the greatest in the first 12 months following the outbreak and then continue for years at a lower level. Even though disease losses would decline, production losses could continue to be substantial in subsequent years due to low weaning weights of calves from cows that became pregnant at the end of the breeding season following the initial outbreak and a higher than normal culling rate of those cows for non-pregnancy. Therefore, these losses in a naive beef herd in the first year following introduction of a PI animal form the basis for any economic analysis.

While there are hundreds of papers on the biology of BVD virus, the PI state and the pathology of the various syndromes associated with BVD virus infection, there have been few published studies showcasing the clinical details of outbreaks of BVD in beef herds. However, these few studies help predict the negative impact of an acute BVD outbreak on a beef herd's pregnancy rates and calving pattern, calf morbidity and mortality rates. Economic losses will result from: [11-20]

- a reduced calf crop percentage
- lower weaning weights
- higher calf treatment expenses
- higher culling rates for non-pregnancy

Reduced calf crop. Ample epidemiologic and biologic data show that BVD virus infection reduces pregnancy rates of cattle. Clinically, the more immunologically naive 2 and 3 year females are likely to be most severely affected.[11] The best data on the degree of decline in pregnancy rate due to an acute BVD outbreak from introduction of PI animals into a naive beef herd is 5%.[12] That figure is conservative because all the herds with PI calves in that study probably were not in the first year of an outbreak of BVD. That possibility is supported by the very low prevalence of PI calves in the positive herds of the study. Mathematical models predict that in a BVD outbreak there will be an initial peak of disease followed by low-level, chronic reproductive losses with a low prevalence of PI animals. [13] Based upon the aforementioned information, a 5% decrease in pregnancy rate due to BVD is a realistic estimate of the economic losses of BVD in a naïve beef herd.

Increased calf mortality. In an acute BVD outbreak, calf mortality between the time of pregnancy examination and weaning increases due to a combination of abortions, stillbirths, congenital defects in newborn calves, birth of weak calves, birth of PI calves and infectious disease in both PI and non-PI calves.[14] A 7% to 8% abortion rate was reported in one study of BVD virus-associated problems in a beef herd. This was probably due to fetal infection with BVD virus.[11] The proportion of PI calves born in reported acute outbreaks of BVD in beef herds has varied from 10% [11] to 42% [15] and appears to be around 6% in another study.[16] Although PI calves are treated for illness more than non-PI calves,[15] most of them live to weaning.[11] Mortality of PI calves is severe at the feedlot phase of beef production.[17] One PI calf can expose a high percentage of susceptible herdmates to BVD virus. BVD virus infection of non-PI calves can cause immunosuppression resulting in an increase in deaths from navel ill, septicemia, neonatal diarrhea and pneumonia. Limited information exists regarding the expected increase in illness to non-PI calves during a BVD outbreak. One study reports no difference in calf mortality rate in herds with or without PI animals.[12] Considering all the previously mentioned data, a conservative estimate of the increased proportion of a calf crop potentially lost from the introduction of a PI animal into a naive beef herd is 10%.

Calf morbidity will likely increase in a BVD outbreak due to subsequent illness in PI and non-PI calves. In one study, up to 75% of the PI calves required treatment for diarrhea and ill-thrift.[15] In another study, a 10% calf morbidity due to BVD and 1.4% calf mortality was observed in an outbreak of BVD in a range beef herd.[16] NAHMS data indicates that about 9% of beef calves are treated for scours between birth and weaning in the United States.[22] For this economic analysis, a conservative estimate of a 20% increase in the morbidity rate of calves and treatment costs during an acute BVD outbreak will be used.

Lower weaning weights. Four factors can contribute to lowering weaning weights of calves in a herd experiencing an acute BVD infection:[11,12,14-20] 1) lower weaning weights in PI calves versus non-PI calves, 2) lower weaning weights in BVD-infected non-PI calves versus non-infected non-PI calves, 3) temporary reduction in milk production or, possibly mastitis,[21] (translates to lower weaning weight in their calves) in cows ill due to acute BVD infection, and 4) in aftermath of uterine invasion of BVD and transient infertility or abortion, more cows becoming pregnant late in the breeding season and subsequently calving later (translates into lower weaning weight in their calves).

A valid measurement of the negative impact of a BVD outbreak on weaning weights requires a better comparison of weaning weights of PI to non-PI animals than has been reported.[11,16] Actual weaning weights instead of 205-day adjusted weaning weights must be considered. For example, when considering a cow herd that historically sees each cow, on average, wean a 500 lb calf at eight months of age (240 days), a change in median calving date of only 2.4 days later in the calving season will decrease calf weaning weights in this herd by 1%. Conservatively, a 3% reduction in weaning weight due to an acute outbreak of BVD is realistic to use in an economic model.

Increased numbers of open cows. There will likely be an increase in the number of cows culled in a BVD outbreak due to non-pregnancy and, possibly, other cows culled because of overt illness due to the immunosuppressive effect of BVD. A 5% increase in the number of cows culled (the percentage increase in non-pregnant cows noted in reference 12) will be used in this economic analysis.

Attendees of this seminar will be shown an electronic spreadsheet (Excel – Microsoft Corporation) that incorporates the aforementioned parameters into an economic analysis of the estimated monetary loss from an acute BVD infection in a naïve beef herd. Copies of the economic analysis template will be available.

Neosporosis

Reports of *Neospora caninum* as a cause of reproductive failure in cattle first appeared in the late 1980's.[23] Exposure to this coccidian parasite is widespread in U.S. dairy and beef cattle. According to a National Animal Health Monitoring System (NAHMS) study, approximately 10% and 11% of dairy cows and beef cows, respectively, tested positive to *N. caninum* antibody.[23] The NAHMS data further indicated that at least one animal tested positive in 75% of the dairy herds and 60% of the beef herds.

The production losses and economic consequences of this disease in U.S. livestock have been characterized best in dairy cattle. Although the ability to conceive is unaltered, a persistent asymptomatic infection occurs. Many infected cows may abort in the face of initial infection and in subsequent pregnancies. Reduced milk production and premature culling are also observed consequences of *N. caninum* infection in these cows. Rarely, calves born to infected dairy cows may have neurologic signs, hind and/or forelimb flexural/extensor abnormalities, may be underweight, or unable to rise.[23]

Economic losses have been estimated for the California dairy industry.[23] Abortion is estimated to cost the producer $500-900/hd. Considering additional monetary losses from milk production and premature culling, the overall financial loss is approximately $35 million annually.

In beef cattle, less is known about the production losses attributed to *N. caninum* infection at the herd level. Results have been reported for a 4-year study of *N. caninum* infection in 419 cows from 8 beef herds (total = 1239 cows) in central Alberta, Canada.[24] Similar to dairy cows,[25,26] infection did not prevent a beef cow from conceiving, but seropositive cows were at increased risk of abortion and stillbirths as well as being culled prematurely.

The following epidemiologic information forms the basis of an economic model to estimate the economic losses to a beef herd from a *N. caninum* infection:

- Prevalence of *N. caninum* within the herd
- Relative risk of increased abortions in infected cows
- Relative risk of increased stillbirths in infected cows
- percentage of aborting cows that are culled

The best available relative risk information regarding this disease in beef cattle comes from the aforementioned work of Waldner and co-workers.[24] In the economic model to be demonstrated to attendees of this seminar, the relative risk number used for abortions and stillbirths was 5.7 and 2.8, respectively. For example, a 5.7 fold increased relative risk of abortion means that a cow that becomes infected with Neospora caninum is 5.7 times more likely to abort than a pregnant herdmate that is not infected. Prevalence of *N. caninum* within a beef herd was set at 11%. This level of infection is typical for North American beef herds.[23] The cull rate was arbitrarily set at 50%, i.e. one-half of the aborting cows were culled.

Attendees of this seminar will be shown an electronic spreadsheet (Excel – Microsoft Corporation) that incorporates the aforementioned parameters into an economic analysis of the estimated monetary loss from a *Neospora caninum* infection in a beef herd. Copies of the economic analysis template will be available.

References

1. Wiltbank JN, Warwick E J, Vernon E H, et al: Factors affecting net calf crop in beef cattle. *J Anim Sci* 1961; 20:409-415.

2. Bellows RA: Factors affecting losses at calving. *Proceedings Short Course for Veterinarians, Colorado State University*, Ft. Collins, Co. 1973; pp 69-84.

3. Corah L: Meeting the energy requirements of beef cows. *Vet Med* 1995; 90:203-210.

4. Rae DO: Herd factors, parity, and body condition score of beef cattle: diagnostic adjuncts to pregnancy examination. *Compend Contin Educ Pract Vet* 1992; 14:256-262.

5. Greene LW, Kasari TR, Herd D: Organic sources of mineral for ruminants: A review. *Vet Clin Nutr* 1995; 2:22-27.

6. Roberts SJ: Infertility in the cow. *Veterinary Obstetrics and Genital Diseases Theriogenology*, 3rd Ed. (S.J. Roberts, ed.) S.J. Roberts Publishing, Woodstock, Vt., 1986; pp 434-575.

7. Barr BC, Dubey, JP, Lindsay, DS, et al: Neosporosis: Its prevalence and economic impact. Veterinary Exchange. *Compend Contin Educ Pract Vet* (Suppl) 1998; 201:1-16.

8. Kastelic JP: Noninfectious embryonic loss in cattle. *Vet Med* 1994; 89:584-589.

9. Roberts SJ: Diseases and accidents during the gestation period. *Veterinary Obstetrics and Genital Diseases Theriogenology*, 3rd Ed. (S.J. Roberts, ed.) S.J. Roberts Publishing, Woodstock, Vt., 1986; pp 123-244.

10. Hubbert WT, Dennis SM, Adams WM, et al: Recommendations for standardizing bovine reproductive terms. *Cornell Vet* 1972; 62:216-237.

11. Taylor LF, Janzen ED, Van Donkersgoed, J: Losses over a 2-year period associated with fetal infection with the bovine diarrhea virus in a beef cow-calf herd in Saskatchewan. *Can Vet J* 1997; 38:23-28.

12. Wittum TE, Grotelueschen DM, Brock KV, et al: Persistent bovine viral diarrhea virus infection in US beef herds. *Prev Vet Med* 2001; 49:83-94.

13. Cherry BR, Reeves MJ, Smith G: Evaluation of bovine viral diarrhea virus control using a mathematical model of infection dynamics. *Prevent Vet Med* 1998; 33:91-108.

14. Wooodard LF: BVD virus associated with outbreaks of abortion, stillbirths, and weak calves. *Vet Med* 1994; 89:379-384.

15. Holland RE, Brezek DM, Sprecher DJ, et al: Investigation of an epizootic of bovine diarrhea virus infection in calves. *J Am Vet Med Assoc* 1993; 202:1849-1854.

16. Kelling CL, Stine LC, Rump KK, et al: Investigation of bovine viral diarrhea virus infections in a range beef cattle herd. *J Am Vet Med Assoc* 1990; 197:589-593.

17. Taylor LF, Janzen ED, Ellis JA, et al: Performance, survival, necropsy, and virological findings from calves persistently infected with the bovine diarrhea virus originating from a single Saskatchewan beef herd. *Can Vet J* 1997; 38:29-37.

18. McDermott JJ, Alves DM, Anderson NG, et al: Measures of herd health and productivity in Ontario cow-calf herds. *Can Vet J* 1991; 32:413-420.

19. Rogers RW, Martin SW, Meek AH: Reproductive efficiency and calf survival in Ontario beef cow-calf herds. Ca*n J Comp Med* 1985; 49:27-33.

20. Swecker WS, Allison MN, Bolin SR: Yype 2 bovine virus diarrhea virus infection in a closed herd of Simmental cattle. *Compend Contin Educ Pract Vet* 1997; 19:S79-S83.

21. Riskanen R, Emanuelson U, Sunberg J, et al: Effects of infection with bovine virus diarrhoea virus on health and reproductive performance in 213 dairy herds in one county in Sweden. *Vet Prevent Med* 1995; 23:229-237.

22. National Animal Health Monitoring System (NAHMS) Beef Cow/Calf Health and Productivity Audit, Part 3: beef Cow/Calf Health and Health Management, pp36-37, January 1994.

23. Barr BC, Dubey, JP, Lindsay, DS, et al: Neosporosis: Its prevalence and economic impact. Veterinary Exchange. *Compend Contin Educ Pract Vet* (Suppl) 1998; 201:1-16.

24. Waldner CL, Janzen ED, Ribble CS: Determination of the association between *Neospora caninum* infection and reproductive performance in beef herds. *J Am Vet Med Assoc* 1998; 213:685-690.

25. Pare J, Thurmond MC, Hietala SK: *Neospora caninum* antibodies in cows during pregnancy as a predictor of congenital infection and abortion. *J Parasitology* 1997; 83:82-87.

26. Thurmond MC, Hietala SK: Effect of congenitally acquired *Neospora caninum* infection on risk of abortion and subsequent abortions in dairy cattle. *Am J Vet Res* 1997; 58:1381-1385.